# Lake Lynn Hydroelectric Project

# FERC No. 2459

# Exhibit C

# Construction History

## TABLE OF CONTENTS



## LIST OF TABLES

# 1.0 CONSTRUCTION HISTORY

The first phase of the construction of the Lake Lynn Project began in 1912. During the period between 1912 and 1913, the following areas of the dam were constructed: the east bulkhead between stations 8+91 and 10+13; the powerhouse substructure between stations 7+55.5 and 8+91; a portion of the Trash Chutes between sections 7+11 and 7+55.5; and varying parts of the spillway between stations 6+64 and 7+11. Work on the dam was suspended in 1913 due to financial and war conditions. When construction was resumed in 1925, the earlier work was incorporated into the completed structure. The first unit was placed in operation on May 31, 1926.

Table 1 provides a summary of the construction history at the Lake Lynn Project.

**Table 1 Summary of Construction History at the Lake Lynn Project**

| Year(s) | Activity |
|---|---|
| 1912-1913 | The first phase of construction. Construction halted due to financials and war conditions. |
| 1925-1926 | Construction was resumed in 1925, the earlier work was incorporated into the completed structure. The first unit was placed in operation on May 31, 1926. |
| 1926 | Construction of protection for the west bank. |
| 1951 | Two 48" low-level outlet valves were embedded with concrete, and the low-level outlet tunnels were filled with concrete. |
| 1953 | The height of east and west bulkheads increased, and length extended into the abutments. |
| 1956 | Concrete repairs were made to tailrace east retaining wall and the wall extending downstream from the baffle wall. |
| 1961 | The wall in the log sluice section at the west end of the dam was replaced with a reinforced concrete wall. Significant repairs to the concrete surfaces of the spillway were made in the early 1960s. |
| 1972 | A total of 16 post-tensioned anchors were installed in the east bulkhead. |
| 1978 and 1988 | West abutment grout bags installed. |
| 1990 | Following the first safety inspection report, sixteen 705-kip post-tensioned anchors were installed through the east bulkhead to improve stability in this section. As the result of subsequent stability analyses, 75 additional rock anchors were installed in 1990. These anchors were installed in the west bulkhead, spillway, and east bulkhead sections and ranged in capacity from approximately 550 kips to 2040 kips. The purpose of these anchors was to make the structures stable for the PMF. |

| Year(s) | Activity |
|---|---|
| 2004-2006 | Extensive Tainter gate remediations were performed to replace corroded members with significant section loss. All Tainter gate chains were replaced and the gate hoists were upgraded. |
| 2007 | Reestablishment of six spillway deck expansion joints. |
| 2011-2012 | Removal of the trash gate house and replacement of the two trash bay gates with a hydraulic cylinder operated wider trash gate. Removal of the center sluice wall. Installation of west upstream trash boom. |
| 2018 | Turbine replacement and upgrade of turbine unit 2. |
| 2021 | Re-establishment of the 6 expansion joints on the deck of the gated spillway. The joint at gate 13 was added to the project to alleviate buckling at this location. Joint 1 which is located at the west bulkhead/bay 26 was not included in the project due to ongoing plans to repair the beam seat. |

## 2.0 PROJECT SCHEDULE OF NEW DEVELOPMENT

The Lake Lynn Project is an existing development, and no new construction or modification of any Lake Lynn Project structures is proposed at this time.

# Lake Lynn Hydroelectric Project

# FERC No. 2459

# Exhibit D

# Statement of Costs and Financing

## TABLE OF CONTENTS



## LIST OF TABLES

# 1.0 ORIGINAL COST OF EXISTING UNLICENSED FACILITIES

This section is not applicable to the Lake Lynn Hydroelectric Project (Lake Lynn Project) because Lake Lynn Generation, LLC (Lake Lynn or Licensee) is not applying for an initial (original) license.

# 2.0 ESTIMATED AMOUNT PAYABLE UPON TAKEOVER PURSUANT TO SECTION 14 OF THE FEDERAL POWER ACT

Under Section 14(a) of the Federal Power Act (FPA), the federal government may take over any project licensed by the Federal Energy Regulatory Commission (FERC or Commission) upon the expiration of the original license. The Commission may also issue a new license in accordance with Section 15(a) of the FPA. If such a takeover were to occur upon expiration of the current license, the Licensee would have to be reimbursed for the net investment, not to exceed fair value, of the property taken, plus severance damages. To date, no agency or interested party has recommended a federal takeover of the Lake Lynn Project pursuant to Section 14(a) of the FPA.

## 2.1 Fair Value

The fair value of the Lake Lynn Project is dependent on prevailing power values and license conditions, both of which are currently subject to change. The best approximation of fair value would likely be the cost to construct and operate a comparable power generating facility. Because of the high capital costs involved with constructing new facilities and the increase in fuel costs associated with operation of such new facilities (assuming a fossil fueled replacement), the fair value would be considerably higher than the net investment amount. If a takeover were to be proposed, the Licensee would calculate fair value based on then-current conditions.

## 2.2 Net Investment

The FPA defines “net investment” as the original cost, plus additions, minus the sum of the following items (to the extent that such items have been accumulated during the period of the license from earnings in excess of a fair return on such investment): (a) unappropriated surplus; (b) aggregate credit balances of current depreciated accounts; and (c) aggregate appropriations of surplus or income held in amortization, sinking fund, or similar reserves.

The net book investment for the Lake Lynn Project is approximately $96,610,000 as of the end of 2021.

### 2.3 Severance Damages

Severance damages are not clearly defined in the FPA or its implementing regulations and many principles applicable in determining this component of takeover compensation are uncertain and can only be estimated. However, Lake Lynn believes that potential severances inflicted by a takeover of the Lake Lynn Project would be significant. Therefore, given the challenges of estimating damages associated with severance, Lake Lynn is reserving the right to provide the Commission with such an estimate should the Commission consider a federal takeover of the Lake Lynn Project.

## 3.0 ESTIMATED COST OF NEW DEVELOPMENT

### 3.1 Land and Water Rights

The Licensee is not proposing to expand land or water rights as a consequence of this license application.

### 3.2 Cost of New Facilities

The Licensee is not proposing any capacity related developments for the Lake Lynn Project.

## 4.0 ESTIMATED AVERAGE ANNUAL COST OF THE PROJECT

The estimated average annual cost of the Lake Lynn Project is approximately $6,842,548. This estimate includes local, state, and federal taxes, depreciation and amortization, and operation and maintenance expenses.

### 4.1 Capital Costs

Capital costs are based on a combination of funding mechanisms that may include contributions from Lake Lynn parent company, debt issuances, revolving credit lines, cash from operations, or other sources of funding. In 2021, the capital cost was approximated to be 5.9 percent of the annual cost.

### 4.2 Taxes

In 2021, Lake Lynn paid approximately $332,361 in local, state, and federal taxes.

### 4.3 Depreciation and Amortization

In 2021, the annualized composite rate of depreciation for the Lake Lynn Project was approximately 3.1 percent.

### 4.4 Operation and Maintenance Expenses

The estimated annual operation and maintenance expenses at the Lake Lynn Project in 2021 were approximately $2,248,374.

### 4.5 Costs of Proposed Environmental Measures

Table 1 provides a summary of the estimated costs of Lake Lynn's proposed protection, mitigation and enhancement (PME) measures, including estimated capital cost, estimated annual operation and maintenance costs, and estimated lost generation (MWh). The PME measures proposed in this application will result in approximately $97,500 in capital costs and the annual cost of operations and maintenance (O&M) of the Lake Lynn Project to be approximately $363,000 annually.

**Table 1 Estimated Costs of Proposed PME Measures**

| Proposed Protection, Mitigation, and Enhancement Measure | Capital Cost ($2022) | Annual O&M Cost ($2022) |
|---|---|---|
| Develop and implement an Operation Plan | $10,000 | $35,000 |
| Develop and implement a Water Quality Monitoring Plan | $7,500 | $15,000 |
| Continue to provide public recreation access at the existing Lake Lynn Project recreation facilities | $0 | $143,000 |
| Develop and implement updated Recreation Management Plan, including Sunset Beach Marina Public Boat Launch Water Depth Monitoring | $25,000 | $155,000 |
| Develop and implement a Shoreline Management Plan | $25,000 | $10,000 |

| Proposed Protection, Mitigation, and Enhancement Measure | Capital Cost ($2022) | Annual O&M Cost ($2022) |
|---|---|---|
| Develop and implement a Historic Properties Management Plan | $30,000 | $5,000 |

## 5.0 ESTIMATED ANNUAL VALUE OF PROJECT POWER

The estimated value of power for the Lake Lynn Project in 2023 is $62.73/MWh (energy only) based on expected generation of 127,047 MWh.

## 6.0 SOURCES AND EXTENT OF FINANCING

Capital projects are financed using cash flow from operations and as necessary, additional debt obligations, or equity injections. Based on the value of Lake Lynn Project power described in Section 5, *Estimated Annual Value of Project Power,* the Lake Lynn Project will have adequate financial resources to meet the costs of operations for the term of the new license.

## 7.0 COST TO DEVELOP THE LICENSE APPLICATION

The estimated cost to prepare the application for a new license for the Lake Lynn Project is approximately $307,000.

## 8.0 ON-PEAK AND OFF-PEAK VALUES OF PROJECT POWER

The estimated on-peak value of power generated in 2023 is $62.73/MWh (energy only). The Lake Lynn Project runs very little during off-peak times (approximately 5 percent of time).

## 9.0 ESTIMATED AVERAGE ANNUAL INCREASE OR DECREASE IN GENERATION DUE TO CHANGE IN PROJECT OPERATIONS

Lake Lynn is proposing to operate the Lake Lynn Project as currently licensed during the next license term. Therefore, estimates of the average annual increase or decrease in generation or the value of Lake Lynn Project power are not applicable at this time.

# Lake Lynn Hydroelectric Project

# FERC No. 2459

# Exhibit E

# Environmental Exhibit

# TABLE OF CONTENTS

## LIST OF TABLES

## LIST OF FIGURES

## LIST OF PHOTOS

## LIST OF APPENDICES

## ACRONYM LIST

| | |
|---|---|
| **A** | |
| ADA | Americans with Disabilities Act |
| AMD | acid mine drainage |
| Applicant | Lake Lynn Generation, LLC |
| **B** | |
| BCC | Birds of Conservation Concern |
| **C** | |
| °C | degrees Celsius ( |
| cfs | cubic feet per second |
| CLEAR | Cheat Lake Environment and Recreation Association |
| COVID-19 | Coronavirus Disease 2019 |
| CPUE | catch per unit effort |
| CSRV | Cumberland and Southern Ridge Valley |
| CWA | Clean Water Act |
| CZMA | Coastal Zone Management Act |
| **D** | |
| DLA | Draft License Application |
| DO | dissolved oxygen |
| **E** | |
| Eagle Creek | Eagle Creek Renewable Energy, LLC |
| eDNA | environmental DNA |
| EFH | Fish Habitat |
| EPRI | Electric Power Research Institution |
| ESA | Endangered Species Act |
| **F** | |
| °F | degrees Fahrenheit |
| FERC / Commission | Federal Energy Regulatory Commission |
| FLA | Final License Application |
| FOC | Friends of the Cheat |
| FPA | Federal Power Act |
| **G** | |
| GIS | geographic information system |

**H**

| | |
|---|---|
| HUC | Hydrologic Unit Code |

**I**

| | |
|---|---|
| IPaC | Information for Planning and Consultation |

**L**

| | |
|---|---|
| Lake Lynn | Lake Lynn Generation, LLC |
| Lake Lynn Project | Lake Lynn Hydroelectric Project |

**M**

| | |
|---|---|
| Mg/l | milligrams per liter |
| MRTC | Monongahela River Trails Conservancy |
| MW | megawatts |
| μS/cm | microsiemes per centimeter |

**N**

| | |
|---|---|
| NEPA | National Environmental Policy Act |
| NGVD | National Geodetic Vertical Datum |
| NHPA | National Historic Preservation Act |
| NLEB | northern long-eared bat |
| NMFS | National Marine Fisheries Service |
| NOAA | National Oceanic and Atmospheric Administration |
| NOI | Notification of Intent |
| NPDES | National Pollution Discharge Elimination System |
| NRCS | Natural Resources Conservation Service |
| NRHP | National Register of Historic Places |
| NVA | nature viewing areas |
| NWI | National Wetland Inventory |

**O**

| | |
|---|---|
| O&M | operations and maintenance |

**P**

| | |
|---|---|
| PAD | Pre-application Document |
| PADCNR | Pennsylvania Department of Conservation and Natural Resources |
| PADEP | Pennsylvania Department of Environmental Protection |
| PASHPO | Pennsylvania State Historic Preservation Office |
| PFBC | Pennsylvania Fish and Boat Commission |
| PHMC | Pennsylvania Historical and Museum Commission |
| PME | protection, mitigation, and enhancement |

| | |
|---|---|
| PNHP | Pennsylvania Natural Heritage Program |

**R**

| | |
|---|---|
| REA | Ready for Environmental Analysis |
| RM | river miles |
| RTE | rare, threatened, and endangered |

**S**

| | |
|---|---|
| SMP | Shoreline Management Plan |

**T**

| | |
|---|---|
| TBSA | Turbine Blade Strike Analysis |
| TCP | Traditional Cultural Properties |
| TLP | Traditional Licensing Process |

**U**

| | |
|---|---|
| USACE | United States Army Corps of Engineers |
| U.S.C. | United States Code |
| USEPA | U.S. Environmental Protection Agency |
| USFWS | U.S. Fish and Wildlife Service |
| USGS | U.S. Geological Survey |

**W**

| | |
|---|---|
| WVDEP | West Virginia Department of Environmental Protection |
| WVDNR | West Virginia Division of Natural Resources |
| WVSHPO | West Virginia State Historic Preservation Office |
| WVU | West Virginia University |
| WWF | Warm Water Fishes |

# 1.0 INTRODUCTION

## 1.1 Project Overview

Lake Lynn Generation, LLC (Lake Lynn, Licensee, or Applicant), a subsidiary of Eagle Creek Renewable Energy, LLC (Eagle Creek), is the owner and operator of the Lake Lynn Hydroelectric Project (FERC No. 2459) (Lake Lynn Project). The current Federal Energy Regulatory Commission (FERC or Commission) license for the Lake Lynn Project was issued on December 27,1994 and expires on November 30, 2024. Lake Lynn must file its final license application (FLA) for a new license with FERC no later than November 30, 2022.

The Lake Lynn Project is located on the Cheat River in Monongalia County, West Virginia and Fayette County, Pennsylvania, approximately 10 miles northeast of Morgantown, West Virginia. The Lake Lynn Project is located about 3.7 miles upstream of the confluence with the Monongahela River. Figure 1.1 provides the general location of the Lake Lynn Project. The Lake Lynn Project does not use any federal facilities and occupies no federal lands. The Lake Lynn Project is not located within any town or city.

The Lake Lynn Project is operated as a dispatchable peaking hydroelectric facility with storage capability. The Lake Lynn Project generating capacity is 51.2 megawatts (MW).

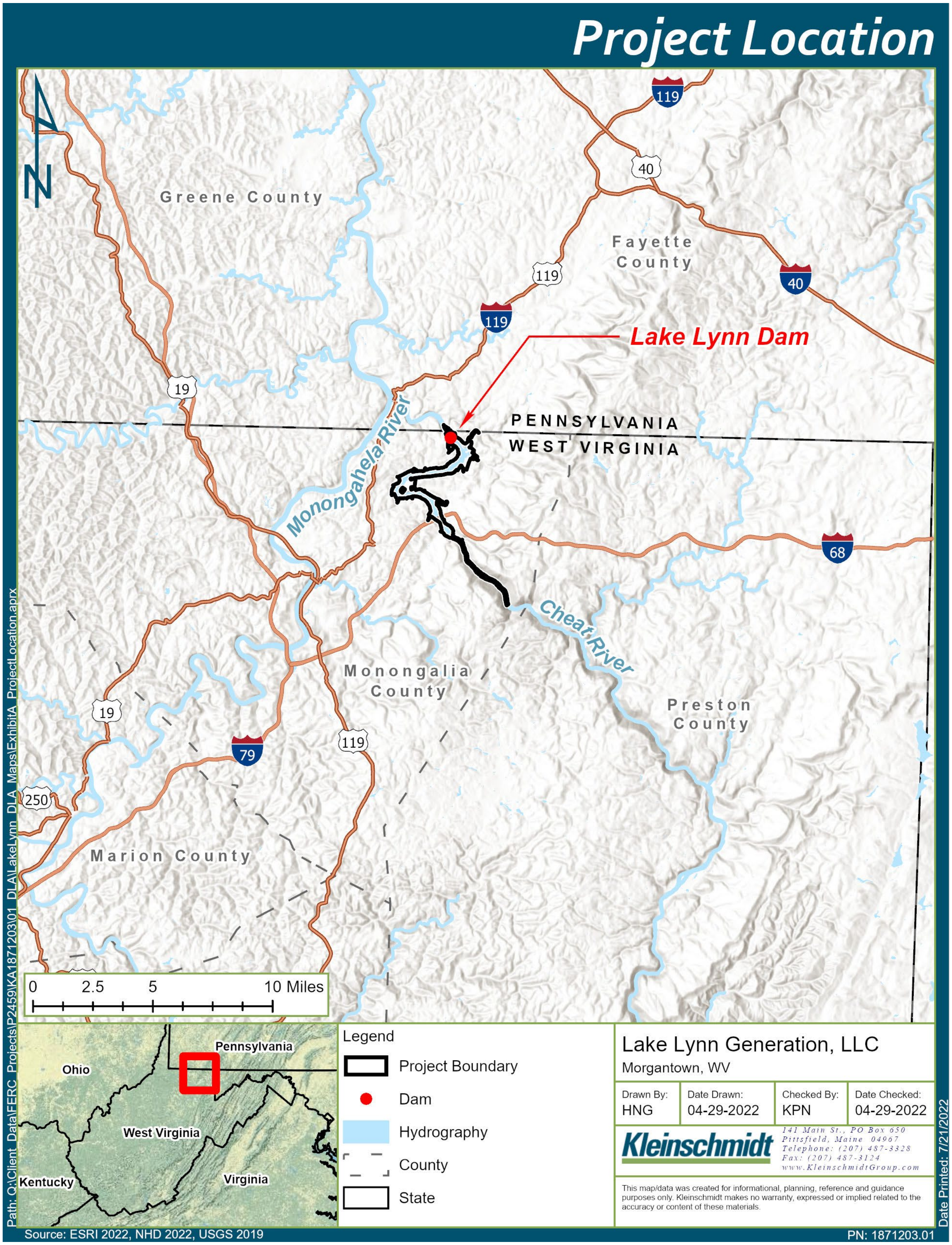


**Figure 1.1 Location of the Lake Lynn Project**

## 1.2 Pre-Filing Consultation Summary

### 1.2.1 Stage 1 Consultation

On August 29, 2019, Lake Lynn filed a Notification of Intent (NOI), a Pre-application Document (PAD), and requested to use the Traditional Licensing Process (TLP) and designation as the non-federal representative for purposes of consultation under Section 7 of the Endangered Species Act (ESA) and Section 106 of the National Historic Preservation Act (NHPA). Prior to filing the NOI and PAD, Lake Lynn initiated consultation with resource agencies, Tribes, and other interested parties to inform them of the Lake Lynn Project relicensing and development of the PAD and to solicit their input. On October 17, 2019, FERC granted approval for Lake Lynn to use the TLP, and authorization for Lake Lynn to act as non-federal representative for ESA and Section 106 NHPA consultation.

Lake Lynn published notice of the NOI and PAD in the *Herald Standard* and *The Dominion Post*, two daily newspapers of general circulation in Monongalia County, West Virginia and Fayette County, Pennsylvania. On November 21, 2019, pursuant to 18 Code of Federal Regulation (CFR) § 16.8(b)(3), Lake Lynn provided written notice to FERC and the Lake Lynn Project Distribution List of its Joint Meeting and Site Visit for the relicensing of the Lake Lynn Project. In accordance with the requirements of 18 CFR.§ 16.8(i), Lake Lynn published notice of the Joint Meeting and Site Visit in the *Herald-Standard* (a daily newspaper of general circulation in Fayette County, Pennsylvania) and *The Dominion Post* (a daily newspaper of general circulation in Monongalia County, West Virginia).

Lake Lynn held a Joint Meeting and site visit for the Lake Lynn Project on December 12, 2019. The purpose of the meeting was to: (1) provide information about the Lake Lynn Project and licensing process; (2) solicit information regarding the existing environmental resources associated with the Lake Lynn Project and data that may need to be obtained; and (3) obtain agency and stakeholder opinions regarding the Lake Lynn Project and its potential effect on existing resources.

### 1.2.2 Stage 2 Consultation

Appendix A provides copies of consultation and comments received from agencies and stakeholders.

Lake Lynn initiated the relicensing process in August 2019 by filing a NOI and PAD At the same time, Lake Lynn requested FERC approval to use the TLP. FERC approved the use of the TLP in October 2019, and in accordance with FERC regulations, Lake Lynn held a Joint Meeting and Site Visit in December 2019. Following the Joint Meeting and Site Visit, resource agencies and other stakeholders were afforded the opportunity to comment on the PAD and to request resource studies that they deemed were needed to evaluate Lake Lynn Project impacts on natural, cultural, and recreational resources.

In response to the NOI/PAD filing and the Joint Meeting and Site Visit, Lake Lynn received written comments and study requests from the U.S. Fish and Wildlife Service (USFWS), West Virginia Division of Natural Resources (WVDNR), Cheat Lake Environment and Recreation Association (CLEAR), Friends of the Cheat (FOC), Monongahela River Trails Conservancy (MRTC), and individual residents in the local community.

Based on the comments received, Lake Lynn developed and distributed a draft Study Plan to the resource agencies and stakeholders on April 15, 2020, for review. Lake Lynn held a conference call/meeting on April 24, 2020, to review and discuss the draft Study Plan. The draft Study Plan was revised based on the discussions and a revised Study Plan was distributed to resource agencies and stakeholders and then finalized and distributed in September 2020 to include changes to the mussel survey as a result of the development for a survey plan for the mussel survey.

The draft study reports for the Desktop Fish Entrainment Assessment, Tailwater Mussel Survey, and Recreation Site Enhancement Feasibility and Assessment were provided to the relicensing stakeholders in January 2021, January 2021, and July 2021, respectively. In addition, the annual shoreline erosion surveys, annual water quality monitoring reports, the Aquatic Habitat Enhancement and Monitoring under the Aquatic Biomonitoring Plan (submitted as part of the Aquatic Biomonitoring Plan annual report) and the American Eel Environmental DNA Sampling (submitted as part of the Aquatic Biomonitoring Plan annual report) were provided to the relicensing stakeholders upon filing with FERC. A summary of all studies completed are included in Table 1.1.

**Table 1.1 Summary of Studies Completed**

| Study Name | Date Completed |
|---|---|
| Desktop Fish Entrainment Assessment | January 2021 |
| Tailwater Mussel Survey | December 2020 |
| Recreation Site Enhancement Feasibility and Assessment | June 2021 |
| American Eel Environmental DNA Sampling | September 2021 |
| Streamflow Data Collaboration | Collaboration completed September 2020 |
| Aquatic Biomonitoring Plan: Aquatic Habitat Enhancement and Monitoring | December 2020 |
| Aquatic Biomonitoring Plan: Angler Creel Survey | Ongoing (to be completed December 2022) |
| Shoreline Classification and Aquatic Habitat Mapping | 2021 (results will be used for development of Shoreline Management Plan) |

### 1.2.3 Comments on the Draft License Application

The Draft License Application (DLA) was filed with FERC and sent via email to interested stakeholders for review and comment on August 5, 2022 with stakeholder comments due by November 7, 2022. Lake Lynn received comments from FERC (letter dated November 3, 2022), the Unites States Department of the Interior Bureau of Indian Affairs (letter dated September 8, 2022), WVDNR (letter dated November 7, 2022), and CLEAR (email dated November 8, 2022). Appendix B provides Lake Lynn's responses to comments and how comments have been addressed in the FLA, as appropriate.

### 1.2.4 Purpose of Draft License Application

The purpose of this Environmental Exhibit is to describe: (1) the existing and proposed project facilities, project lands, and waters; (2) existing and proposed project operations and maintenance, including protection, mitigation, and enhancement (PME) measures for each resource area potentially affected by the relicensing; and (3) to provide a draft analysis of the effects of the proposed relicensing on each environmental resource. Lake Lynn proposes to continue to operate the Lake Lynn Project under existing conditions, no new facility construction is proposed, and proposed PME measures are provided in Section 3.2.2, *Proposed Environmental Measures*.

# 2.0 STATUTORY AND REGULATORY REQUIREMENTS

## 2.1 Federal Power Act

Issuance of a new license for the Lake Lynn Project is subject to requirements under the Federal Power Act (FPA) and other federal statutes. Requirements applicable to this DLA are summarized in the following sections.

### 2.1.1 Section 18 Fishway Prescriptions

Under Section 18 of the FPA, USFWS and the National Marine Fisheries Service (NMFS) have the authority to prescribe fishways at federally regulated hydropower projects. Currently there are no fish passage facilities or prescriptions at Lake Lynn Project. No preliminary prescriptions have been filed by either agency. Following the filing of the FLA, fishway prescriptions, if any, would be filed within 60 days after FERC's Notice for Acceptance and Ready for Environmental Analysis (REA) Notice in accordance with 18 CFR §4.34(b).

### 2.1.2 Section 4(e) Conditions

Section 4(e) of the FPA requires that any license issued by FERC for a project within a federal reservation shall be subject to and contain such conditions as the Secretary of the responsible federal land management agency deems necessary for the adequate protection and use of the reservation. The Lake Lynn Project does not encompass any federal lands; therefore, these conditions do not apply.

### 2.1.3 Section 10(j) Recommendations

Under Section 10(j) of the FPA, FERC must consider recommendations provided by federal and state fish and wildlife agencies for the protection, mitigation, and enhancement of fish and wildlife resources affected by the Lake Lynn Project prior to issuing the new license. FERC would include these conditions unless it determines that they are inconsistent with the purposes and requirements of the FPA or other applicable law. No preliminary Section 10(j) recommendations have been provided by state fish and wildlife agencies to date.

## 2.2 Section 401 of the Clean Water Act

Section 401 of the Federal Clean Water Act (CWA), 33 United States Code (U.S.C.) § 1341, et. seq requires that any applicant for a federal license or permit to conduct an activity that will or may discharge into waters of the United States (as defined in the CWA) must present the federal authority with a certification from the appropriate state agency. Pursuant to W. Va. Code § 22-11-7a the West Virginia Department of Environmental Protection (WVDEP) is the appropriate permitting agency designated to carry out the certification requirements prescribed in Section 401 of the CWA for waters of West Virginia under delegated authority from the U.S. Environmental Protection Agency (USEPA). The Pennsylvania Department of Environmental Protection (PADEP) is the appropriate permitting agency designated to carry out the certification requirements prescribed in Section 401 of the CWA for waters of Pennsylvania under delegated authority from the USEPA. Lake Lynn would request Water Quality Certification (WQC) from the WVDEP, as appropriate, in accordance with 18 CFR §4.34(b) within or before 60 days of FERC's issuance of notice of acceptance of the FLA and REA notice.

## 2.3 Endangered Species Act

The ESA (19 U.S.C. § 1536(c)), as amended, provides a program for the conservation of threatened and endangered plants and animals and their habitats in which they are found. The lead federal agencies for implementing ESA are the USFWS and the National Oceanic and Atmospheric Administration (NOAA) Fisheries Service. Section 7 of the ESA requires federal agencies, in consultation with the USFWS and/or NOAA to ensure that actions they authorize, fund, or carry out are not likely to jeopardize the continued existence of any listed species or result in the destruction or adverse modification of designated critical habitat of such species. On October 17, 2019, FERC granted Lake Lynn designation as the FERC's non-federal representative for carrying out information consultation pursuant to Section 7 of the ESA. The endangered Indiana bat (*Myotis sodalis*), the threatened northern long-eared bat (*Myotis septentrionalis*), the threatened flat-spired three-toothed snail (*Triodopsis platysayoides*), and the candidate monarch butterfly (*Danaus plexippus*) have potential to occur within the Lake Lynn Project area. See additional discussion in Section 4.8, *Rare*, *Threatened, and Endangered Species*.

## 2.4 Magnuson-Stevens Fishery Conservation and Management Act

The Magnuson-Stevens Fishery Conservation and Management Act requires federal agencies to consult with NOAA Fisheries on actions that may adversely affect Essential

Fish Habitat (EFH). EFH is only applicable to federally managed commercial fish species that live at least one component of their lifecycle in marine waters. All fish in the Cheat River are freshwater species that are not managed commercially; therefore, there is no designated EFH in the Lake Lynn Project area.

## 2.5 Coastal Zone Management Act

Under Section 307 (c)(3)(A) of the Coastal Zone Management Act (CZMA), FERC cannot issue a license for a project within or affecting a states' coastal zone unless the state CZMA agency concurs with the license applicant's certification of consistency with the state's CZMA program, or the agency's concurrence is conclusively presumed by its failure to act within 180 days of its receipt of the applicant's certification.

The Lake Lynn Project is not located within a Coastal Zone and, therefore, is not subject to the CZMA. West Virginia does not have any Coastal Zones. Pennsylvania has two coastal areas: Lake Erie Coastal Zone located within Erie County and Delaware Estuary Coastal Zone within Bucks, Philadelphia, and Delaware counties[1].

## 2.6 National Historic Preservation Act

Section 106 of the NHPA, as amended, requires FERC to consider the effect of its undertakings on historic properties. Historic properties are any prehistoric or historic districts, sites, buildings, structures, Traditional Cultural Properties (TCP), and objects significant in American history, architecture, engineering, and culture that are eligible for inclusion in the NRHP. FERC initiated consultation under Section 106 with federally recognized Indian tribes, including the Osage Nation, the Delaware Nation, and the Delaware Tribe of Indians, by letters dated June 27, 2019. On October 17, 2019, FERC granted Lake Lynn designation as its non-federal representative for executing information consultation pursuant to Section 106 of the NHPA. Lake Lynn consulted with the West Virginia State Historic Preservation Office (WVSHPO), the Pennsylvania State Historic Preservation Office (PASHPO) and the tribes that may have an interest in the Lake Lynn Project regarding the relicensing via an initial letter on May 20, 2019 and the distribution of the NOI and PAD on August 29, 2019. The PASHPO indicated that a preliminary review

[1] West Virginia Department of Environmental Protection Coastal Resources Management Program. https://www.dep.pa.gov/Business/Water/Compacts%20and%20Commissions/Coastal%20Resources%20Management%20Program/Pages/About-the-Program.aspx. Accessed: November 23, 2022.

of the Lake Lynn Project indicates that there may be National Register-eligible aboveground resources in the Lake Lynn Project area and that if changes are proposed surveys must be conducted. On June 19, 2019, the Cherokee Nation stated that the Lake Lynn Project is outside their Area of Interest and deferred to federally recognized tribes that may have an interest in the area. On July 10, 2019, the Delaware Nation stated that the location of the proposed Lake Lynn Project does not endanger cultural or religious sites of interest and requested to be contacted within 24 hours if any artifacts are discovered. No other tribes have responded to the information request. Lake Lynn consulted with the WVSHPO, PASHPO and the tribes that may have an interest in the Lake Lynn Project on a draft Study Plan. No study requests or comments related to cultural resources or historic structures were received. Lake Lynn submitted a formal Lake Lynn Project review request to the WVSHPO and PASHPO on October 26, 2020. The DLA was distributed to the WVSHPO, PASHPO and the tribes that may have an interest in the Lake Lynn Project relicensing concurrent with filing the DLA. On September 9, 2022, the Bureau of Indian Affairs submitted comments on the DLA indicating that the Catawba Indian Nation was not listed as one of the American Indian tribes contacted in the application. Lake Lynn has included the Catawba Indian Nation on the distribution list of the FLA to include them as part of tribal consultation as required under 36 CFR Part 800.2(c)(2)(ii). On August 12, 2022, the Oneida Nation noted that it did not have comments on the DLA.

## 2.7 Wild and Scenic Rivers and Wilderness Acts

Section (7) of the Wild and Scenic Rivers Act requires federal agencies to decide as to whether the operation of a hydropower project under a new license would unreasonably diminish the scenic, recreational, and fish and wildlife values present in the designated area. The Wilderness Act of 1964 established a National Wilderness Preservation System. There are no nationally designated wild and scenic rivers or wilderness areas within the Lake Lynn boundary or in the vicinity of the Lake Lynn Project.

# 3.0 PROPOSED ACTIONS AND ALTERNATIVES

## 3.1 No-Action Alternative

The no-action alternative means that the Lake Lynn Project would continue to operate as authorized by the current license. Existing facilities would remain in place and existing PME measures would continue, but there would be no additional protection or enhancement of resources as described below. If the Lake Lynn Project were to operate as in the past, Lake Lynn would continue to produce energy in the present manner. The no-action alternative represents the baseline Lake Lynn Project energy production and environmental conditions for comparison with the applicant's proposed action.

## 3.2 Applicant's Proposed Action

### 3.2.1 Proposed Project Facilities and Operations

The Licensee is proposing no modifications to the existing Lake Lynn Project facilities. The existing dam, powerhouse, and generating equipment are all well maintained, in good working order, and no changes are required or proposed to these facilities that are outside the normal maintenance practices or ongoing FERC safety requirements.

As described in Exhibit B, Lake Lynn proposes to operate the Lake Lynn Project as a dispatchable peaking hydroelectric facility with storage capability. The facility's ponding capability varies by season and allows for peaking. The Lake Lynn Project has four identical Francis generating units with a total rated capacity of 51.2 MW. The Licensee is proposing no changes to the way in which the Lake Lynn Project is currently operated.

Lake Lynn is proposing to remove approximately 310.89 acres of land that are not required for Lake Lynn Project purposes. The following is a list of areas proposed for removal (Table 3.1). Additionally, the areas proposed for removal are depicted on Figure 3.1, Figure 3.2, Figure 3.3, Figure 3.4, and Figure 3.5.

**Table 3.1 Summary of Areas Proposed for Removal from the Lake Lynn Project Boundary**

| Area ID | Proposed Acres Removed | Reason for Removal |
|---|---|---|
| Area A | 76.66 | Land no longer needed for Lake Lynn Project purposes |
| Area B | 11.37 | Land no longer needed for Lake Lynn Project purposes |
| Area C | 1.06 | The Licensee owns the property and there are private leases granted to individuals. The area does not provide public recreation and is not needed for project purposes |
| Area D | 18.45 | Land no longer needed for Lake Lynn Project purposes |
| Area E | 69.42 | Land no longer needed for Lake Lynn Project purposes |
| Area F | 35.66 | Land no longer needed for Lake Lynn Project purposes |
| Area G | 44.28 | Land no longer needed for Lake Lynn Project purposes |
| Area H | 5.95 | Land no longer needed for Lake Lynn Project purposes |
| Contour adjustments | 48.05 | Land no longer needed for Lake Lynn Project purposes |

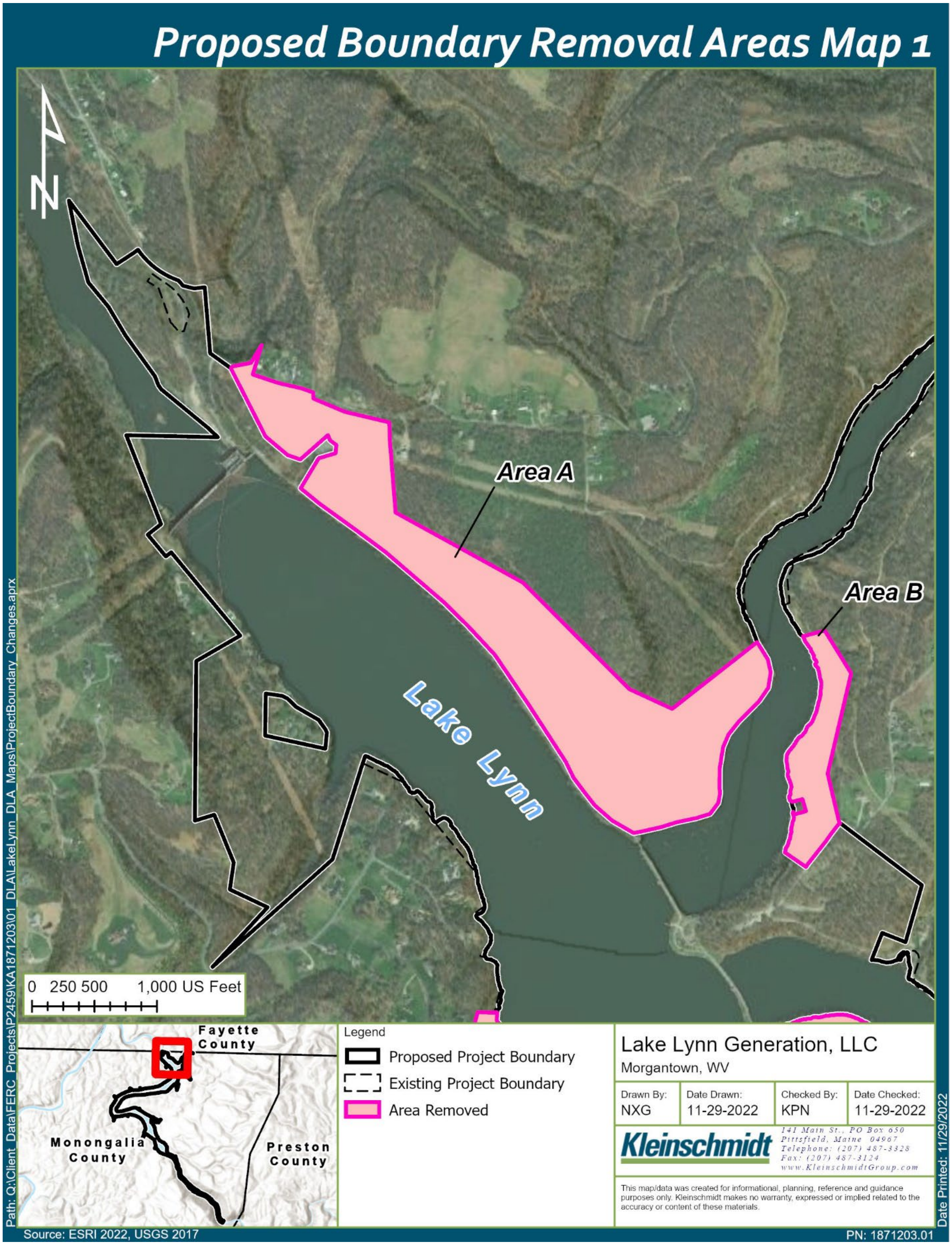


**Figure 3.1 Areas Proposed for Removal from the Lake Lynn Project Boundary**

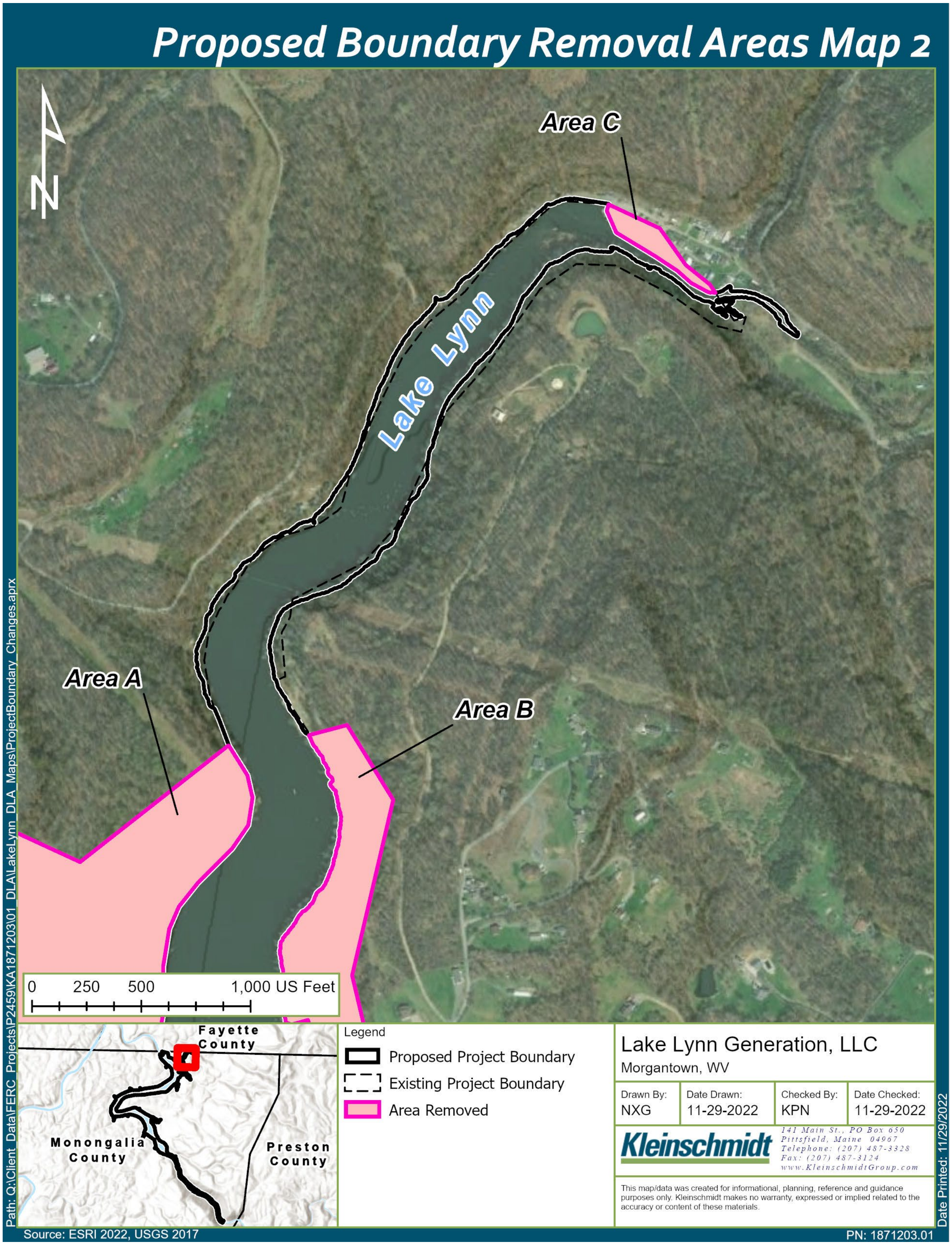


**Figure 3.2 Areas Proposed for Removal from the Lake Lynn Project Boundary**

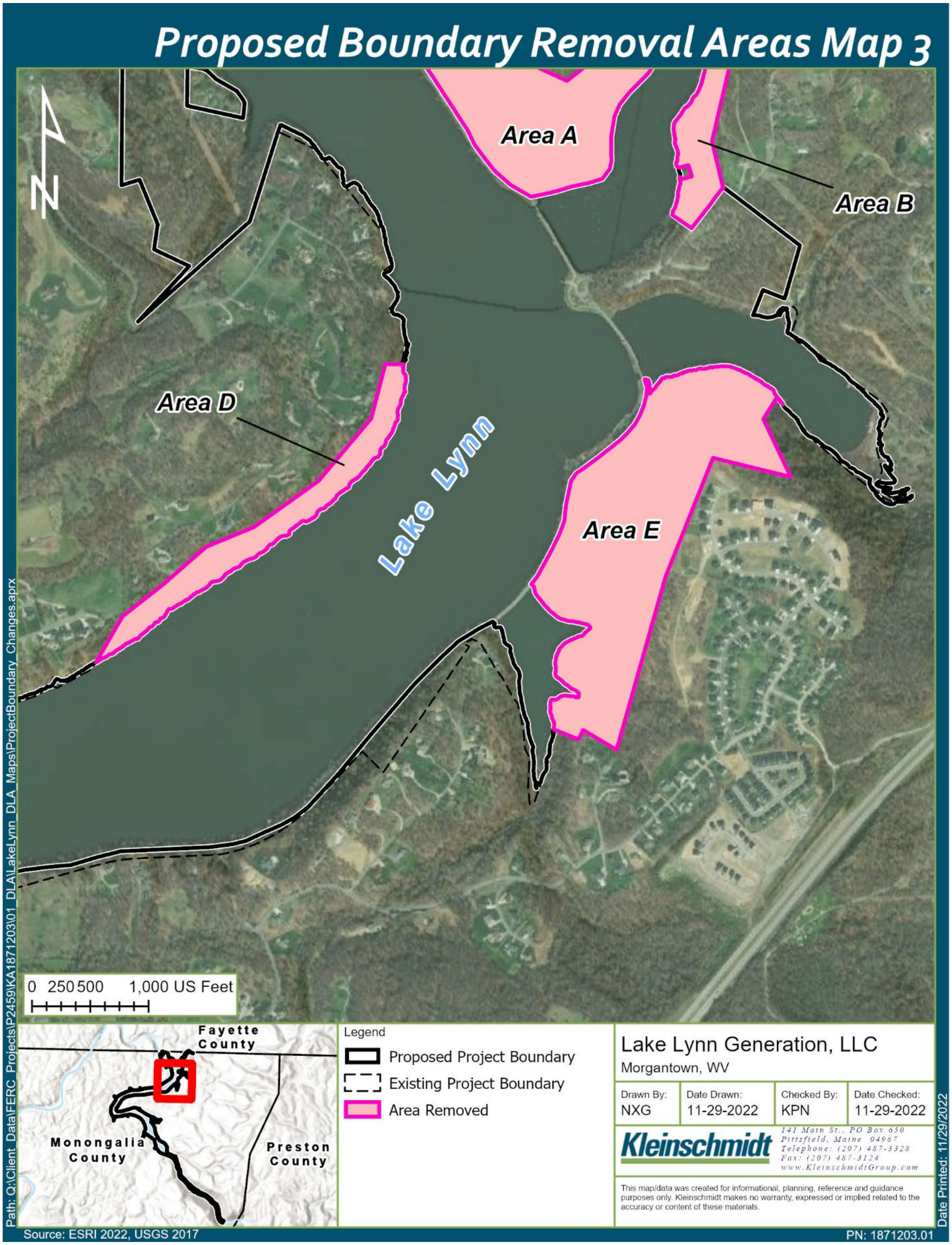


**Figure 3.3 Areas Proposed for Removal from the Lake Lynn Project Boundary**

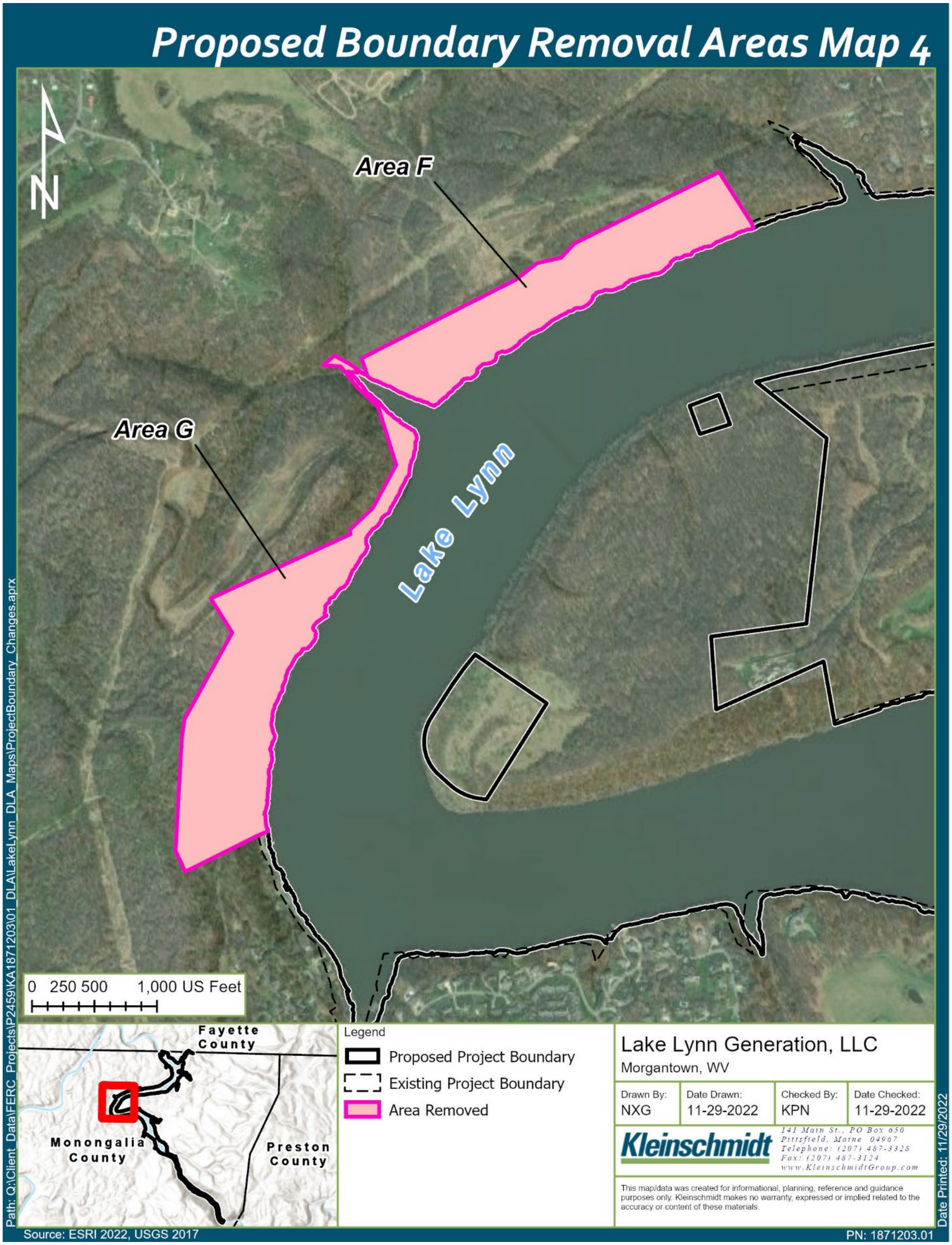


**Figure 3.4 Areas Proposed for Removal from the Lake Lynn Project Boundary**

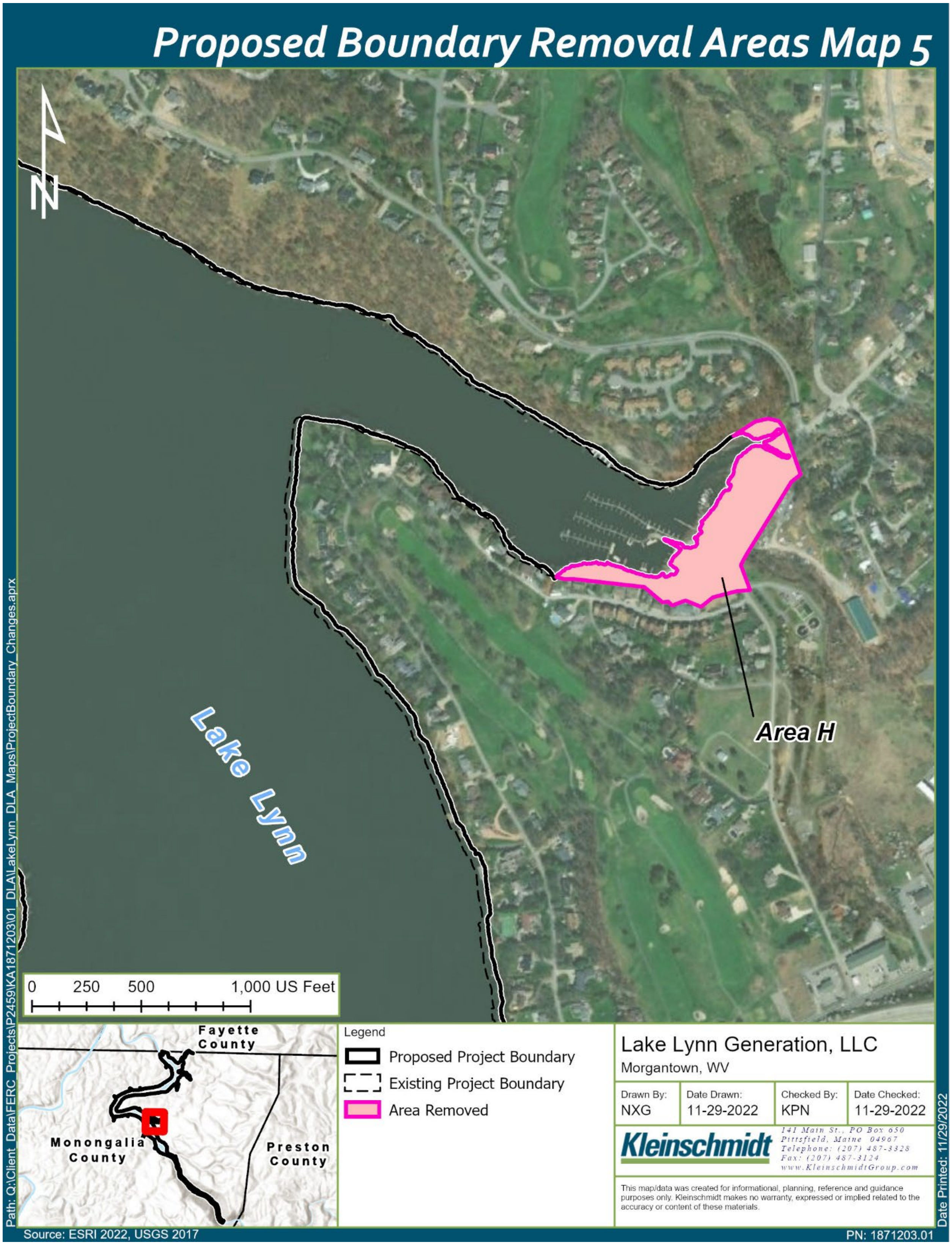


**Figure 3.5 Areas Proposed for Removal from the Lake Lynn Project Boundary**

### 3.2.2 Proposed Environmental Measures

Lake Lynn proposes the following PME measures:

- Develop an Operation Plan within one year of license issuance in consultation with USFWS, WVDNR, WVDEP, PADEP, and PFBC that will include standard operating procedures to be implemented during periods of low dissolved oxygen (DO) levels that will allow the reservoir to be drawn down to 865 feet (ft), and document how Lake Lynn will comply with the operational requirements of the license.
- Develop a water quality monitoring plan for the new license term within one year of license issuance in consultation with USFWS, WVDNR, WVDEP, PADEP, and PFBC that includes monitoring DO and water temperature from April 1 through October 31 each year at the reservoir water quality monitoring station and the tailwater monitoring site.
- Continue to provide public recreation access to the Lake Lynn Project at the existing Lake Lynn Project recreation facilities.
- Develop a new Recreation Management Plan for the new license term within one year of license issuance in consultation with USFWS, WVDNR, PFBC, WVDEP, PADEP, Monongalia County, Fayette County, CLEAR, FOC, and MRTC that would be informed by the results of the Recreation Site Enhancement Feasibility and Assessment and include a review and update of the Recreation Plan every 10 years. The Recreation Management Plan would also include water depth monitoring on an annual basis prior to the recreation season at the Sunset Beach Marina Public Boat Ramp. The Recreation Management Plan would include a measure for, if warranted, conducting a bathymetric survey in the vicinity of the Sunset Beach Marina Public Boat Ramp every 10 years and excavation to maintain the boat ramp usability.
- Develop a shoreline management plan (SMP) within one year of license issuance in consultation with USFWS, WVDNR, WVDEP, PADEP, PFBC, Monongalia County, Fayette County, WVSHPO, Pennsylvania SHPO, CLEAR, and FOC that would outline allowed activities and procedures for granting permission for shoreline activities.
- Develop a Historic Properties Management Plan within two years of license issuance in consultation with WVSHPO, Pennsylvania SHPO, and Tribes.

Table 3.2 below identifies the anticipated capital and annual operations and maintenance (O&M) costs associated with implementing the proposed PME measures.

**Table 3.2 Estimated Proposed PME Capital and O&M Costs**

| Proposed Protection, Mitigation, and Enhancement Measure | Capital Cost ($2022) | Annual O&M Cost ($2022) |
|---|---|---|
| Develop and implement an Operation Plan | $10,000 | $35,000 |
| Develop and implement a Water Quality Monitoring Plan | $7,500 | $15,000 |
| Continue to provide public recreation access at the existing Lake Lynn Project recreation facilities | $0 | $143,000 |
| Develop and implement updated Recreation Management Plan, including Sunset Beach Marina Public Boat Launch Water Depth Monitoring | $25,000 | $155,000 |
| Develop and implement a Shoreline Management Plan | $25,000 | $10,000 |
| Develop and implement a Historic Properties Management Plan | $30,000 | $5,000 |

# 4.0 ENVIRONMENTAL ANALYSIS

## 4.1 Analysis of Proposed Action

Exhibit E includes a review of existing resource information as well as an analysis of anticipated effects of Lake Lynn Project operations relative to current conditions (e.g., No-Action Alternative) and Lake Lynn's proposed action. This analysis considers geographic, temporal, and cumulative scopes, as appropriate.

### 4.1.1 Geographic Scope

The geographic scope of the analysis defines the physical limits or boundaries of the proposed action's effect on the resources. Because the proposed action has the potential to affect the resources differently, the geographic scope for each resource varies. Generally, for upland based resources such as wildlife and land use, the geographic scope is limited to those lands within the Lake Lynn Project boundary. For aquatic resources and those affected by flow discharges and water levels, the geographic scope generally includes the impoundment and tailwater for a distance downstream to a point where flow effects are attenuated.

### 4.1.2 Temporal Scope

Based on the potential term of a new license, the temporal scope analyzed is up to 40 years into the future, with focus on how reasonably foreseeable future actions affect resources. The discussion of historical information is limited to available information for the resource areas.

### 4.1.3 Cumulative Effects

According to the Council on Environmental Quality's regulations for implementing the National Environmental Policy Act (NEPA) (Section 1508.7), a cumulative effect is the impact on the environment which results from the incremental impact of the action when added to other past, present, and reasonably foreseeable future actions, regardless of what agency or person undertakes such other actions. Lake Lynn has not identified any resource which has the potential to be cumulatively affected by the operations and maintenance of the Lake Lynn Project.

## 4.2 General Description of the River Basin

### 4.2.1 General Description of Watershed

The Lake Lynn Project is located on the Cheat River in Monongalia County, West Virginia, and Fayette County, Pennsylvania (Figure 4.1). The Cheat River is an 84-mile-long tributary of the Monongahela River. The Monongahela River is approximately 128 miles long, flows from south to north, and is located in northcentral West Virginia and southwestern Pennsylvania. The Monongahela River watershed (HUC 050200) is approximately 7,340 square miles (USACE 2012). The Lake Lynn Project is approximately 3.7 miles upstream of the confluence of the Cheat River with the Monongahela River in Point Marion, West Virginia.

The Cheat River originates within the Monongahela National Forest in Parsons, West Virginia, at the confluence of Shavers Fork and Black Fork (Figure 4.1). Shavers Fork is an 88.5-mile-long river which begins in northcentral Pocahontas County at Thorny Flat, the highest peak of Cheat Mountain, and generally flows north-northwest through Randolph and Tucker counties. Black Fork is a short stream about 4 miles in length formed by the confluence of the Dry Fork and the Blackwater River in the town of Hendricks. Black Fork then flows northwest through the towns of Hambleton and Parsons, West Virginia, where it joins with Shavers Fork to create the Cheat River. The Cheat River flows north until it joins the Monongahela River in Point Marion, Pennsylvania. The Cheat River watershed (Hydrologic Unit Code [HUC] 05020004) is approximately 100 miles long with an average width of approximately 15 miles and a drainage area of 1,426 square miles. The average elevation of the watershed is approximately 2,270 feet above mean sea level (WVDEP 2013).

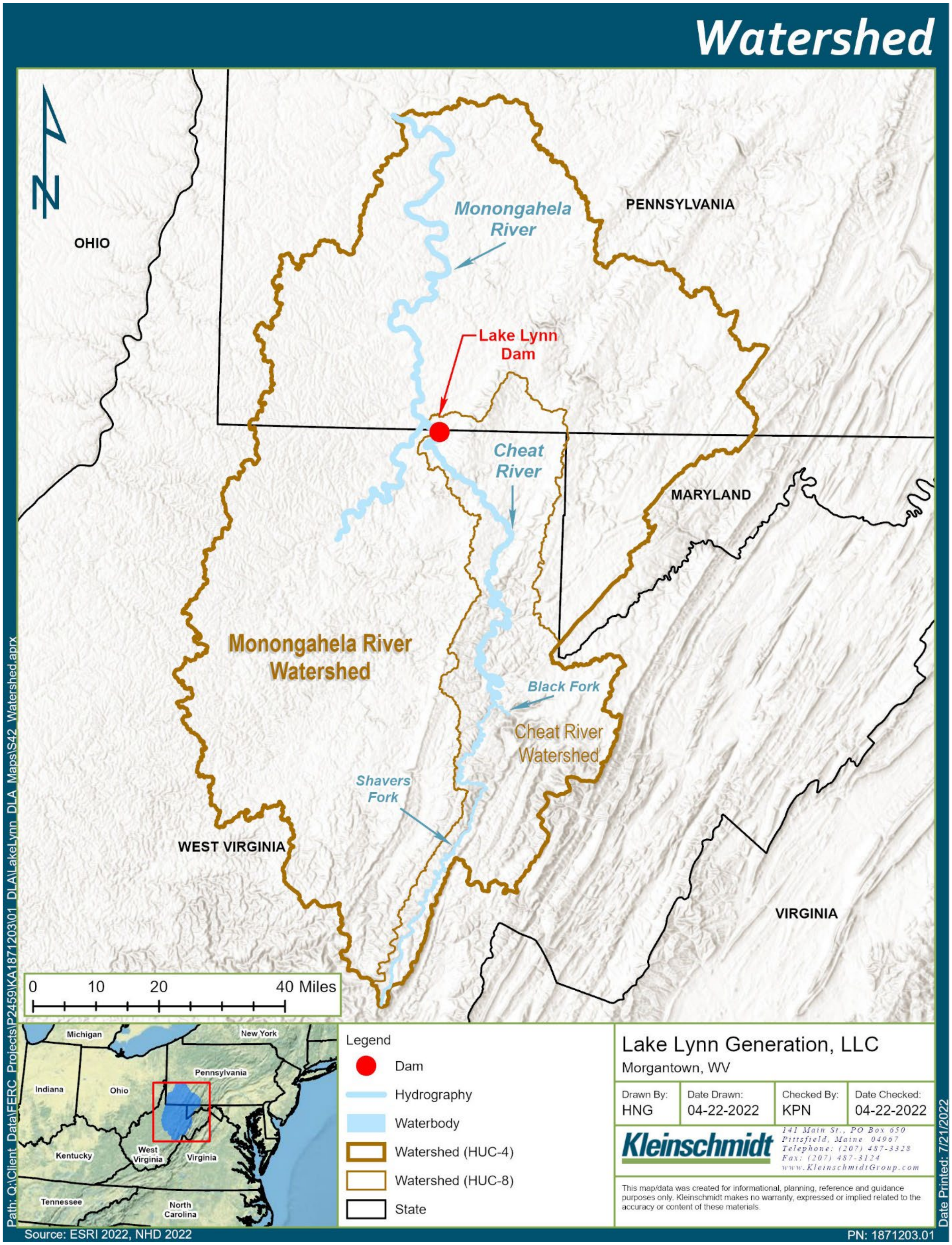


**Figure 4.1 Overview of the Cheat River Watershed**

### 4.2.2 Topography

The Cheat River basin topography is characterized by mountainous ridges and deep, wide valleys. The Cheat River basin spans across three geographic ecoregions, the Central Appalachian Forest, the Cumberland and Southern Ridge Valley, and the Western Allegheny Plateau. The majority of the Cheat River basin (54 percent) is within the Central Appalachian ecoregion, which is known for its mountainous terrain, cooler climate, and biologically diverse habitat (WVDEP 2013). In the Central Appalachian Forest ecoregion, the Cheat River basin meanders through the Western Allegheny Mountains, the Northern High Allegheny Mountains, and the Southern High Allegheny Mountains. The elevation of the basin ranges from 1,800 feet in Preston County, West Virginia, to 4,800 feet in Pocahontas County, West Virginia, deep within the Monongahela National Forest (LSA 2022a).

Nearly 45 percent of the river basin is within the Cumberland and Southern Ridge Valley (CSRV) ecoregion, characterized by its parallel mountain ridgelines and lowland valleys (WVDEP 2013). The Cheat River basin lies within the Cumberland Mountains, a subregion of the CSRV, which stretches from the southern part of West Virginia to Tennessee. The area is characterized as extremely rugged, mountainous terrain ranging from 570 feet to over 4,400 feet in elevation (LSA 2022b). Approximately 1 percent of the basin lies within the Western Allegheny Plateau ecoregion, which is characterized by rounded hills and wide fertile valleys of mixed oak forests and agricultural lands (WVDEP 2013). This ecoregion spans from east to west and includes areas of New York, northwestern West Virginia, western Pennsylvania, and eastern Ohio (LSA 2022c).

### 4.2.3 Climate

The Monongahela River watershed has a humid continental climate which is characteristic of mid-latitude temperate regions. This climate is characterized by variable weather patterns and four seasons with large temperature variations due to the position between polar and tropical air masses. Dominant airflow patterns are from the west most of the year. During the summer, low pressure cyclonic systems dominate with southern winds and heavy precipitation. From June through November, northeasterly moving hurricanes and tropical storms occasionally produce heavy rains and winds in the region (USACE 2012).

The climate of the Cheat River watershed is characterized by relatively cold winters and moderately hot, showery summers. The average annual temperature at the Morgantown Municipal Airport (approximately 6 miles southwest of the Lake Lynn dam) from 2012 to 2021 was 55 degrees Fahrenheit (°F) with a range of 53°F to 56°F (NRCC 2022). The monthly mean temperature ranged from 32°F in January to 75°F in July. The average annual total precipitation was 44 inches and ranged from 35 inches to 55 inches. The monthly mean precipitation ranged from 2.2 inches in November to 5.5 inches in July (NRCC 2022).

### 4.2.4 Land and Water Use

The Monongahela River is controlled and maintained for navigation by the United States Army Corps of Engineers (USACE) via a series of nine locks and dams (FERC 2016). Four of these dams (Opekiska, Hildebrand, Morgantown in West Virginia, and Point Marion in Pennsylvania) are located upstream of the Cheat River confluence with the Monongahela River. The other five dams (Grays Landing, Maxwell, Charleroi, Locks and Dam 3, and Braddock) are located downstream of the confluence in Pennsylvania (USACE 2012).

Rivers in the Monongahela River basin, including the Cheat River, were historically used for wastewater assimilation from mining and gas extraction, treated industrial and municipal wastewater, and storm water discharge (PFBC 2011). Due to historical mining activities, these rivers have displayed severe water pollution issues. However, with the introduction of water pollution controls over the past fifty years, these rivers have experienced improved water quality (PFBC 2011).

Today, the Cheat River is primarily used for hydroelectric power generation, wildlife and aquatic habitat, public water supply, and recreation, such as fishing and whitewater kayaking. The Cheat River is the drinking water source for the towns of Parsons, Rowlesburg, Kingwood, and Albright in West Virginia (FOC 2022a).

The only other dam on the Cheat River is at the Albright Power Station dam, approximately 24 river miles (RM) upstream of the Lake Lynn dam. The dam provided the cooling water supply for the power station. The Albright Power Station was decommissioned in 2012, and the dam is under consideration for removal (FOC 2022b).

Land use in the Cheat River basin is dominated by forested area (86 percent), while 8 percent of the land cover is classified as developed, 5 percent is planted/cultivated area, and less than 1 percent is defined as impervious surface area (WVDEP 2013). The watershed is sparsely populated and very rural. The tributaries that form Black Fork, the principal tributary to the Cheat River, rise in sparsely settled mountainous terrain, much of which is part of the Monongahela National Forest. Additionally, the watershed encompasses portions of the following state and federal public lands:

- *Wildlife Management Areas*: Beaver Dam (37,674 acres), Blackwater (58,978 acres), Cheat (80,771 acres), Little Indian Creek (1,036 acres), Otter Creek (68,782 acres), Potomac (139,786 acres), and Snake Hill (3,092 acres);
- *State Parks*: Blackwater Falls (446 acres), Canaan Valley (6,014 acres), and Cass Scenic Railroad (11 miles long);
- *State Forest*: Coopers Rock (12,747 acres);
- *National Forest*: Monongahela (900,000 acres); and
- *National Wildlife Refuge*: Canaan Valley.

### 4.2.5 References

Federal Energy Regulatory Commission (FERC). 2016. Multi-Project Environmental Assessment for Hydropower License: Opekiska Lock and Dam Hydroelectric Project, FERC Project No. 13753-002 and Morgantown Lock and Dam Hydroelectric Project, FERC Project No. 13762-002, West Virginia; Point Marion Lock and Dam Hydroelectric Project, FERC Project No. 13771-002, Grays Landing Lock and Dam Hydroelectric Project, FERC Project No. 13763-002, Maxwell Locks and Dam Hydroelectric Project, FERC Project No. 13766-002, Monongahela Locks and Dam 4 Hydroelectric Project, FERC Project No. 13767-002, Pennsylvania. September 2016.

Friends of the Cheat (FOC). 2022a. Watershed Profile. Available online: https://www.cheat.org/about/watershed-profile/. Accessed April 20, 2022.

Friends of the Cheat (FOC). 2022b. Albright Power Dam Removal Project. Available online: https://www.cheat.org/our-work/watershed-restoration/albright-power-dam-removal-project/. Accessed April 20, 2022.

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United States Army Corps of Engineers (Pittsburgh District) (USACE). 2012. Monongahela River Watershed Initial Watershed Assessment. September 2011, Revised February 2012. Pg. 23-24. Available online: https://www.lrp.usace.army.mil/Portals/72/docs/HotProjects/signed%20IWA_final_revised%20FEB12%20public%20comments%20incorporated.pdf. Accessed: April 20, 2022.

West Virginia Department of Environmental Protection (WVDEP). 2013. West Virginia Watersheds: A Closer Look. Available online: https://dep.wv.gov/WWE/wateruse/WVWaterPlan/Documents/WatershedACloserLookNovember2013.pdf. Accessed: April 20, 2022.

## 4.3 Geological and Soil Resources

### 4.3.1 Affected Environment

The Lake Lynn Project is within the Paleozoic – Pennsylvanian geological region, which formed 299-318 million years ago. Specifically, the Lake Lynn Project vicinity is a mix of Conemaugh Group, Quaternary Alluvium, Pottsville Group, Allegheny Formation, Monongahela Group, and Greenbrier Group. These geological features vary among types but are predominantly cyclical sequences of red and grey shale (mostly non-marine), siltstone, and sandstone, with thin limestones, and coal (SGMC 2017). Thin limestone, shales, and a variety of coals are widely distributed within the Lake Lynn Project vicinity.

The existing topography around the Cheat Lake shoreline is relatively steep with areas of bedrock and large cobbles. The local bedrock consists primarily of sandstone and shale. Much of the bedrock is covered with alluvium composed of sand, gravel, silt, and clay. Several outcrops are located along shoreline, including very high cliffs. Relief in the area is on the order of 300 to 400 feet, with the Cheat River flowing between relatively steep slopes on either side, rising from 870 feet to about 1,200 feet (Lake Lynn 2021). Level land in the Lake Lynn Project boundary is limited to Cheat Lake Park and along a terraced area near the Sunset Beach Marina (Lake Lynn 2021).

Based on a review of the United States Department of Agriculture Natural Resources Conservation Service's (NRCS) Web Soil Survey, the predominant soil types within the Lake Lynn Project area are loamy with mixed stony and silty components (NRCS 2022). Within the Lake Lynn Project boundary, most of the area is water (approximately 85.6 percent) with the remaining soils comprising the remaining 14.4 percent. Specifically, the most common soil types within the Lake Lynn Project area include Dekalb very stony loams, 15-35 percent and 35-65 percent slopes (DdE and DdF); Culleoka-Westmoreland silt loams, 35-65 percent slopes (CwD); Gilpin silt loam, 35-65 percent slopes (GaF); and Dekalb channery loams (DaC, DaD, and DaE). Although some variation exists between these soil types, they are typically found along steep slopes, ridgetops, hillsides, and stream terraces. Water capacity varies from low to moderate, and permeability varies from rapid (i.e., DdE and DdF) to moderate (i.e., CwD and GaF). However, all these soil types have medium to rapid runoff potential and are high-erosion hazard soils. These soil types are at high risk of runoff and severe erosion, particularly in bare earth or unprotected areas. The establishment of vegetative cover for soil protection along the shoreline of the

Cheat Lake is difficult because of the soils' low fertility, reservoir elevation fluctuation, and wave action along the shoreline from wind or watercraft.

In accordance with Article 402 of the existing FERC license, the Licensee has conducted shoreline erosion surveys of the entire Cheat Lake Shoreline every 3 years since 1995 to identify new areas of erosion along the Cheat Lake shoreline. Since 1995, the Licensee has also conducted annual erosion surveys of the Cheat Lake Park shoreline extending from the Cheat Lake dam to the Cheat Haven Peninsula. A total of 19 shoreline erosion monitoring stations where historical erosion has been observed were visually inspected during the most recent annual shoreline erosion survey conducted in 2021. Since 2018, active annual erosion has been minimal as discussed in the 2018, 2019, 2020, and 2021 annual shoreline erosion survey reports. In 2021, three of the 19 survey stations exhibited moderate erosion and one additional station was added during the survey.

### 4.3.2 Environmental Effects

#### 4.3.2.1 Effects of the Proposed Action

The current FERC license requires that the Licensee release a minimum flow of 212 cubic feet per second (cfs) from the dam with an absolute minimum flow of 100 cfs regardless of inflow. The Lake Lynn Project is operated as a dispatchable peaking hydroelectric facility with storage capability. The facility's ponding capability varies by season and allows for peaking. During the recreation season, fluctuations in lake level are maintained from 868 ft to 870 feet which help alleviates extreme wave action. There are no proposed changes to the existing operation of the hydroelectric facility. As such, geological conditions, soils, and shoreline erosion are expected to remain on current trends as identified in the annual shoreline erosion reports. The most recent shoreline erosion survey report (2021) concluded that the three stations that exhibited moderate erosion as compared to 2020 were in an area of low wind fetch along a narrow portion of the reservoir and that the change was likely due to boat traffic. Wave action from wind and watercraft are anticipated to continue to be a contributing factor to the shoreline erosion within the Lake Lynn Project boundary.

During the prefiling consultation, WVDNR requested the Licensee conduct a reservoir sedimentation study at areas that have demonstrated an affinity for a build-up of sediment (i.e., Sunset Beach Marina) and develop a plan to monitor and address any sedimentation issues. In addition, CLEAR requested that the Licensee continue monitoring and remediation of the ongoing shoreline erosion. Rather than conducting a new study, Lake Lynn proposed in its Study Plan to continue conducting the shoreline erosion surveys during relicensing rather than conducting a new study which was not warranted due to the results of recent shoreline erosion surveys. In addition, in 2019, Lake Lynn conducted a bathymetric survey in the vicinity of the Sunset Beach Marina public boat launch and excavated the area in 2020 to maintain the functionality of the public boat launch.

In its comments on the DLA, WVDNR recommended monitoring sedimentation at the Sunset Beach Marina public boat launch on a yearly basis so that any sedimentation issues can be addressed as they occur. WVDNR also recommended that a dredging plan be developed in consultation with WVDNR.

Lake Lynn does not anticipate soil or geologic resources to be adversely affected by the proposed action. Lake Lynn will maintain the Sunset Beach Marina public boat launch during the new license term and proposes to consult with WVDNR on the details for monitoring sedimentation and periodic excavation that would be included in the new Recreation Management Plan proposed to be developed within one year of license implementation. Water depths at the Sunset Beach Marina public boat launch would be taken an annual basis prior to the recreation season at the Sunset Beach Marina Public Boat Ramp. If warranted, a bathymetric survey in the vicinity of the Sunset Beach Marina Public Boat Ramp would be conducted every 10 years along with excavation to maintain the boat ramp usability. Lake Lynn is also proposing to develop a Shoreline Management Plan (as discussed in Section 4.9.2.1) that would manage shoreline activities within the Lake Lynn Project boundary. Although Lake Lynn cannot control upland activities outside the Lake Lynn Project boundary, the development of a Shoreline Management Plan that clearly outlines allowed activities and procedures for granting permission for shoreline activities will help manage shoreline activities that could cause shoreline erosion. The Licensee proposes to discontinue the shoreline erosion surveys required under the existing FERC license.

#### 4.3.2.2 Effects of the No-Action Alternative

Under the no-action alternative, Lake Lynn would continue to operate the Lake Lynn Project under the terms and conditions of the current license. Thus, the no-action alternative would include the existing facilities and current operation as described in Section 3.0. Under the no-action alternative, the licensee would not receive a new FERC license and would continue to operate the Lake Lynn Project under the existing license requirements. The effects of the proposed action on soil and geological resources would be minimal under the no-action alternative.

### 4.3.3 Unavoidable Adverse Effects

Minor amounts of sedimentation and erosion may occur after implementation of PME measures related to shoreline and erosion management. However, PME measures are intended to reduce the effects of operations and any necessary on-site maintenance activities on erosion and sedimentation.

### 4.3.4 References

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## 4.4 Water Resources

### 4.4.1 Affected Environment

#### Water Quantity, Storage, and Use

The Cheat River watershed has a drainage area of approximately 1,426 square miles. The drainage area at the Lake Lynn dam is approximately 1,411 square miles (FERC 1995). The Cheat River is the second largest tributary to the Monongahela River (Allegheny 1991). Inflow data to the Lake Lynn Project was estimated using flow data from a combination of the active U.S. Geological Survey (USGS) gages located upstream, including USGS Gage No. 03070260 Cheat River at Albright, West Virginia, and USGS Gage No. 03070500 Big Sandy Creek at Rockville, West Virginia (USGS 2022a,b). USGS Gage 03070260 is approximately 27 RMs upstream of the Lake Lynn dam with a drainage area of 1,046 square miles. Big Sandy Creek is a tributary that joins the Cheat River approximately 15 RMs upstream of the Lake Lynn dam. USGS gage 03070500 is approximately 5 RMs upstream of the confluence of Big Sandy Creek and the Cheat River with a drainage area of 200 square miles. To estimate inflow, the Licensee prorated daily average flow data from USGS Gage 03070260 (factor of 1.078) to where Big Sandy Creek joins the Cheat River. The prorated flow data for Big Sandy Creek (proration factor=1.04) was then added to this. The resulting flow data was then prorated (factor of 1.053) from Big Sandy Creek to the Lake Lynn dam. The period of record for the inflow analysis was January 1, 2011, to December 31, 2021. Flow duration curves are provided in Appendix C.

The annual mean inflow from 2011 to 2021 to the Lake Lynn Project was 3,511 cfs with the monthly mean inflow ranging from 1,457 cfs in August to 5,845 cfs in February (Table 4.1). The daily average minimum flows observed during this time period occurred in late September to early October 2019. The daily average maximum flow of 55,858 cfs occurred on March 1, 2021.

**Table 4.1 Monthly average, minimum, and maximum inflow to the Lake Lynn Project (January 1, 2011, to December 31, 2021)**

| Month | Average (cfs) | Minimum (cfs) | Maximum (cfs) |
|---|---|---|---|
| January | 4,282 | 728 | 31,958 |
| February | 5,845 | 565 | 30,934 |
| March | 5,556 | 802 | 55,858 |
| April | 5,190 | 792 | 31,567 |
| May | 4,457 | 514 | 31,100 |
| June | 2,520 | 202 | 23,742 |
| July | 2,079 | 151 | 41,994 |
| August | 1,457 | 139 | 33,546 |
| September | 1,511 | 81 | 33,051 |
| October | 1,758 | 83 | 11,705 |
| November | 2,830 | 403 | 30,655 |
| December | 4,790 | 711 | 36,917 |
| Annual | 3,511 | 81 | 55,858 |

Source: USGS 2022a,b

The Cheat River in the Lake Lynn Project area is used for hydroelectric power generation, recreation, wastewater assimilation, and aquatic and wildlife habitat. There are no active water withdrawals located within the Lake Lynn Project boundary. The Cheat River at the Lake Lynn Project is not used for irrigation or domestic water supply, and there are no other known entities with water rights within the Lake Lynn Project boundary.

The WVDEP issues individual National Pollution Discharge Elimination System (NPDES) permits to both publicly and privately-owned wastewater treatment facilities. The Licensee has a general NPDES permit that covers sewerage systems at the Lake Lynn Recreational Facility, Cheat Lake Park (Information System ID WVG551086) (USEPA 2022). Other NPDES discharges into Lake Lynn Project waters are listed in Table 4.2.

**Table 4.2 NPDES discharges into Cheat Lake**

| Permit Holder | Information System ID Number |
|---|---|
| SCL, PSD, LLC Summit at Cheat Lake | WV0105945 |
| Emma Kaufman Camp | WVG550032 |
| Morgantown Utility Board Cheat Lake (POTW)p | WV0083071 |

Source: USEPA 2022

#### 4.4.1.1 Water Quality

##### 4.4.1.1.1 Water Quality Standards

The Cheat River upstream of Cheat Lake and Cheat Lake are classified by the state of West Virginia as Category A (Water Supply, Public), Category B (Aquatic Life, Trout Waters), and Category C (Water Contact, Recreation). Trout waters are defined as "*waters which sustain year-round trout populations*" (WVDEP 2022a). In West Virginia, Cheat Lake is managed as a cool water lake. WVDEP defines cool water lakes as "*lentic water bodies that have a summer hydraulic residence time greater than 14 days and are managed by WVDNR for the support of cool water fish species, such as walleye and trout*" (WVDEP 2022a). Water quality standards applicable to these West Virginia classifications are summarized in Table 4.3 and Table 4.4

**Table 4.3 Selected West Virginia Water Quality Standards Applicable to Cheat Lake**

| Parameter | Human Health | | Aquatic Life |
|---|---|---|---|
| | Category A: Water Supply, Public | Category C: Water Contact, Recreation | Category B2: Trout Waters |
| Dissolved Oxygen | No less than 5 milligrams per liter (mg/l) at any time | No less than 5 mg/l at any time | No less than 7 mg/L in spawning areas, and no less than 6 mg/L at any time |
| Temperature | N/A | N/A | No heated effluents will be discharged in the vicinity of spawning areas. Maximum temperatures for cold waters are expressed in Table 4.4. |
| pH | No values below 6.0 nor above 9.0. Higher values due to photosynthetic activity may be tolerated. | No values below 6.0 nor above 9.0. Higher values due to photosynthetic activity may be tolerated. | No values below 6.0 nor above 9.0. Higher values due to photosynthetic activity may be tolerated. |

Source: WVDEP 2022a

**Table 4.4 Maximum Temperatures for Category B2 Trout Waters**

| | Daily Mean (°F) | Hourly Maximum (°F) |
|---|---|---|
| October-April | 50 | 55 |
| September and May | 58 | 62 |
| June-August | 66 | 70 |

Source: WVDEP 2022a

The Cheat River in Pennsylvania, which includes the reach of river from the West Virginia-Pennsylvania border immediately downstream of the Lake Lynn tailrace to the confluence with the Monongahela River, is designated and protected as Warm Water Fishes (WWF) aquatic life habitat. This designation focuses on the maintenance and propagation of fish species and additional flora and fauna which are indigenous to a warm water habitat (PA Code 2022). Water quality standards applicable to the Cheat River downstream of the Lake Lynn dam are summarized in Table 4.5.

**Table 4.5 Pennsylvania Water Quality Standards Applicable to the Cheat River downstream of the Lake Lynn dam**

| Parameter | WWF Designation |
|---|---|
| Dissolved Oxygen (mg/l) | 7-day average 5.5 mg/l; minimum 5.0 mg/l. |
| Temperature | Maximum temperatures in the receiving water body<br><br>January 1-31: 40 °F<br>February 1-29: 40 °F<br>March 1-31: 46 °F<br>April 1-15: 52 °F<br>April 16-30: 58 °F<br>May 1-15: 64 °F<br>May 16-31: 72°F<br>June 1-15: 80 °F<br>June 16-30: 84 °F<br>July 1-31: 87 °F<br>August 1-15: 87 °F<br>August 16-30: 87 °F<br>September 1-15: 84 °F<br>September 16-30: 78 °F<br>October 1-15: 72 °F<br>October 16-31: 66 °F<br>November 1-15: 58 °F<br>November 16-30: 50 °F<br>December 1-31: 42 °F |
| pH | From 6.0 to 9.0 inclusive |

Source: PA Code (2022)

#### 4.4.1.1.2 Water Quality Data

In accordance with License Article 405, the Licensee developed and implements a plan to continuously monitor dissolved oxygen, pH, water temperature, and conductivity in the reservoir, in the Lake Lynn Project tailrace, and downstream of Grassy Run and other tributaries from April 1 through October 31 annually and submits an annual report to FERC and the resource agencies (Figure 4.2).

In accordance with License Article 406, as amended, the Licensee must report any deviations of DO below the 5 mg/L standard in the tailrace to FERC and the resource agencies within 5 days of the deviation and must file an annual monitoring report. The Licensee has developed a standard operating procedure for low DO conditions that describes the steps to be taken to mitigate low DO levels in the tailrace. These procedures include opening spill gates to increase flow in the tailwater and reducing generation when DO levels approach the DO standard of 5 mg/L.

Water quality data from 2013 to 2017 are summarized in Table 4.6, and data for 2018 to 2020 are summarized in Table 4.7. Periods of low DO levels were generally found in the late summer and early fall for most years, particularly at the reservoir site. pH was in attainment with the standard except for a few points in April 2014 and April 2015.

**Table 4.6 Range (Mean) of water quality data by year collected from April 1 to October 31 of 2013 to 2017 at the Lake Lynn Project.**

| Monitor/Gage | Year | Water Temperature (°C) | pH | DO (mg/L) | Specific Conductance (µS/m at 25°C) |
|---|---|---|---|---|---|
| Reservoir (USGS Gage No. 03071590 Stewartstown Gage) | 2013 | 3.8-26.0 (18.2) | 6.4-7.2 (6.9) | 4.5-12.8 (7.8) | 98-115 (105) |
| | 2014 | 4.9-26.6 (18.5) | 6.5-7.3 (6.8) | 1.9-12.7 (7.3) | 53-201 (117) |
| | 2015 | 6.1-25.6 (19.3) | 6.4-7.2 (6.8) | 1.1-11.8 (7.1) | 62-159 (115) |
| | 2016 | 5.8-26.7 (19.6) | 6.4-7.2 (6.8) | 1.0-12.1 (6.8) | 52-205 (116) |
| | 2017 | 7.4-25.1 (18.5) | 6.4-7.2 (6.8) | 1.0-11.8 (7.4) | 48-160 (106) |
| Tailrace (USGS Gage No. 03071605 Davidson Gage) | 2013[a] | 14.5-24.1 (20.3) | 6.7-7.2 (7.1) | 5.1-9.9 (8.4) | 64-151 (110) |
| | 2014 | 5.6-26.4 (19.1) | 6.6-7.4 (7.1) | 4.3-12.6 (8.7) | 56-177 (121) |
| | 2015 | 12.0-26.4 (21.4) | 6.3-7.2 (7.0)[b] | 3.4-12.5 (8.7)[b] | 68-163 (121) |
| | 2016 | 7.2-27.4 (20.2) | 6.4-7.4 (6.9) | 3.8-12.6 (8.4) | 62-178 (115) |
| | 2017 | 8.6-24.5 (19.1) | 6.3-7.2 (6.9) | 5.1-12.0 (8.6) | 52-157 (109) |

| Monitor/Gage | Year | Water Temperature (°C) | pH | DO (mg/L) | Specific Conductance (µS/m at 25°C) |
|---|---|---|---|---|---|
| Downstream (USGS Gage No. 03071690 Nilan Gage) | 2013 | 14.0-24.9 (20.0)[c] | 6.6-7.0 (6.8)[d] | 4.3-13.1 (8.3)[d] | 124-167 (148) |
| | 2014 | 6.0-26.6 (18.9) | 5.3-7.3 (6.8) | 3.4-12.3 (8.0) | 54-217 (128) |
| | 2015 | 6.6-27.1 (19.4) | 5.7-7.3 (6.9) | 4.1-12.4 (8.3) | 69-209 (122) |
| | 2016 | 7.0-27.2 (19.7) | 6.4-7.4 (7.0) | 3.1-12.2 (8.0)[e] | 69-209 (127) |
| | 2017 | 8.4-24.5 (19.0) | 6.3-7.4 (6.8) | 4.3-10.8 (7.7) | 58-208 (122) |

Source: USGS 2022c, d, e
*Range is based on the daily minimum and maximum.
[a] August 1-October 31, 2013 only
[b] May5-October 31, 2014 only
[c] July 31-October 31, 2013 only
[d] September 30-October 31, 2013 only
[e] Missing data July 4-September 10, 2016

In 2018 in the reservoir, the daily minimum DO concentration was below 5 mg/L in mid to late May, early June, several days in July and August, and in late October (Table 4.7) (LLG 2019). In the tailrace, DO was below the 5 mg/L standard on August 2 and 3 for three 10-minute periods and on September 10 for approximately 45 minutes. Following these short-term deviations, operations were adjusted and DO returned to concentrations above 5 mg/L. As required by License Article 406, the Licensee reported these deviations to FERC and the resource agencies.

In 2019, the daily minimum DO concentration in the reservoir was below 5 mg/L from late July to late October (Table 4.7). In the tailrace, the DO concentration was below 5 mg/L on August 28, September 9 to 19, September 22 to October 2, and several days in October (October 4-6, 9, 16, 18, 21, 22). The Licensee reported these excursions and consulted with the resource agencies to identify options to mitigate the low DO. The Licensee ceased generation and obtained a temporary variance from FERC to reduce the headpond elevation to increase flows downstream (FERC 2019, LLG 2020a). The excursions below the standard in 2019 were attributed to low inflow conditions because of a lack of precipitation. At the downstream site, the daily minimum DO concentration was below 5 mg/L in late June, several days throughout July and August, and most days in September and October. pH was in attainment with standard at all three sites in 2019.

In 2020, the daily minimum DO in the reservoir was below the standard from mid-July to early September (excluding August 9), in late September, and several days in October (Table 4.7). There were two short-term (less than two hours) deviations of DO below the standard in the tailrace (July 30 and August 29). In accordance with the standard operating procedures for low DO conditions, changes made to operations quickly resulted in DO concentrations in the tailrace increasing to over the 5 mg/L standard (LLG 2020b,c, LLG 2021a). At the downstream site, the daily minimum DO concentration was below 5 mg/L on several days from July to mid-September. pH was in attainment with standard at all three sites in 2020.

**Table 4.7 Average (minimum-maximum) daily average water temperature and conductivity, range of daily minimum DO, and daily minimum and maximum pH from April 1 to October 31, 2018, 2019, and 2020 at the Lake Lynn Project.**

| Monitor/Gage | Year | Daily Average Water Temperature (°C) | Min-Max pH | Daily Minimum DO (mg/L) | Daily Average Specific Conductance (µS/m at 25°C) |
|---|---|---|---|---|---|
| Reservoir (USGS Gage No. 03071590 Stewartstown Gage) | 2018 | 20.4 (6.9-29.4) | 6.0-7.8 | 0.1 – 11.3 | 110 (69-180) |
| | 2019 | 21.1 (7.7-29.1) | 6.5-7.3 | 0.0-10.9 | 133 (78-180) |
| | 2020 | 19.2 (8.1-29.0) | 6.2-8.2 | 0.3-11.2 | 81 (43-128) |
| Tailrace (USGS Gage No. 03071605 Davidson Gage) | 2018 | 18.4 (6.7-25.2) | 6.0-7.0[a] | 4.5-10.7 | 141 (80-309)[b] |
| | 2019 | 17.4 (7.6-24.0) | 6.5-7.6 | 3.5-11.1 | 125 (80-388) |
| | 2020 | 19.0 (8.2-27.5) | 7.0-7.9 | 4.8-11.8 | 455 (180-1,018) |
| Downstream (USGS Gage No. 03071690 Nilan Gage) | 2018 | NA | NA | 5.1-12.2 | NA |
| | 2019 | NA | NA | 2.9-8.2 | NA |
| | 2020 | 13.2 (1.9-24.3) | 6.6-7.5[c] | 2.4-10.9 | 376 (134-795) |

[a] Missing April 6-May 3, May 18-August 12, 2018
[b] Through July 18, 2018 only
[c] Data for April 5-May 21 2020 only

In 2021, at the reservoir site, the daily average water temperatures ranged from 6.4°C to 25.3°C with an average of 18.4°C (Table 4.8, Figure 4.3). The daily minimum DO ranged from 0.8 mg/L to 11.6 mg/L, with an average of 6 mg/L. The DO concentration was below 5 mg/L from July 20 through the end of August, from September 27 to October 6 and occasionally from October 19 through the end of October (Figure 4.3). The reservoir pH ranged from 8.1 to 9.6 with an average of 8.8; daily maximum pH levels were above the standard from late August through September (Figure 4.4). The daily average conductivity ranged from 47 to 138.1 microsiemes per centimeter (µS/cm) (Table 4.8, Figure 4.5.)

At the tailwater monitoring station, the daily average water temperature ranged from 7.4 degrees Celsius (°C) to 25.6°C, with an average of 17°C (Table 4.9, Figure 4.6). Daily minimum DO levels in the tailwater ranged from 4 mg/L to 13.1 mg/L with an average of 8.4 mg/L. The daily minimum DO concentration was below the 5 mg/L standard on August 11 to 14 and August 16, which was likely due to an equipment malfunction, on August 20 and 30, and on September 1 (LLG 2021b, LLG 2022) (Figure 4.6). The daily average pH level ranged from 6.0 to 7.4 with an average of 6.4 and was in attainment with the standard throughout the study (Figure 4.7).

The downstream monitoring station had daily minimum DO levels ranging from 1.9 mg/L and 10.4 mg/L (Table 4.10). The daily minimum DO was below 5 mg/L on several days from late June through October (Figure 4.8). The pH ranged from 5.9 to 7, with an average of 6.4 (Figure 4.9).

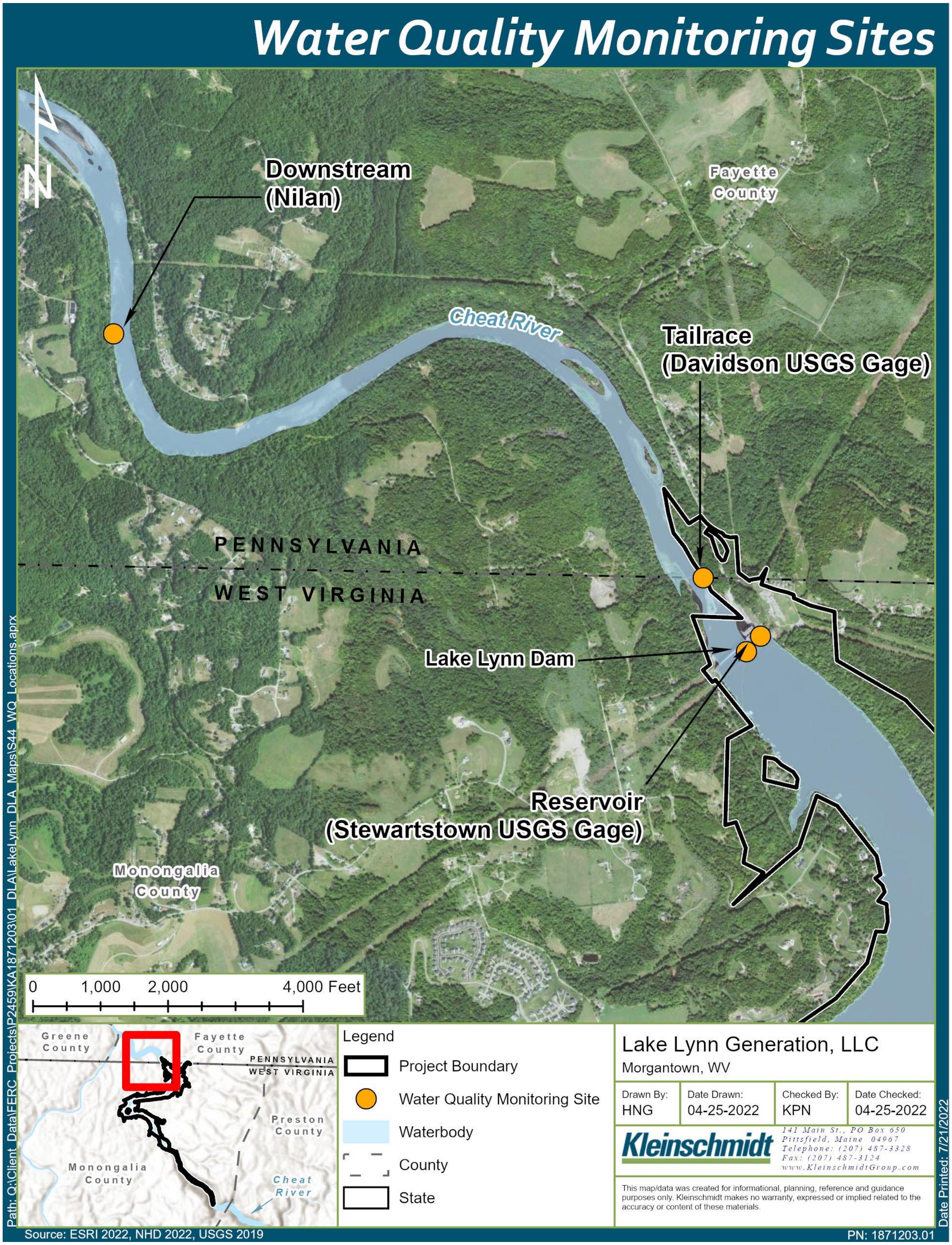


**Figure 4.2 Water quality monitoring stations at the Lake Lynn Project**

**Table 4.8 Water quality data statistics from the Lake Lynn Reservoir monitoring site, April 1 to October 31, 2021**

| Statistic | Daily average pH | Daily Minimum DO (mg/L) | Daily Average Water Temperature (°C) | Daily Average Conductivity (µS/cm) |
|---|---|---|---|---|
| Minimum | 8.1 | 0.8 | 6.4 | 47 |
| Maximum | 9.6 | 11.6 | 25.3 | 138.1 |
| Mean | 8.8 | 6.2 | 18.4 | 90.1 |

**Table 4.9 Water quality data statistics from the Lake Lynn Tailrace monitoring site, April 1 to October 31, 2021**

| Statistic | Daily Average pH | Daily Minimum DO (mg/L) | Daily Average Water Temperature (°C) |
|---|---|---|---|
| Minimum | 6.0 | 4.0 | 7.4 |
| Maximum | 7.0 | 13.1 | 25.6 |
| Mean | 6.4 | 8.4 | 17.0 |

*Data for conductivity was erroneous and not included in the annual report.

**Table 4.10 Water quality data statistics from the Lake Lynn Downstream monitoring site, April 1 to October 31, 2021.**

| Statistic | Daily Average pH | Daily Minimum DO (mg/L) |
|---|---|---|
| Minimum | 5.9 | 1.9 |
| Maximum | 7.0 | 10.4 |
| Mean | 6.4 | 5.9 |

*Data for temperature and conductivity was erroneous and not included in the annual report.

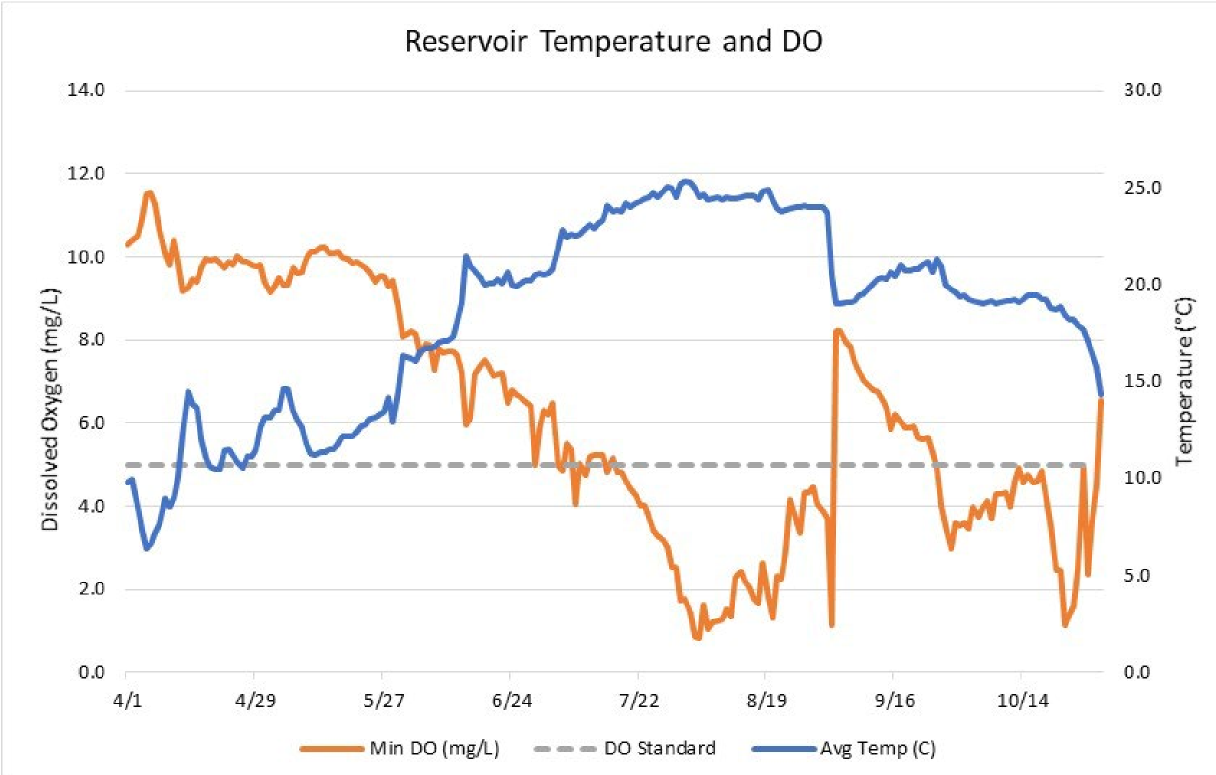


**Figure 4.3 Daily minimum DO and daily average water temperature at the reservoir monitoring site, April 1 to October 31, 2021.**

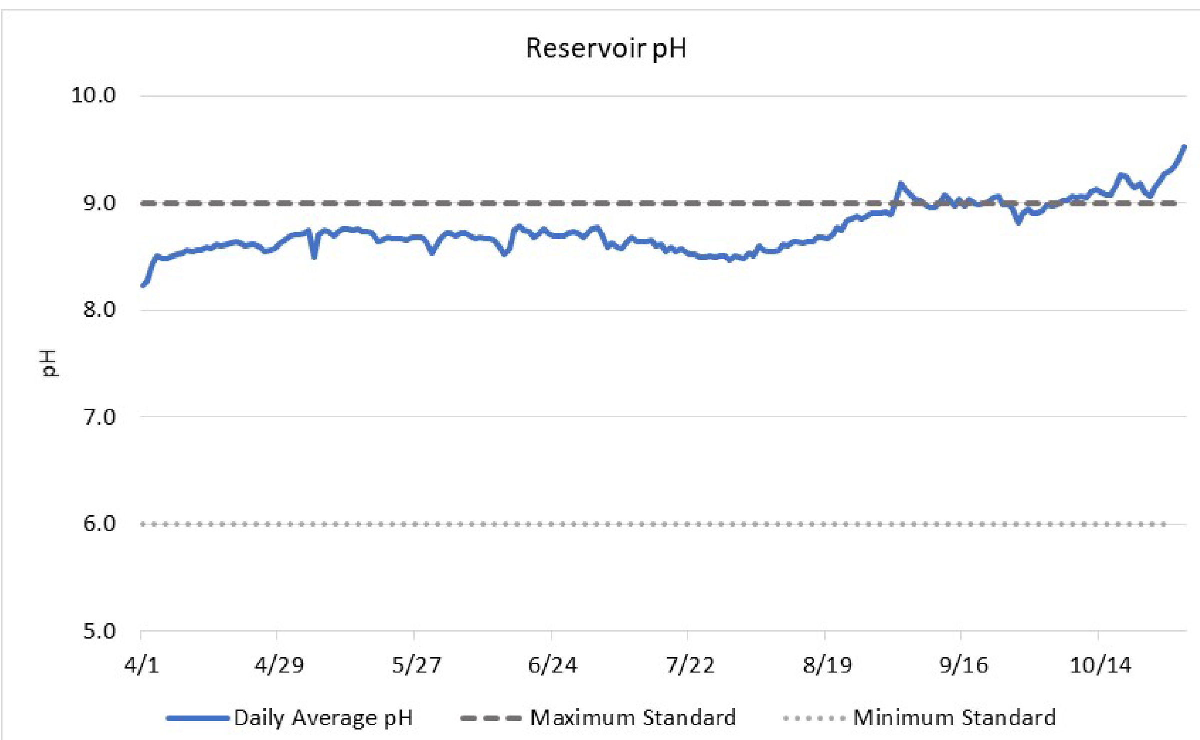


**Figure 4.4 Daily average pH at the reservoir monitoring site, April 1 to October 31, 2021.**

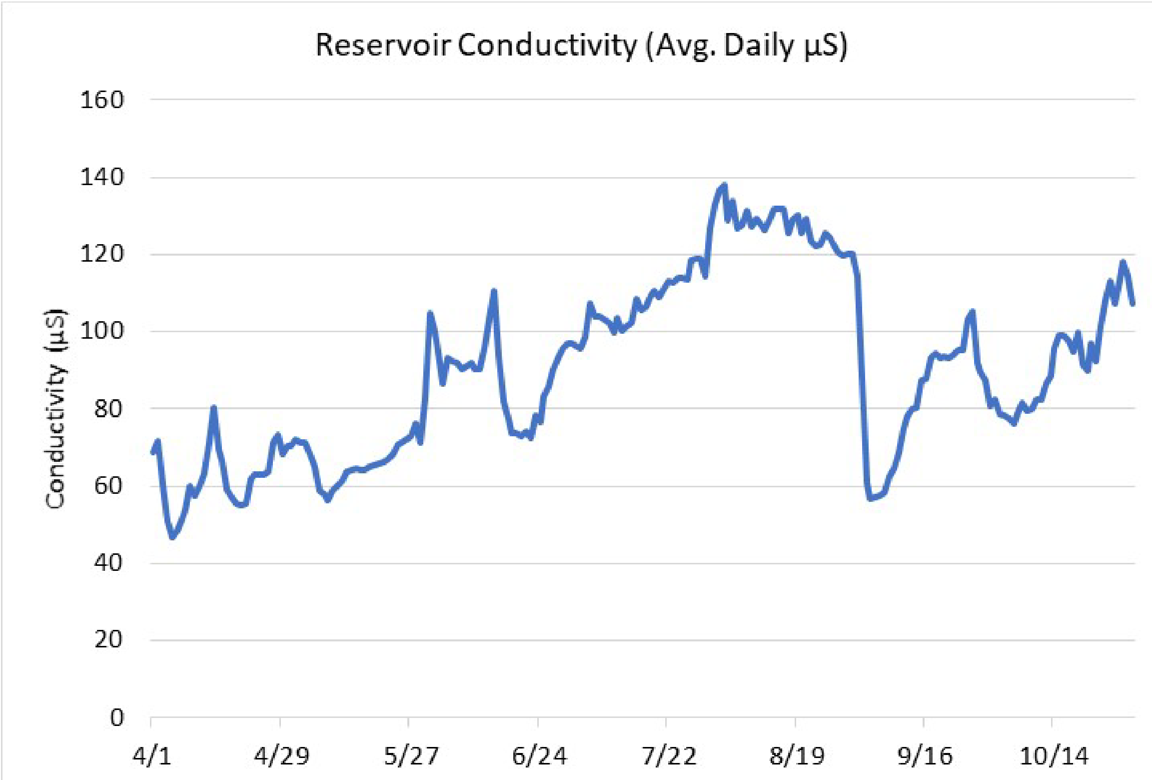


**Figure 4.5 Daily average conductivity at reservoir monitoring site, April 1 to October 31, 2021.**

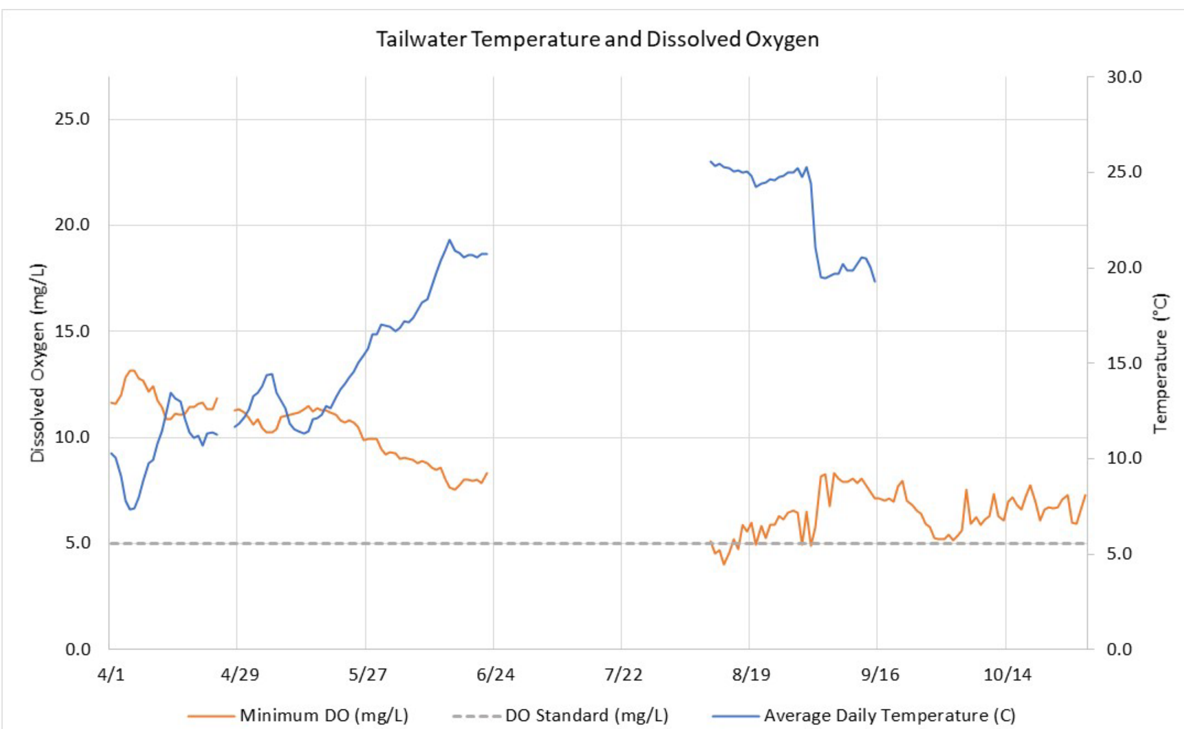


**Figure 4.6 Daily minimum DO and daily average water temperature at the tailwater monitoring site, April 1 to October 31, 2021.**

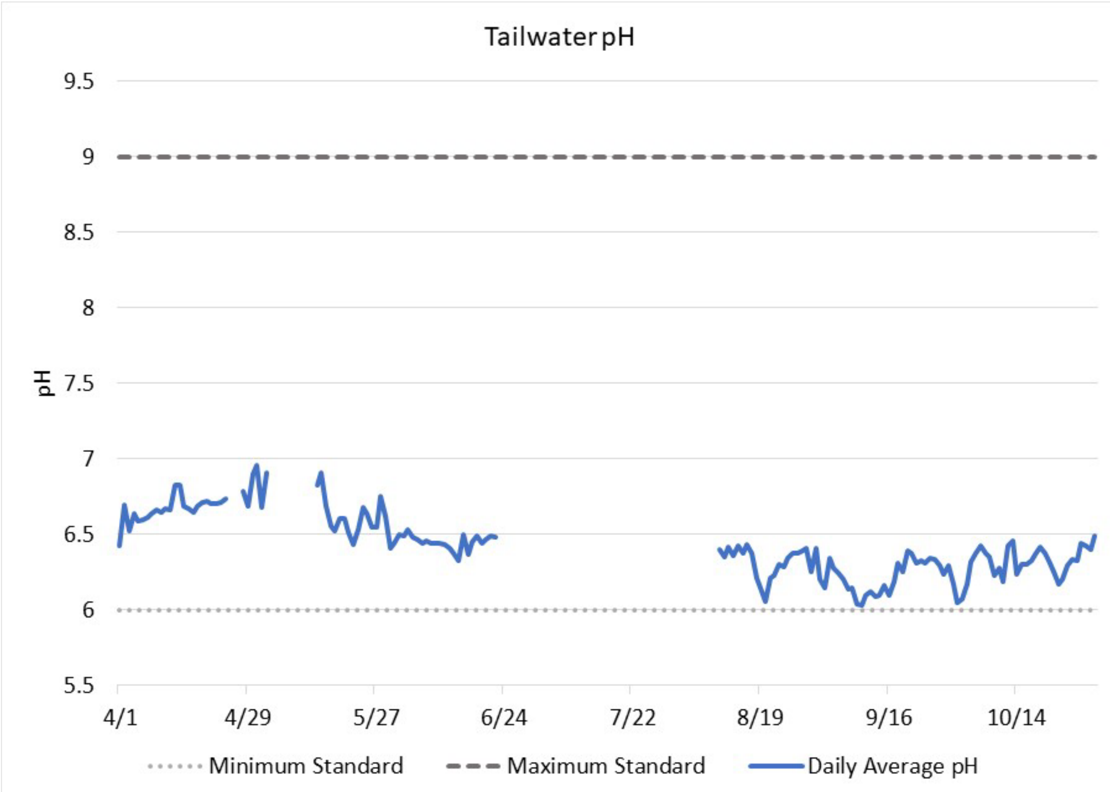


**Figure 4.7 Daily average pH at the tailwater monitoring site, April 1 to October 31, 2021.**

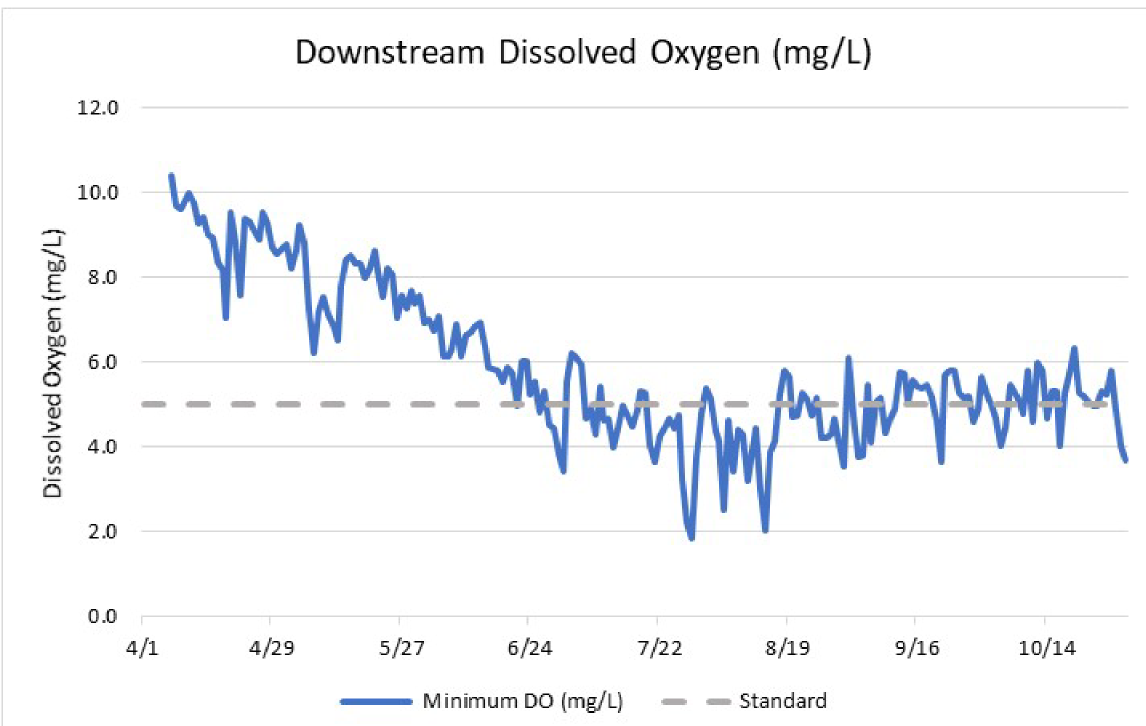


**Figure 4.8 Daily minimum DO at the downstream monitoring site, April 1 to October 31, 2021.**

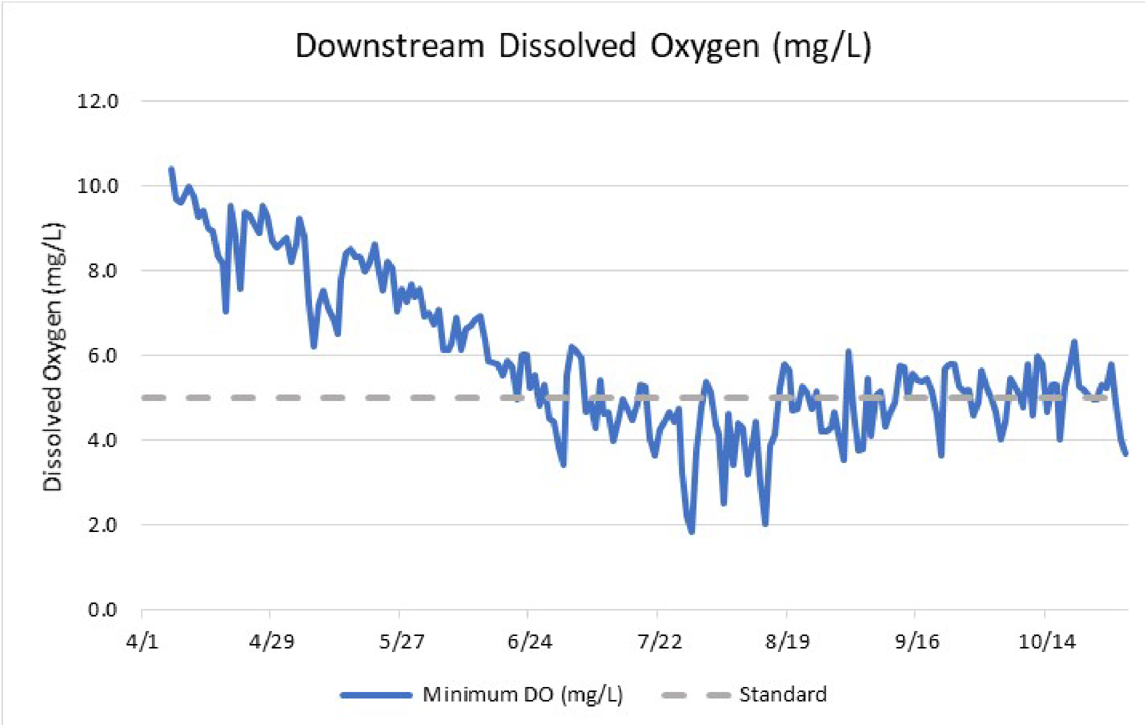


**Figure 4.9 Daily average pH at the downstream monitoring site, from April 1 to October 31, 2021.**

The WVDEP conducts spot measurements during several months each year (ranges from 6 to 12 months depending on year) downstream of the Lake Lynn dam (Station Code MC-0001-3.5) (WVDEP 2022b). DO, temperature, pH, and conductivity data for 2009 to 2021, including minimum, maximum and averages, are summarized in Table 4.11. The DO concentration ranged from 5.3 to 15.4 mg/L and was above the 5 mg/L standard. pH ranged from 5.5 to 8.1, though maintained an average from 6.4 to 7.0 and was in attainment with the standard in 2012 to 2021. Conductivity ranged from 1.0 to 168.0 µS/cm, with yearly averages ranging from 54.7 to 110.7 µS/cm. Temperature ranged from 0.4 °C to 27.8 °C, with yearly average ranging from 12.5 to 15.4 °C.

**Table 4.11 WVDEP water quality data collected downstream of the Lake Lynn dam, 2009 to 2021.**

| | 2009 | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 | 2017 | 2018 | 2019 | 2020 | 2021 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **DO** | | | | | | | | | | | | | |
| **Average (mg/L)** | 10.2 | 10.8 | 10.9 | 9.3 | 9.4 | 10.2 | 10.0 | 11.1 | 10.5 | 10.2 | 8.8 | 9.3 | 9.6 |
| **Min** | 6.7 | 6.9 | 7.9 | 5.3 | 5.4 | 5.7 | 7.8 | 7.5 | 6.6 | 7.9 | 5.6 | 6.1 | 5.6 |
| **Max** | 13.6 | 15.4 | 14.2 | 12.1 | 12.4 | 13.6 | 13.3 | 14.0 | 13.0 | 13.2 | 14.0 | 13.6 | 13.3 |
| **Temperature** | | | | | | | | | | | | | |
| **Average (°C)** | 13.3 | 14.1 | 10.2 | 15.4 | 12.5 | 12.8 | 14.7 | 13.9 | 13.7 | 13.8 | 15.3 | 13.6 | 12.8 |
| **Min** | 2.2 | 0.4 | 0.4 | 2.5 | 1.6 | 0.2 | 0.7 | 0.8 | 5.6 | 2.0 | 2.5 | 4.2 | 1.6 |
| **Max** | 24.1 | 26.6 | 24.1 | 24.9 | 23.2 | 22.5 | 26.0 | 27.0 | 23.2 | 25.1 | 26.0 | 27.8 | 25.3 |
| **pH** | | | | | | | | | | | | | |
| **Average** | 6.9 | 6.9 | 6.4 | 7.0 | 6.7 | 6.9 | 7.0 | 6.9 | 6.9 | 6.7 | 6.8 | 6.9 | 6.7 |
| **Min** | 6.2 | 5.5 | 5.8 | 6.7 | 6.3 | 6.2 | 6.3 | 6.6 | 6.4 | 6.3 | 6.0 | 6.7 | 6.3 |
| **Max** | 7.5 | 7.8 | 7.1 | 7.3 | 7.3 | 7.5 | 8.1 | 7.4 | 7.4 | 7.1 | 7.1 | 7.2 | 7.1 |
| **Conductivity** | | | | | | | | | | | | | |
| **Average (µS/cm)** | 99.6 | 94.3 | 77.3 | 94.9 | 108.0 | 107.4 | 74.9 | 100.9 | 91.4 | 54.7 | 108.2 | 103.1 | 110.7 |
| **Min** | 75.0 | 11.0 | 8.0 | 7.0 | 76.0 | 11.0 | 14.0 | 11.0 | 9.0 | 1.0 | 82.9 | 72.5 | 74.0 |
| **Max** | 136.0 | 166.0 | 125.0 | 136.0 | 152.0 | 151.0 | 129.0 | 133.0 | 131.0 | 101.0 | 168.0 | 119.0 | 144.0 |

Source: WVDEP 2022b

### 4.4.2 Environmental Effects

#### 4.4.2.1 Effects of the Proposed Action

The Licensee is proposing to continue to operate the Lake Lynn Project as currently licensed with no changes to Lake Lynn Project facilities and will continue to provide the existing seasonal elevations and minimum flows downstream of the dam. As such, the proposed action is not expected to adversely affect water quantity in the Lake Lynn Project area as compared to existing conditions. The proposed modification to the Lake Lynn Project boundary is not anticipated to affect water quantity or water quality.

The Licensee proposes to prepare a new water quality monitoring plan for the new license term that includes the stations and parameters that can be affected by Lake Lynn Project operations. The Licensee proposes that the new water quality monitoring plan would include monitoring of DO and water temperature from April 1 through October 31 each year at the reservoir water quality monitoring station and the tailwater monitoring site only. The downstream monitoring site is at USGS Gage No. 03071690 Nilan, approximately 2.6 RM downstream of the Lake Lynn dam, and downstream of Grassy Run. Since this station is downstream of Grassy Run, water quality monitoring at this station is impacted by Grassy Run and other factors outside the control of the Licensee. The Licensee also proposes to discontinue pH and conductivity monitoring.

The Licensee closely monitors tailrace DO levels and has developed standard operating procedures to adjust operations to mitigate low DO concentrations. These procedures include limiting or reducing generation and opening additional spill gates to increase flow downstream. Lake Lynn is proposing to continue to follow those procedures. In 2019, Lake Lynn consulted with the resource agencies and received a temporary variance from FERC to draw down the reservoir to 865 ft during a period of low DO levels in an effort to mitigate the low tailrace DO conditions. In 2020, when DO levels started to decrease, Lake Lynn consulted with the agencies again and received support for pursuing a similar variance. In 2022, when DO levels started to decrease, Lake Lynn consulted with the agencies again and received support for pursuing a similar temporary variance from FERC. Lake Lynn is proposing to develop an Operation Plan under the new license that will include standard operating procedures to be implemented during period of low DO levels in an effort to mitigate low tailrace DO levels that will also allow the reservoir to be drawn down to 865 ft, consistent with the consultation with resource agencies in 2019, 2020, and

2022. The Operation Plan will also document how Lake Lynn will comply with the operational requirements of the license.

Existing water quality conditions at the Lake Lynn Project are anticipated to continue under the proposed action. Periods of low DO concentrations (e.g., less than the 5 mg/L standard) are expected to be minimal because the operational changes implemented (e.g., reducing generation, opening spill gates) have been consistently shown to quickly improve DO concentrations in the tailrace (e.g., LLG 2020b, c; LLG 2021b). Lake Lynn's proposal to implement the procedures (draw the reservoir down to 865 ft) obtained via a temporary variance in 2019 would provide flexibility to further mitigate low tailrace DO conditions.

#### 4.4.2.2 Effects of the No-Action Alternative

The effects of the no-action alternative mimic the anticipated effects of the proposed action because the Licensee is proposing no changes to existing facilities or operations.

### 4.4.3 Unavoidable Adverse Effects

The proposed action and PME measures (i.e., continued operation and relicensing of the Lake Lynn Project and standard operating procedures to mitigate low DO values) are not expected to result in unavoidable adverse effects to water quantity and water quality resources in the Lake Lynn Project area.

### 4.4.4 References

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## 4.5 Fish and Aquatic Resources

### 4.5.1 Affected Environment

#### Aquatic Habitat – Cheat Lake

Cheat Lake is approximately 13-miles-long with a surface area of 1,729 acres and a volume of about 72,000 acre-feet at a full pool elevation of 870 feet National Geodetic Vertical Datum (NGVD). The Lake Lynn impoundment is approximately 950-feet-wide immediately upstream of the Lake Lynn dam, narrowing to 300 feet at the upstream end, with a maximum width of approximately 2,500 feet. The Licensee operates the Lake Lynn Project as a dispatchable peaking facility which allows for storage capability. Impoundment elevations are maintained between 868 to 870 feet NGVD from May 1 to March 31, between 857 to 870 feet from November 1 through March 31, and between 863 to 870 feet from April 1 to April 30. Additionally, the licensee is required to release a minimum flow of 212 cfs from the dam, with an absolute minimum of 100 cfs regardless of inflow.

The licensee worked with WVDNR and West Virginia University (WVU) to document the distribution and relative abundance of aquatic habitat in Cheat Lake as part of the 2018-2020 Aquatic Biomonitoring Plan. Aquatic vegetation provides habitat for fish and aquatic organisms, yet historically Cheat Lake has had limited aquatic vegetation (Smith and Welsh 2015) The study identified 22 areas of significant aquatic vegetation in Cheat Lake. Overall, aquatic vegetation was found to be limited in Cheat Lake.

WVDNR and WVU conducted studies in 2019 and 2020 to evaluate aquatic habitat in Cheat Lake with an emphasis on yellow perch spawning and water level fluctuation. During the study, 40 artificial habitat structures were deployed at two sites on Cheat Lake in 2019 and 2020. The structures were monitored for egg masses during the spring spawning period. Habitat variables and water quality were recorded at the sites during the study. A complete report was developed by Welsch et al. (2020) and provided to FERC and the stakeholders as part of the 2020 Annual Biomonitoring Report. Researchers found that yellow perch in Cheat Lake spawn in nearshore habitat, in a variety of depths or distances from the shore. Deepwater spawning reduces the effects of lake level drawdowns on egg dewatering, yet less available habitat was noted in deeper water. Yellow perch spawning periods were identified as March 21 to April 16 in 2019 and March 21 to April 11 in 2020. The lake level typically does not reach the minimum lake elevations permitted during March or April, therefore, although the potential for egg dewatering is high, the actual percent of eggs dewatered is lower than the rates documented with artificial habitat during the study (Welsh and Matt 2020).

#### 4.5.1.1 Cheat River (Downstream of Cheat Lake)

The Lake Lynn Project boundary extends downstream approximately 656 feet from the Lake Lynn dam. The Cheat River flows approximately 3.6 RMs from the Lake Lynn dam until joining the Monongahela River near Point Marion, Pennsylvania. The Cheat River downstream of the Lake Lynn dam is comprised of two distinct aquatic habitat reaches. From the Lake Lynn dam to approximately 1.2 miles downstream, the Cheat River is a riffle-run complex, composed of a heterogenous mixture of cobble, gravel, boulder, bedrock, and sand (Table 4.12, Photo 4.1). Downstream of the riffle-run complex, the Cheat River transitions into pool habitat until its confluence with the Monongahela River (Photo 4.2). Pool habitat substrate is composed mostly of cobble and gravel, with the most downstream reaches of the Cheat River transitioning to sand and silt (TRC 2020).

**Table 4.12 Cheat River Substrate Summary during 2020 Mussel Survey**

| Site | State | % Substrate Composition | | | | | | | | Total |
|---|---|---|---|---|---|---|---|---|---|---|
| | | Br | Bo | Co | Gr | Sd | St | LWD | Vegetation | |
| 1 | WV | 10 | 30 | 45 | 10 | 5 | - | - | - | 100 |
| 2 | WV | 5 | - | 40 | 20 | 10 | - | - | - | 100 |
| 3 | PA | - | - | 70 | - | - | - | - | 30 | 100 |
| 4 | PA | - | - | 45 | 30 | 25 | - | - | - | 100 |
| 5 | PA | - | - | 60 | 30 | - | - | - | 10 | 100 |
| 6 | PA | - | 5 | 55 | 25 | - | - | - | 15 | 100 |
| 7 | PA | - | - | 60 | 40 | - | - | - | - | 100 |
| 8 | PA | - | - | 40 | 35 | - | - | 5 | 20 | 100 |
| 9 | PA | - | - | 65 | 15 | - | - | - | 20 | 100 |
| 10 | PA | - | - | 75 | 15 | - | - | - | 10 | 100 |
| 11 | PA | - | - | 60 | 15 | 25 | - | - | - | 100 |
| 12 | PA | - | - | - | - | 55 | 35 | 10 | - | 100 |
| Br=Bedrock, Bo=Boulder, Cb=Cobble, GR=Gravel, Sd=Sand, St= Silt, LWD= Large Woody Debris | | | | | | | | | | |

Source: TRC 2020

**Photo 4.1 Cheat River Habitat Directly Downstream of the Lake Lynn Dam during the 2020 Mussel Survey (TRC 2020)**

**Photo 4.2 Cheat River Pool Habitat Downstream of the Lake Lynn Dam during the 2020 Mussel Survey (TRC 2020)**

During the 1970s water quality degradation was documented in the Cheat River due to acid mine drainage (AMD) discharged from abandoned or active coal mine operations. In 1994, an illegally sealed underground mine failed and discharged contaminated water directly into Muddy Creek (TRC 2020). AMD entered the Cheat River directly above Cheat Canyon and polluted the watershed. Effects of AMD were noted at multiple sites during the 2020 mussel survey completed as part of the relicensing (Photo 4.3) (TRC 2020).

**Photo 4.3 Acid Mine Drainage in the Cheat River Downstream of the Lake Lynn Dam during 2020 Mussel Survey (TRC 2022)**

#### 4.5.1.2 Fish and Aquatic Assemblages

The Cheat River watershed supports warm water and cool water fisheries. Important recreational fishery species include largemouth bass, smallmouth bass, trout, crappie, walleye, and channel catfish. The licensee has conducted biological monitoring in Cheat Lake and in the tailwater since 1997, in accordance with the current FERC License. Biological surveys were also conducted by WVDNR in 2005 and 2008 and by WVU in 2011, 2014, and 2015. Researchers assessed water quality, aquatic habitat, and aquatic communities (fish and benthic macroinvertebrates). Freshwater mussel, American eel eDNA, water quality monitoring and aquatic habitat studies have also been conducted in the Lake Lynn Project area by the Licensee and other researchers. Table 4.13 summarizes the research efforts that have taken place in the Lake Lynn Project area since 1997. Aquatic resource quality has generally improved over the sampling period (Wellman et al. 2008).

**Table 4.13 Summary of Cheat River and Cheat Lake Biomonitoring Activities from 1997 to 2020**

| Activity | '97 | '98 | '99 | '00 | '01 | '02 | '03 | '04 | '05 | '06 | '07 | '08 | '09 | '10 | '11 | '12 | '13 | '14 | '15 | '16 | '17 | '18 | '19 | '20 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Water quality monitoring (Cheat Lake) | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X |
| Water quality monitoring (downstream of Cheat Lake) | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X |
| Fish community (Cheat Lake and embayments) | X | X | | | X | | X | | X | | | X | | | X | | | X | X | | | | | |
| Benthic macroinvertebrates (downstream of Cheat Lake) | X | X | | | X | | | | X | | | | | | X | | | X | X | | | | | |
| Walleye population monitoring and stock assessment | X | X | | | X | | | | X | | | X | | | X | | | X | X | | | | | |
| Adult walleye movement | | | | | | | | | X | X | X | X | X | | X | X | X | X | X | | | | | |
| Aquatic vegetation mapping | | | | | | | | | X | X | X | | X | | X | X | X | | X | | | | | |
| Bathymetric mapping (Cheat Lake) | | | | | | | | | | | | | | | X | X | X | | X | | | | | |

| Activity | '97 | '98 | '99 | '00 | '01 | '02 | '03 | '04 | '05 | '06 | '07 | '08 | '09 | '10 | '11 | '12 | '13 | '14 | '15 | '16 | '17 | '18 | '19 | '20 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Artificial habitat enhancement and monitoring | | | | | | | | | | | | | | | | | | | | | | X | X | X |
| American Eel eDNA (downstream of Cheat Lake) | | | | | | | | | | | | | | | | | | | | | | X | X | X |
| Angler creel survey | | | | | | | | | | | | | | | | | | | | | | | | 1 |
| Freshwater mussel survey (Cheat River downstream of Cheat Lake) | | | | | | | | | | | | | | | | | | | | | | | | X |

1 – the angler creel survey is taking place in 2022.

**Lake Lynn Fisheries** - WVDNR's 2005 and 2008 surveys were conducted in May and October and included nighttime boat electrofishing and gill netting. Sampling locations are shown in Figure 4.10 and Figure 4.11. WVU sampled the fish community in 2011, 2014, and 2015 with nighttime boat electrofishing and gill netting during the spring and fall seasons. In total, WVU collected 35 fish species and 8,338 individual fish. Most fish (7,499 individuals) were collected during nighttime boat electrofishing as compared to gill netting (839 individuals). Overall, species richness increased in the riverine zone of Cheat Lake, compared to previous studies. In prior studies in the riverine zone, species richness was as low as 8 species (1990), whereas an average of 23 species were collected during WVU's the 2011 to 2015 samples (Table 4.14). In addition to species richness, species abundance increased between 2011 and 2015 for sportfish and non-game species as compared to prior studies. The most abundant sportfish in Lake Lynn during the 2011 and 2014 sampling included bluegill, smallmouth bass, largemouth bass, yellow perch, and channel catfish. The most abundant non-game species included the emerald shiner, mimic shiner, logperch, brook silverside, and gizzard shad (Smith and Welsh 2015).

In accordance with the 2021-2023 Biomonitoring Plan, the Licensee is conducting a creel survey (a sampling survey that targets recreational anglers) in 2022 to document recreational fishing effort and success. The initial study was planned for 2020, but was postponed due to the Coronavirus Disease 2019 (COVID-19) pandemic. The survey includes survey boxes and in-person creel surveys at six locations on Cheat Lake. Areas surveyed include Ices Ferry Bridge access, Edgewater Marina, Lakeside Marina, Sunset Beach Marina, Cheat Lake Park, and the Lake Lynn Project Tailwater Fishing Pier. The survey is collecting information through December 2022 including angler effort, fish harvest data for game fish species, and size distribution of game fish species.

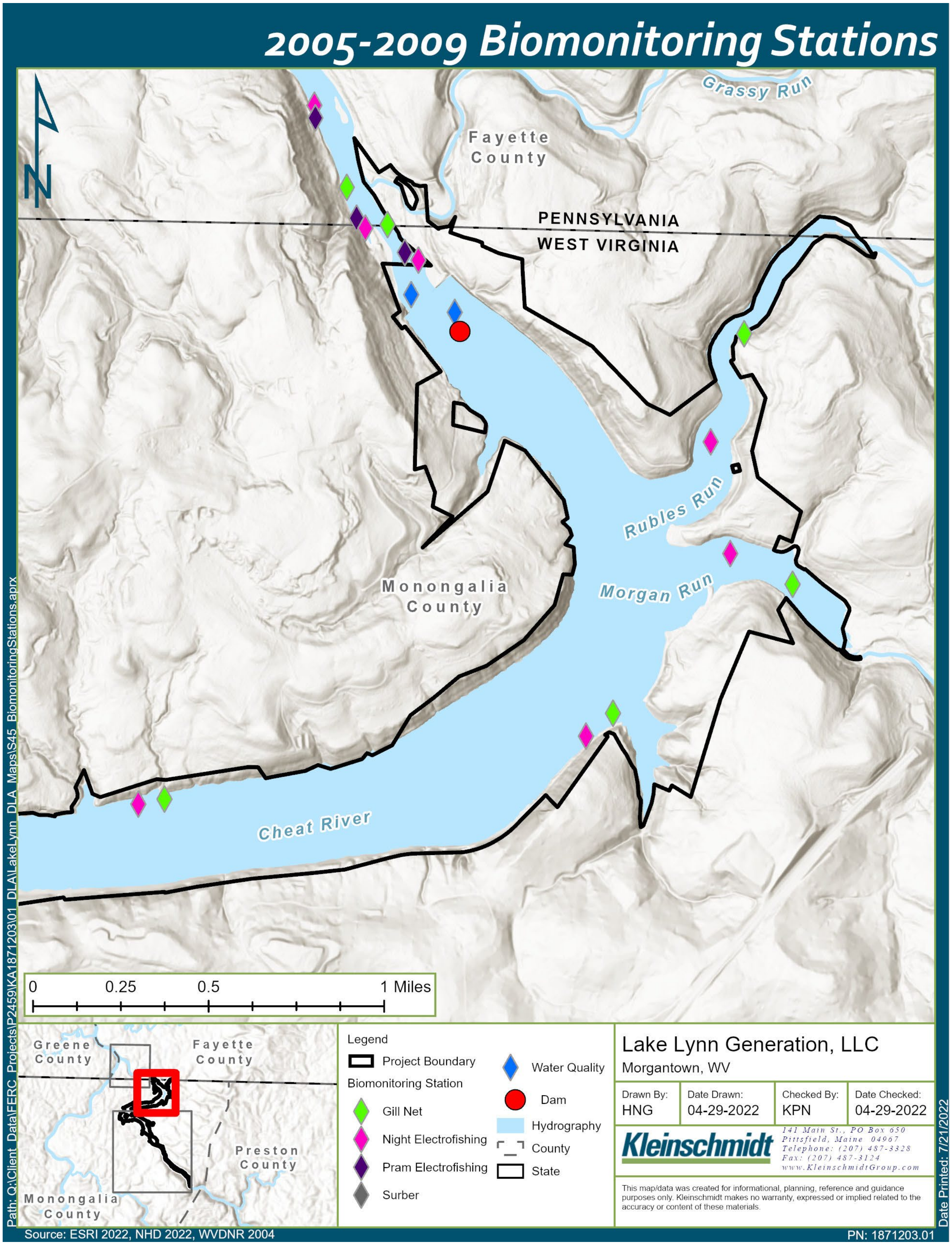


**Figure 4.10 Fish Sampling Locations in Lake Lynn (2005, 2008, 2011, 2014, and 2015) (1 of 2).**

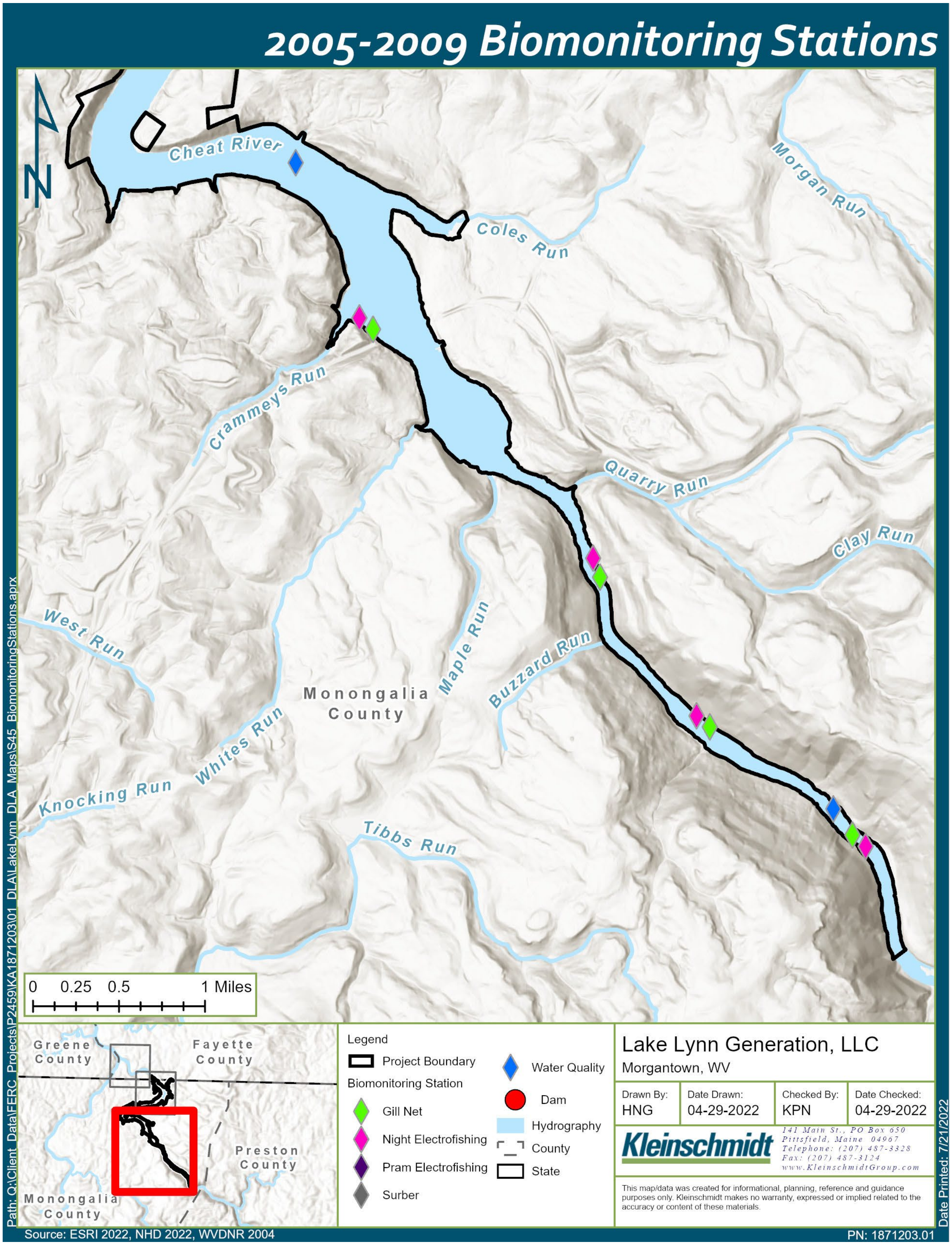


**Figure 4.11 Fish Sampling Locations in Lake Lynn (2005, 2008, 2011, 2014, and 2015) (2 of 2).**

**Table 4.14 Temporal Trends in Fish Catch Per Unit Effort of Boat Electrofishing in the Lake Lynn Impoundment**

| Boat Electrofishing | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| **Species** | **1990** | **1997** | **1998** | **2001** | **2005** | **2008** | **2011** | **2014** | **Grand Total** |
| Banded Darter | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.50 | 0.00 | 0.50 | 0.11 |
| Black Crappie | 0.22 | 0.00 | 0.11 | 0.00 | 0.00 | 0.50 | 2.50 | 3.75 | 0.81 |
| Bluegill | 8.44 | 15.08 | 11.56 | 30.11 | 12.50 | 186.00 | 10.50 | 27.25 | 36.59 |
| Bluntnose Minnow | 0.22 | 0.00 | 0.00 | 9.11 | 10.50 | 14.25 | 7.75 | 0.75 | 5.38 |
| Brook Silverside | 4.00 | 5.00 | 4.89 | 11.33 | 6.00 | 37.25 | 11.25 | 5.75 | 10.58 |
| Brown Bullhead | 5.11 | 0.00 | 0.56 | 0.00 | 0.00 | 0.00 | 0.50 | 0.00 | 0.59 |
| Common Carp | 0.89 | 2.67 | 2.56 | 2.33 | 3.50 | 1.25 | 0.25 | 0.75 | 1.88 |
| Emerald Shiner | 7.11 | 21.67 | 20.56 | 25.67 | 5.00 | 7.25 | 125.50 | 22.25 | 29.30 |
| Chain Pickerel | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.25 | 3.00 | 0.37 |
| Channel Catfish | 0.22 | 0.42 | 0.22 | 1.00 | 0.75 | 3.00 | 1.00 | 2.00 | 1.05 |
| Channel Darter | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.50 | 0.06 |
| Gizzard Shad | 0.00 | 0.00 | 0.22 | 2.44 | 1.00 | 0.75 | 5.75 | 0.00 | 1.31 |
| Golden Redhorse | 0.00 | 0.92 | 1.67 | 1.33 | 4.25 | 4.25 | 19.50 | 40.00 | 8.39 |
| Golden Shiner | 0.00 | 0.00 | 0.11 | 0.11 | 0.00 | 0.50 | 0.00 | 0.00 | 0.10 |
| Greenside Darter | 0.00 | 0.00 | 0.00 | 0.33 | 0.00 | 0.00 | 0.00 | 1.25 | 0.20 |
| Green sunfish | 0.22 | 0.00 | 0.33 | 2.11 | 1.75 | 19.50 | 1.25 | 10.50 | 4.21 |
| Flathead Catfish | 0.00 | 0.25 | 0.33 | 0.00 | 0.25 | 0.00 | 0.00 | 0.25 | 0.14 |
| Freshwater Drum | 0.44 | 0.58 | 0.56 | 0.78 | 0.75 | 1.00 | 0.50 | 3.00 | 0.93 |
| Hybrid Striped Bass | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.25 | 0.00 | 0.03 |
| Hybrid Sunfish | 1.56 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.25 | 0.25 | 0.19 |
| Johnny Darter | 0.00 | 0.00 | 0.11 | 0.44 | 0.00 | 3.25 | 0.00 | 1.75 | 0.67 |
| Largemouth Bass | 2.44 | 2.75 | 3.89 | 3.67 | 8.50 | 4.50 | 9.50 | 7.50 | 6.39 |
| Logperch | 0.00 | 1.42 | 3.33 | 3.11 | 10.75 | 1.50 | 2.25 | 14.00 | 4.52 |
| Longnose Gar | 0.00 | 0.00 | 0.00 | 0.22 | 0.00 | 0.50 | 0.25 | 1.25 | 0.27 |
| Mimic Shiner | 0.89 | 0.00 | 0.00 | 33.78 | 5.50 | 54.50 | 12.75 | 29.50 | 17.55 |

| Boat Electrofishing | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| **Species** | **1990** | **1997** | **1998** | **2001** | **2005** | **2008** | **2011** | **2014** | **Grand Total** |
| Northern Hogsucker | 0.00 | 0.00 | 0.33 | 0.00 | 0.50 | 0.25 | 0.00 | 0.25 | 0.17 |
| Northern Pike | 0.22 | 0.08 | 0.22 | 0.11 | 0.75 | 0.00 | 0.00 | 0.00 | 0.17 |
| Popeye Shiner | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.25 | 0.03 |
| Pumpkinseed | 4.67 | 1.75 | 2.33 | 1.22 | 0.50 | 3.75 | 0.50 | 0.50 | 1.81 |
| Quillback | 0.00 | 0.33 | 0.00 | 0.00 | 0.00 | 0.00 | 0.75 | 0.25 | 0.15 |
| Rainbow Darter | 0.00 | 0.00 | 0.22 | 0.00 | 0.00 | 0.00 | 0.00 | 2.50 | 0.32 |
| River Carpsucker | 0.00 | 0.00 | 0.22 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.04 |
| Rock Bass | 0.67 | 0.42 | 3.33 | 2.11 | 0.25 | 6.50 | 2.00 | 11.25 | 3.32 |
| Rosyface Shiner | 0.00 | 0.00 | 0.00 | 0.00 | 30.25 | 3.50 | 0.00 | 0.00 | 3.86 |
| Sauger | 0.00 | 0.67 | 2.44 | 1.78 | 1.75 | 1.50 | 4.25 | 4.50 | 2.17 |
| Smallmouth Redhorse | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.50 | 0.00 | 0.06 |
| Silver Redhorse | 1.56 | 0.25 | 0.78 | 0.00 | 0.00 | 0.25 | 0.00 | 11.25 | 1.61 |
| Silver Shiner | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 5.00 | 0.00 | 6.25 | 1.29 |
| Smallmouth Bass | 0.44 | 6.42 | 5.78 | 4.78 | 5.00 | 18.50 | 27.00 | 35.50 | 12.41 |
| Spottail Shiner | 0.22 | 1.67 | 1.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.25 | 0.41 |
| Spotted Bass | 0.22 | 0.75 | 0.00 | 1.00 | 2.25 | 4.75 | 3.25 | 8.75 | 2.45 |
| Spotfin Shiner | 0.22 | 0.00 | 0.00 | 0.67 | 7.25 | 9.00 | 0.50 | 0.25 | 2.08 |
| Walleye | 0.00 | 0.00 | 0.00 | 1.00 | 0.00 | 0.50 | 6.25 | 2.00 | 1.17 |
| Warmouth | 0.22 | 0.00 | 0.00 | 0.00 | 0.00 | 0.25 | 0.00 | 0.00 | 0.05 |
| White Bass | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 3.50 | 0.00 | 0.40 |
| White Sucker | 0.00 | 0.00 | 0.00 | 0.00 | 0.25 | 0.00 | 0.00 | 0.00 | 0.03 |
| White Crappie | 0.00 | 0.33 | 0.00 | 0.67 | 0.00 | 0.00 | 0.00 | 0.00 | 0.15 |
| Yellow Bullhead | 0.44 | 0.08 | 0.11 | 0.33 | 0.00 | 0.00 | 0.00 | 0.50 | 0.18 |
| Yellow Perch | 9.56 | 7.92 | 24.22 | 14.00 | 1.75 | 0.25 | 1.25 | 22.75 | 11.25 |

Source: WVDNR 2004

**Cheat River Fisheries** - WVDNR conducted fisheries surveys in the Cheat Lake tailwater and in the Cheat River downstream of the dam in 2005 and 2008. The surveys consisted of nighttime boat electrofishing, tote barge electrofishing, and gill netting. Surveys took place during low water conditions in May and October. Eight tailwater survey stations and three river survey locations were established (Figure 4.12). Catch per unit effort (CPUE) was calculated as fish captured per hour of fishing effort. Tote barge electrofishing at tailwater stations targeted juvenile fish collection (Smith and Welsh 2015). In addition to the 2005 to 2009 samples, WVU sampled the Cheat Lake tailwater and in the Cheat River downstream of the dam in 2011 and 2014. The survey locations and methods were consistent with WVDNR's 2005 and 2008 surveys. Boat electrofishing and gill netting was conducted twice a year, whereas tote barge electrofishing was conducted three times a year.

During the 2011 and 2014 surveys in the Cheat River downstream of the Lake Lynn dam, WVU collected 3,352 fish consisting of 51 species. Fish abundance, which ranged from 1,825 in 2011 to 1,527 in 2014, was the highest since the biomonitoring program began. Species richness was also the highest in 2011 and 2014 since the biomonitoring program began (Table 4.15). Most fish were captured via boat electrofishing and tote barge electrofishing as compared to gill netting. WVU researchers captured six species during the 2011 and 2014 surveys for the fish time since the biomonitoring program began (channel darter, variegate darter, chain pickerel, popeye shiner, muskellunge, and striped shiner). The most abundant species sampled in the Cheat River included the emerald shiner, smallmouth bass, golden redhorse, mimic shiner, and channel catfish (Smith and Welsh 2015).

**Table 4.15 Fish Species Richness for Cheat Lake Tailwater and Cheat River Summarized by Gear Type**

| Species Richness | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| **Region** | **Gear** | **1990** | **1997** | **1998** | **2001** | **2005** | **2008** | **2011** | **2014** |
| Cheat Tailwater | Night Boat Electrofishing | - | 15 | 19 | 24 | 18 | 25 | 14 | 20 |
| | Biomonitoring Gill Nets | - | 8 | 15 | 13 | 14 | 14 | 9 | 5 |
| | PRAM electrofishing | - | 18 | 14 | 25 | 16 | 17 | 16 | 30 |
| Cheat River | Night Boat Electrofishing | 23 | 20 | 24 | 26 | 22 | 25 | 29 | 31 |
| | Biomonitoring Gill Nets | 17 | 7 | 14 | 10 | 16 | 17 | 16 | 11 |
| TW & River | Night Boat Electrofishing | 24 | 22 | 28 | 28 | 25 | 31 | 30 | 37 |
| | Biomonitoring Gill Nets | 17 | 11 | 19 | 16 | 19 | 20 | 19 | 12 |
| | All gears | 28 | 32 | 35 | 37 | 36 | 39 | 35 | 44 |

Source: WVDNR 2004

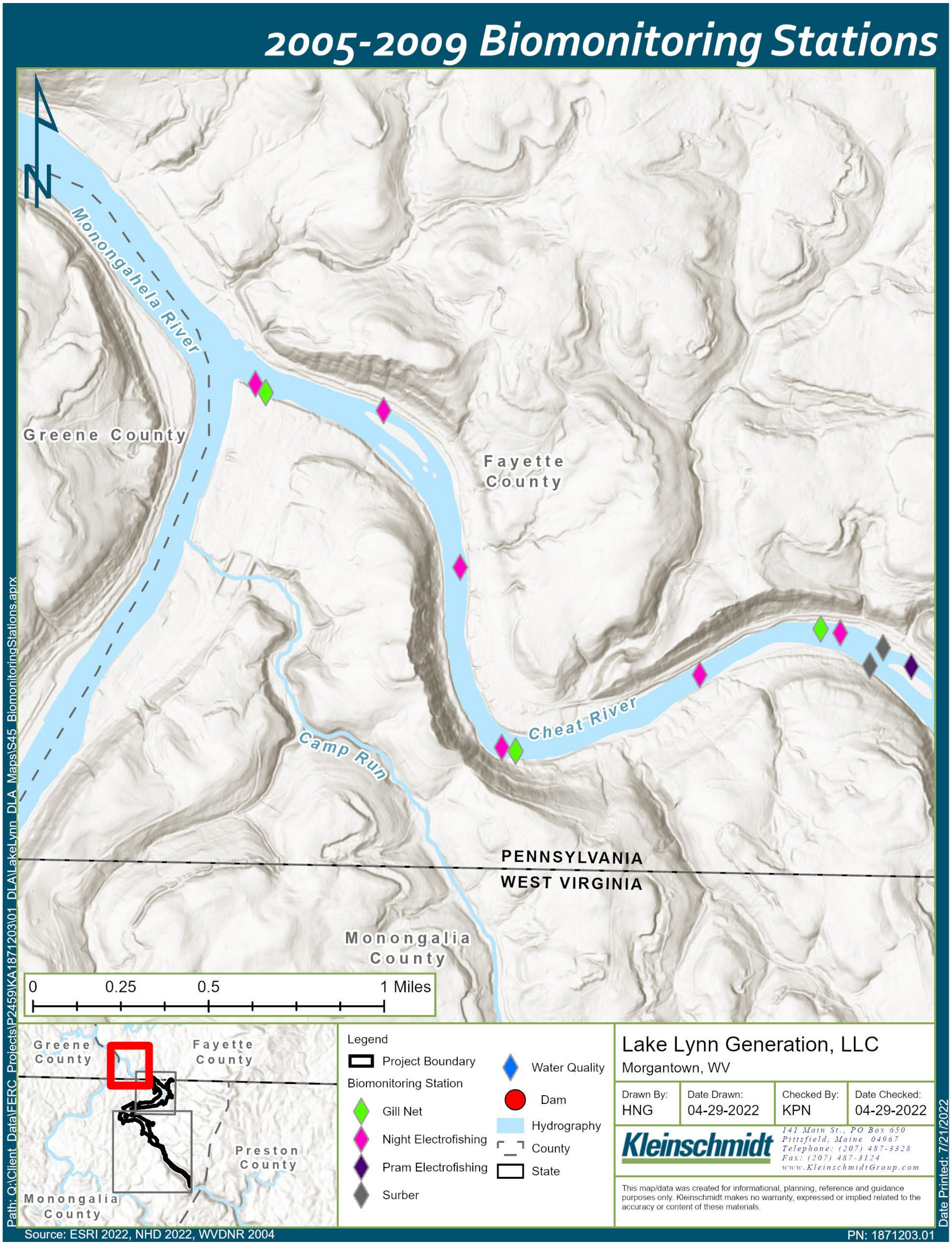


**Figure 4.12 Tailwater and Cheat River fish sampling locations, 2005 and 2008; WVU fish sampling locations 2011 and 2014.**

#### 4.5.1.3 Essential Fish Habitat

There is no EFH in the vicinity of the Lake Lynn Project (NOAA 2022).

#### 4.5.1.4 Diadromous Fish Species

No migratory fish species are reported from the Cheat River. As part of annual biomonitoring activities, the Licensee used environmental DNA (eDNA) techniques to monitor for the presence of American eel in the Lake Lynn Project tailwater area beginning in 2018. The Licensee collected 5 water samples from the tailwater area in August of 2018. American eel DNA was not detected in 2018 (TRC 2021). In 2019, the Licensee collected a total of 16 eDNA samples seasonally (March, June, August, and October) from the tailwater area (Figure 4.13). American eel DNA was not detected in 2019 (TRC 2021).


**Figure 4.13 2019 American Eel eDNA Study Sites**

The Licensee conducted a third phase of the American eel eDNA study in 2020 to detect yellow eels moving upriver. The objective of the third phase was to collect samples during

April, May, June and July, August, September of 2020 during daytime and nighttime hours. The Licensee collected samples at five sites in 2020: on July 29 (daytime), July 30 (nighttime), September 29 (nighttime), and October 29 (daytime), and in December. American eel DNA was not detected in 2020.

In 2021, the Licensee completed the fourth phase of the American eel eDNA study which included sampling from five study sites below the dam during the day and night on May 27, June 10, August 10, and September 8. Samples were processed using the modified filter extraction protocol identified by USFWS (USFWS 2022). All eDNA samples were negative for the presence of American eel markers from the May, June, and September sampling events (USFWS 2022). American eel eDNA was detected in a sample collected during the daylight hours on August 10, 2021. Detection reflected a low quantity of American eel eDNA present due to amplification of limited number of replicates and lack of detection at the same sites less than four hours earlier during the night sampling event (USFWS 2022).

#### 4.5.1.5 Benthic Macroinvertebrates

Benthic macroinvertebrate data were collected below the Lake Lynn dam on a regular basis between 1998 and 2015. During recent surveys (e.g., 2011 and 2014) samples were collected at three stations as established during the 2005 and 2008 biomonitoring program (see Figure 4.10 and Figure 4.11). These sites were sampled twice during each study year. The location of the samples was consistent with previous biomonitoring studies and relied on a standard Surber stream bottom sampler. Researchers collected 6,338 benthic macroinvertebrates during the 2011 and 2014 sampling. The caddisfly family *Hydropsychiidae* was the most abundant taxa documented in 2011 and 2014. Samples during 2011 and 2014 demonstrated greater taxa richness (29 taxa total) and taxa abundance than years prior. Additionally, several sensitive mayfly and stonefly taxa were collected during 2011 and 2014 (Smith and Welsh 2015). The studies demonstrated that macroinvertebrate abundance has increased and pollution-sensitive species that indicate good water quality (caddisfly, mayfly and stonefly taxa) were prevalent during the most recent surveys.

#### 4.5.1.6 Freshwater Mussels

Freshwater mussels are sedentary organisms that use benthic habitats through their life cycle. They require areas with high oxygen content and a rich food source of organic particles and micro-organisms (WVDNR 2003). The Cheat River historically supported 17 species of freshwater mussels (Ortmann 1919) (Table 4.16).

**Table 4.16 Mussels Known Historically from the Cheat River**

| Common Name | Scientific Name | Regulatory Status |
|---|---|---|
| Mucket | *Actinonaias ligamentina* | -- |
| Elktoe | *Alasmidonta marginata* | -- |
| Threeridge | *Amblema plicata* | -- |
| Cylindrical Papershell | *Anodontoides ferussacianus* | -- |
| Purple Wartyback | *Cyclonaias tuberculate* | -- |
| Spike | *Eurynia dilatate* | -- |
| Longsolid | *Fusconaia subrotunda* | -- |
| Plain Pocketbook | *Lampsilis cardium* | -- |
| Wavyrayed Lampmussel | *Lampsilis fasciola* | -- |
| Flutedshell | *Lasmigona costata* | -- |
| Black Sandshell | *Ligumia recta* | -- |
| Clubshell | *Pleurobema clava* | SE[1] & FE[2] |
| Round Pigtoe | *Pleurobema sintoxia* | -- |
| Kidneyshell | *Ptychobranchus fasciolaris* | -- |
| Pimpleback | *Cyclonaias pustulosa* | -- |
| Creeper | *Strophitus undulates* | -- |
| Rainbow | *Villosa iris* | -- |

[1] Federally Endangered
[2] State Endangered
Source: PFBC 2018

In 2020, the Licensee conducted a study to identify what freshwater mussel species, if any, occur within the Cheat River from the Lake Lynn dam downstream to the confluence with the Monongahela River. The Licensee developed the freshwater mussel study plan in consultation with WVDNR and PFBC. A draft freshwater mussel report was provided to the stakeholders on November 25, 2020 (Attachment D).

The study area included 12 discrete sites downstream of the Lake Lynn downstream to the confluence with the Monongahela River (Figure 4.14). The study survey techniques consisted of a qualitative timed search which were consistent with West Virginia protocol (WVDNR 2020). Survey sites were located in areas where suitable mussel habitat was identified. Survey methods included visually and tactilely searching for mussels while snorkeling. No live mussels were found during the survey, yet eight live Pink heelsplitters (native species) were observed at the confluence of the Cheat River and Monongahela River immediately downstream of the survey area limits. These mussels were assumed to be part of a mussel bed located within the Monongahela River. The Pink heelsplitter is not a federal or state listed mussel species. Mussel habitat in the mussel survey area may be limited due to water quality degradation caused by AMD. Evidence of AMD was observed at multiple sites during the mussel survey (TRC 2020). Freshwater mussels are sensitive to poor water quality due to their lack of mobility. Substrate in the survey area was suitable for mussels, yet the water quality degradation, may prevent mussels from colonizing these areas (TRC 2020).

#### 4.5.1.7 Fish Passage

There are no fish passage measures or facilities at the Lake Lynn Project.

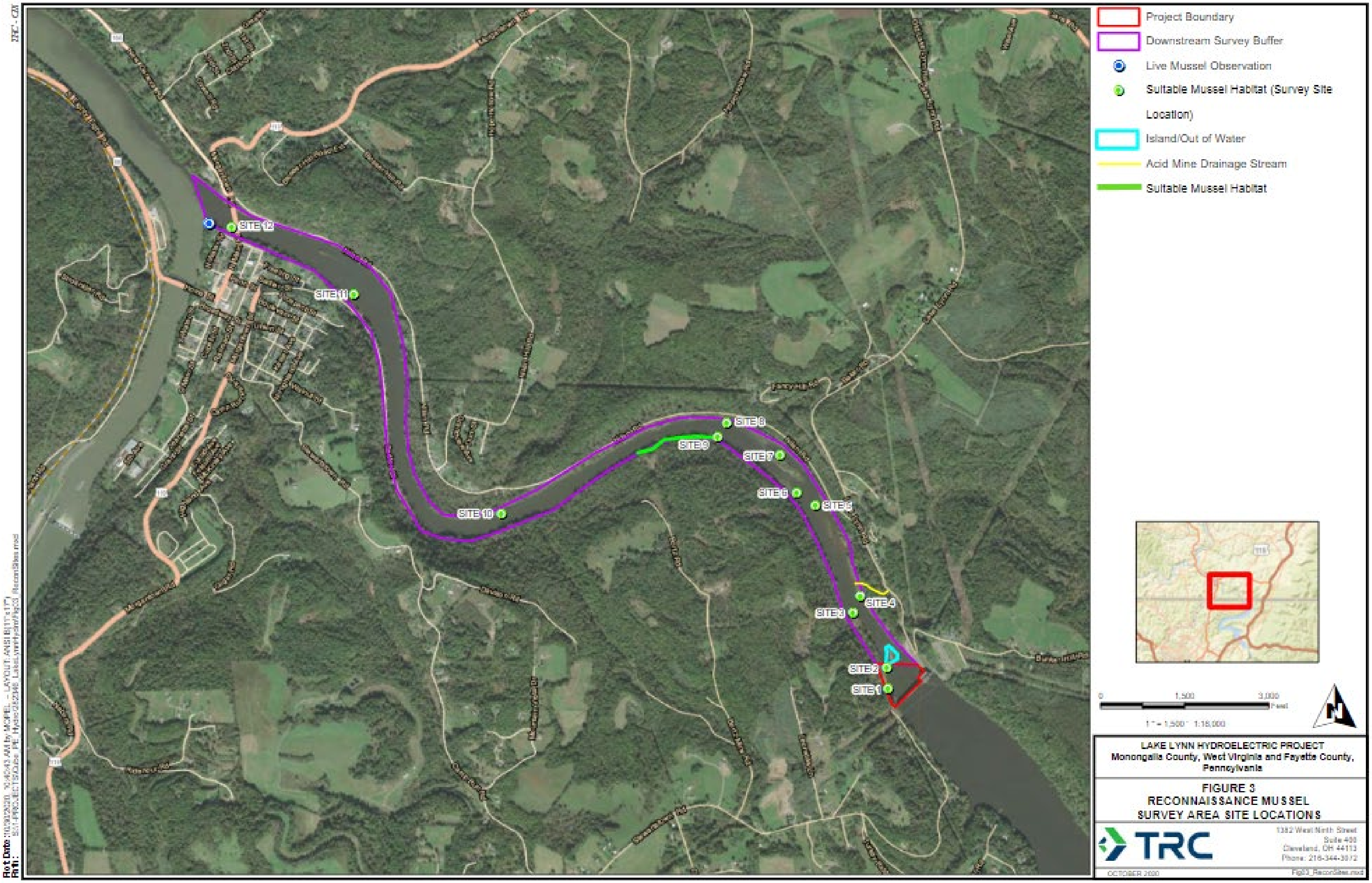


**Figure 4.14 2020 Cheat River Mussel Survey Locations**

#### 4.5.1.8 Entrainment

Lake Lynn conducted a desktop Fish Entrainment Assessment at the Lake Lynn Project (Normandeau Associates 2022). Community data for biological sampling conducted upstream of Lake Lynn in Cheat Lake documented 35 fish species between 2011 and 2015. Seven species were identified as representative of that community and were included in the desktop assessment of fish entrainment at the Lake Lynn Project (bluegill, channel catfish, smallmouth bass, walleye, emerald shiner, golden redhorse, and gizzard shad). Life history information for the target fish species was reviewed and based on the available habitat requirements and behavioral responses to environmental conditions it was determined that gizzard shad are the target species most susceptible to entrainment at the Lake Lynn Project. These fish may be present in the vicinity of the Lake Lynn Project intakes and could be entrained. Entrainment of shad tends to peak in the fall and winter in reservoirs where they are abundant. The entrainment potential for the remaining target fish species is expected to be low given the lack of high-quality aquatic habitat in the immediate vicinity of the intake structure coupled with the fact that none of the additional fish species are considered obligatory migrants. In general, entrainment for most of the target fish species considered during the evaluation is not anticipated to be high at Lake Lynn. Gizzard shad are the target species most likely to be seasonally entrained during periods of low water temperatures. However, due to their high burst speed swimming capability at all sizes, they are expected to have relatively low entrainment susceptibility during the warmer months of the year.

In the event individuals are entrained, the USFWS Turbine Blade Strike Analysis (TBSA) Tool was used to conduct assessments for fish lengths representative of the size range of target species with potential to fit through the existing rack spacing at Lake Lynn. The TBSA analysis produced a range of survival estimates for turbine survival through the four Francis units at the Lake Lynn Project and were slightly higher for Units 1, 3, and 4 than for the recently modified Unit 2. Survival rates calculated for size classes representative of juvenile life stages (i.e., those less than or equal to six inches) ranged from 82-95 percent.

In addition to the qualitative evaluation for the seven target fish species, quantitative estimates of entrainment and entrainment survival were calculated. Density data available from the Electric Power Research Institution (EPRI) (1997) database was combined with estimated monthly generation volumes to calculate estimates of monthly entrainment for the seven target species. Annual entrainment estimates for species other than gizzard shad ranged from a low of 115 individuals (redhorse) to a high of 7,167 individuals (channel catfish). Three different sets of monthly entrainment density data were pulled from the EPRI (1997) database to calculate estimates for gizzard shad entrainment at the Lake Lynn Project and produced a wide range of estimates with the highest estimate over 14 million individuals entrained annually and a lowest estimate of 265 individuals entrained annually. Entrainment estimates for each target species were adjusted to reflect the predicted survival rates generated during the TBSA analysis for the Lake Lynn turbine units. The percentage of the annual entrainment expected to experience mortality was generally low, ranging from 12 percent of entrained individuals for bluegill to 37 percent of entrained individuals for redhorse. Similar to the observations for overall abundance, the estimates for the rate of entrainment mortality for gizzard shad varied from a low of 8 percent of entrained individuals to 345 percent of entrained individuals.

#### 4.5.1.9 Fisheries Management

Several fisheries in the Cheat River watershed are managed for recreational opportunities, including the walleye and yellow perch fishery in Cheat Lake. Walleye were reintroduced to Cheat Lake from 1999 – 2002. Natural reproduction was not assessed until the 2005 biomonitoring surveys. From 2005 through 2009, walleye stocking assessments and walleye surveys were conducted by the Licensee in Cheat Lake as part of the biomonitoring program. WVDNR marked walleye with oxytetracycline for otolith identification prior to stocking. These marked fingerlings were stocked during the spring of 2005.

During the walleye assessment, otoliths were removed from appropriate-sized fish to determine if marks were present. Walleye collected from the Lake Lynn tailwater, and the Monongahela River were also assessed for marking (Smith and Welsh 2015). The studies suggest an occurrence and potential increase in natural reproduction during this time (Smith 2018). Age, growth, and diet metrics were also collected during WVNDR’s stocking assessment surveys as was a separate channel catfish survey. WVDNR collected 764 fish from 2012 through 2015. Of these fish, 118 walleye were collected. The most abundant species included the channel catfish, white bass, walleye, and black crappie. Age analysis conducted on walleye suggested that female walleye reach maturity quickly and reach large maximum sizes. Diet analysis found that yellow perch were present in 67 percent of Cheat Lake walleyes, suggesting that yellow perch are an important forage species for the walleye fishery (Smith and Welsh 2015).

Walleye movement and distribution data were collected by WVU from 2012 through 2015 in Cheat Lake using acoustic telemetry. Data was analyzed to understand trends associated with spawning timing and locations, as well as non-spawning movement. Movement varied seasonally and was associated with environmental conditions. Elevated water temperatures in the spring were associated with pre-spawning movements. Spawning timing was determined to occur from mid-March through early April in Cheat Lake. Most spawning occurred in the uppermost part of Cheat Lake below the first riffle/run complex. Female walleye made post-spawn migrations during April, while males made post-spawn migrations during the following fall. Additionally, elevated river discharge and fluctuations in water temperatures were also associated with large non-spawning movements of walleye in Cheat Lake (Smith and Welsh 2015).

### 4.5.2 Environmental Effects

#### 4.5.2.1 Effects of the Proposed Action

The proposed action (i.e., continued operation of the Lake Lynn Project as a dispatchable peaking facility with storage capability with existing minimum flow requirements) is not expected to adversely affect fish and aquatic resources in the Cheat River or in Cheat Lake. The Licensee is proposing no changes to operations and will maintain existing seasonal elevations and minimum flow requirements to maintain aquatic habitat in the impoundment and in the Cheat River downstream of the Lake Lynn Project. The licensee follows best practices for drawdown and refill regimes when maintenance drawdowns are required. The licensee consults with pertinent resource agencies regarding the timing and duration of periodic maintenance drawdowns. In the case of a drawdown, the licensee would continue to pass required minimum flows to protect downstream reaches.

The fisheries assemblage in Cheat Lake and the Cheat River has improved in species abundance and richness over recent years. Managed recreational fisheries such as the walleye fishery, have demonstrated an increase in natural reproduction. There is no EFH identified in the vicinity of the Lake Lynn Project, therefore continued operation will not adversely affect EFH. Additionally, due to the lack of historical and limited contemporary evidence of diadromous fish in the Lake Lynn Project area, the proposed action is not expected to adversely affect diadromous fish populations.

Water quality in the Lake Lynn Project area is adversely affected by AMD, which may affect aquatic organisms that lack mobility, such as freshwater mussels. AMD effects and overall water quality may be improving, as demonstrated by an improvement in macroinvertebrate communities. Overall macroinvertebrate abundance has increased, and sensitive species (Mayfly and Stonefly taxa) were identified during the most recent surveys, which are indicators of good water quality.

The Licensee will continue to provide access for recreational fishing via a tailrace fishing area, Cheat Lake Park, and the public boat launch. These angling opportunities within the Lake Lynn Project area will be maintained by the Licensee as part of the proposed action.

The licensee has conducted a number of biological monitoring studies in Cheat Lake and in the tailwater since 1997, in accordance with the current FERC License. Biological surveys were also conducted by WVDNR in 2005 and 2008 and by WVU in 2011, 2014, and 2015. Researchers assessed water quality, aquatic habitat, and aquatic communities (fish and benthic macroinvertebrates). Freshwater mussel, American eel eDNA, water quality monitoring and aquatic habitat studies have also been conducted in the Lake Lynn Project area by the Licensee and other researchers. Lake Lynn is not proposing to discontinue the triennial update to the biological monitoring plan for conducting biological monitoring studies.

#### 4.5.2.2 Effects of the No-Action Alternative

The effects of the No Action Alternative mimic the anticipated effects of the proposed action because the licensee is proposing no changes to existing facilities or operations.

### 4.5.3 Unavoidable Adverse Effects

The proposed operation and relicensing of the Lake Lynn Project with operational PME measures (i.e., pond elevation restrictions, angling access, seasonal minimum flow requirements) is not expected to result in any unavoidable adverse effects to fish or aquatic resources.

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## 4.6 Wildlife Resources

### 4.6.1 Affected Environment

The Cheat River watershed occupies three geographic ecoregions including the Central Appalachian Forest, the CSRV, and the Western Allegheny Plateau. Approximately 54 percent of the Cheat River basin is contained within the Central Appalachian ecoregion, which is characterized by rugged, mountainous terrain, cooler temperatures, and biologically diverse natural communities (WVDEP 2013). The Ridge and Valley ecoregion encompasses nearly 45 percent of the Cheat River watershed and is marked by a series mountain ridgelines and valleys. Only about 1 percent of the watershed occurs within the Western Allegheny Plateau ecoregion. This ecoregion is comprised of rolling hills with wide valleys dominated by mixed oak forest and agricultural (WVDEP 2013). The Cheat River watershed is dominated by forested area (86 percent); the remaining land cover is classified as developed (8 percent), planted/cultivated (6 percent), and impervious surface area (<1 percent) (WVDEP 2013).

#### 4.6.1.1 Wildlife Habitats

The natural communities (see section 4.7, *Botanical Resources*) within the Lake Lynn Project vicinity provides habitat for a variety of wildlife species, including over 200 resident and transient bird species, 50 mammal species, and 37 amphibian species with the potential to occur in the Lake Lynn Project area (WVDNR 2001, WVDNR 2003, PGC 2019, Marshall 2019, BBC 2014, and Sibley 2014).

#### 4.6.1.2 Wildlife

##### 4.6.1.2.1 Mammals

The Cheat River corridor potentially provides habitat to over 50 mammal species (WVDNR 2001, WVDNR 2003, and PGC 2019). Habitat within the Lake Lynn Project boundary is mostly aquatic with limited terrestrial habitat. Many of the mammalian wildlife species are likely use the riparian corridor for movement and foraging. While some mammals such as red fox, raccoon, Virginia opossum, gray squirrel, and striped skunk are likely common along the riparian corridors associated with the Lake Lynn Project boundary, larger mammal species such as black bear may be transient within the Lake Lynn Project boundary. Grasslands and agricultural areas are generally uncommon within the Lake Lynn Project boundary; however, several areas of open grassland and agriculture occur within the Lake Lynn Project vicinity. Mammals typically found in open areas or grassland habitats include eastern cottontail rabbits and rodents such as the meadow-jumping mouse. Several bat species may also use terrestrial habitat and manmade structures in and adjacent to the Lake Lynn Project boundary. Beaver, fisher, and river otter were eradicated in the past, but were reintroduced in the 1930s, 1969, and 1985, respectively (WVDNR 2001). Appendix D lists mammal species which may occur within a 5-mile radius of the Lake Lynn Project dam (WVDNR 2001, WVDNR 2003, and PGC 2019).

#### 4.6.1.2.2 Amphibians and Reptiles

Reptiles and amphibian species may use different habitat types including riparian, woodlands, scrub-shrub, or grasslands and early successional areas. These species have different habitat requirements depending on life stage or time of year. Amphibians and reptiles that may be found in wetland or aquatic habitat such as the open water impoundment or tributaries during one or more life stage include frogs, salamanders, and turtle species, as well as the northern water snake. These species use wetland and aquatic habitat for breeding, foraging, and protection. Species such as black ratsnake, spotted salamander, red spotted newt (eft form), and grey tree frog use forested areas, including riparian areas, for foraging, shelter, and feeding. Grasslands and agricultural areas may be used by the northern black racer, eastern American toad, and eastern garter snake (Alden et al., 1999, Marshall 2019). Appendix D lists resident amphibian species that could occur in Cheat River habitats within a 5-mile radius of the Lake Lynn Project dam.

### 4.6.1.3 Birds

There are over 200 resident and transient bird species found in the Cheat River corridor (BBC 2014, Sibley 2014). Habitats associated with the Lake Lynn Project, including the impoundment, tributaries, wetlands, and riparian areas, may provide breeding habitat, migratory stopovers, and wintering habitat for a variety of bird species. Bird species typically found along the shoreline of the impoundment may include belted kingfisher, song sparrow, bank swallow, and waterfowl such as the mallard duck and wood duck. Birds of prey such as bald eagle, osprey, red-tailed hawk, and barred owl may use many different habitat types on a seasonal basis including forests, scrub-shrub or early successional areas, wetlands, and open water (Stokes 1996). Appendix D lists bird species that may occur or use the habitat within a 5-mile radius of the Lake Lynn Project dam.

### 4.6.2 Environmental Effects

#### 4.6.2.1 Effects of the Proposed Action

Lake Lynn is not proposing any changes to operations or to the Lake Lynn Project facilities (e.g., dam or powerhouse). The proposed action does not include any ground-disturbing activities; therefore, no adverse effects on wildlife resources are anticipated.

#### 4.6.2.2 Effects of the No-Action Alternative

The effects of the no-action alternative mimic the anticipated effects of the proposed action because the Licensee is proposing no changes to existing facilities or operations.

### 4.6.3 Unavoidable Adverse Effects

Continued operation and relicensing of the Lake Lynn Project along with PME measures are not expected to have unavoidable adverse effects on wildlife resources.

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## 4.7 Botanical Resources

### 4.7.1 Affected Environment

#### 4.7.1.1 Upland Botanical Resources

Geographic information system (GIS) analysis of NatureServe land cover data revealed that a majority of the landcover within 1 mile of the Lake Lynn Project boundary is forested habitat (Table 4.17, Figure 4.15). In addition to forested communities, other upland communities in the Lake Lynn Project vicinity include agricultural fields, developed-open space (e.g., golf course), and some residential areas (NatureServe 2009).

The most prominent forested botanical communities within a mile of the Lake Lynn Project boundary include the southern and central Appalachian cove forest and the south-central interior mesophytic forest accounting for over 41 percent of the overall area within 1 mile of the Lake Lynn Project boundary (over 46 percent of the terrestrial area). Other forested communities include northeastern interior dry-mesic oak forest, Allegheny-Cumberland dry oak forest and woodland, and Appalachian (hemlock)-northern hardwood forest. Appendix D lists botanical species that may occur within a 1-mile radius of the Lake Lynn Project boundary.

**Table 4.17 Botanical Communities within 1 Mile of Lake Lynn Project Boundary**

| Botanical Community | % of Project Area |
|---|---|
| Southern and Central Appalachian Cove Forest | 27.3 |
| South-Central Interior Mesophytic Forest | 14.1 |
| Open Water | 10.4 |
| Developed-Open Space | 9.4 |
| Agriculture - Pasture/Hay | 9.3 |
| Northeastern Interior Dry-Mesic Oak Forest | 8.9 |
| Allegheny-Cumberland Dry Oak Forest and Woodland | 6.5 |
| Appalachian (Hemlock)-Northern Hardwood Forest | 6.1 |
| Developed-Low Intensity | 2.9 |
| Ruderal Forest | 1.5 |
| Agriculture - Cultivated Crops and Irrigated Agriculture | 1.0 |
| Total of "Other" Communities with less than 1% coverage | 2.5 |
| **Total** | **100.0** |

Source: NatureServe 2009

Within the existing Lake Lynn Project boundary, over 77 percent of the area is open water (lacustrine and riverine wetlands associated with Cheat Lake and Cheat River) (Table 4.18, Figure 4.16 through Figure 4.21). See Section 4.7.1.2 for additional information about wetlands. Upland communities are predominantly forested with southern and central Appalachian and Allegheny-for almost 67 percent (350 acres) of the upland area. These communities also represent the greatest change in acreage between the existing Lake Lynn Project boundary and the proposed Lake Lynn Project boundary with a combined reduction of almost 170 acres. Other forested communities include Appalachian (hemlock)- northern hardwood forest, south-central interior mesophytic forest, ruderal forest, and northeastern interior dry-mesic oak forest. Other non-forested upland communities found within the Lake Lynn Project boundary include Appalachian shale barrens, developed areas, floodplains, and agricultural areas (e.g., pastures, cultivated crops, and tree plantations) (Figure 4.16 through Figure 4.21). Table 4.18 gives an overview of the botanical communities found within the existing and proposed Lake Lynn Project boundary along with the area change among these communities.

**Table 4.18 Botanical Communities within the Existing and Proposed Lake Lynn Project Boundary**

| Botanical Community | Area - Existing Project Boundary (Acres) | Area - Existing Project Boundary (%) | Area - Proposed Project Boundary (Acres) | Area - Proposed Project Boundary (%) | Area Change Between Existing and Proposed Project Boundary (Acres) |
|---|---|---|---|---|---|
| Open Water (Lacustrine and Riverine Wetlands) | 1,785.04 | 77.25 | 1,736.55 | 0.87 | -48.49 |
| Southern and Central Appalachian Cove Forest | 196.96 | 8.52 | 113.70 | 0.06 | -83.26 |
| Allegheny-Cumberland Dry Oak Forest and Woodland | 153.42 | 6.64 | 67.45 | 0.03 | -85.97 |
| Developed-Open Space | 53.65 | 2.32 | 29.53 | 0.01 | -24.12 |
| Appalachian (Hemlock)-Northern Hardwood Forest | 39.91 | 1.73 | 15.89 | 0.01 | -24.03 |
| South-Central Interior Mesophytic Forest | 34.05 | 1.47 | 5.70 | 0.00 | -28.35 |
| Developed-Medium Intensity | 13.12 | 0.57 | 10.41 | 0.01 | -2.71 |
| Agriculture - Pasture/Hay | 9.88 | 0.43 | 3.44 | 0.00 | -6.44 |
| Ruderal Forest | 5.72 | 0.25 | 3.60 | 0.00 | -2.13 |
| Developed-Low Intensity | 3.80 | 0.16 | 1.48 | 0.00 | -2.32 |
| North-Central Interior Floodplain | 3.67 | 0.16 | 3.90 | 0.00 | 0.23 |
| Northeastern Interior Dry-Mesic Oak Forest | 3.13 | 0.14 | 1.94 | 0.00 | -1.19 |
| Managed Tree Plantation | 2.86 | 0.12 | 2.67 | 0.00 | -0.19 |
| Developed-High Intensity | 1.74 | 0.08 | 0.03 | 0.00 | -1.71 |
| South-Central Interior Large Floodplain | 1.67 | 0.07 | 2.02 | 0.00 | 0.34 |
| Appalachian Shale Barrens | 1.25 | 0.05 | 0.70 | 0.00 | -0.54 |
| Non-Specific Disturbed | 0.89 | 0.04 | 0.89 | 0.00 | 0.00 |
| **Total** | **2,310.76** | **100%** | **1999.87** | **100%** | **0** |

Source: NatureServe 2009

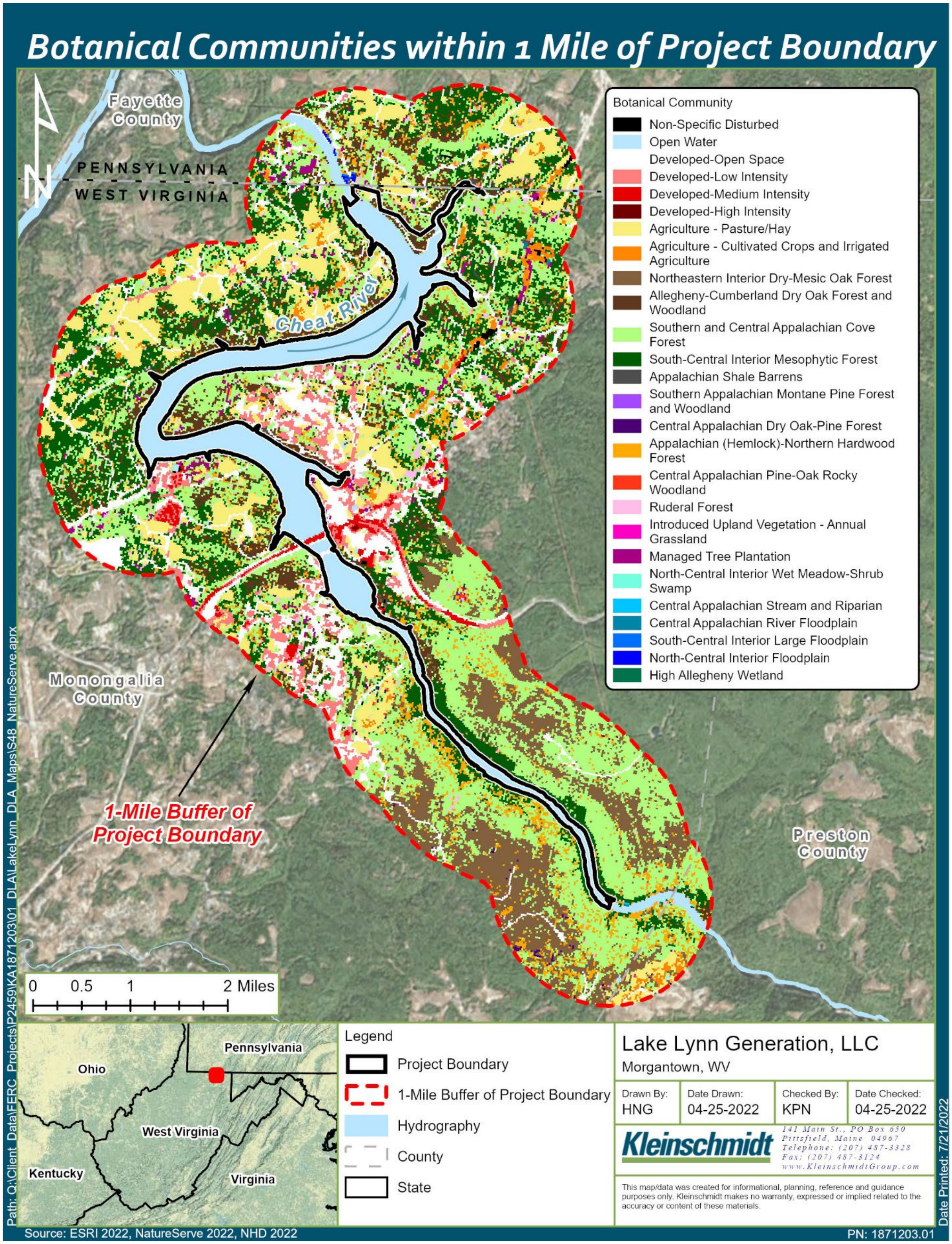


**Figure 4.15 Botanical Communities within 1 Mile of Lake Lynn Project**

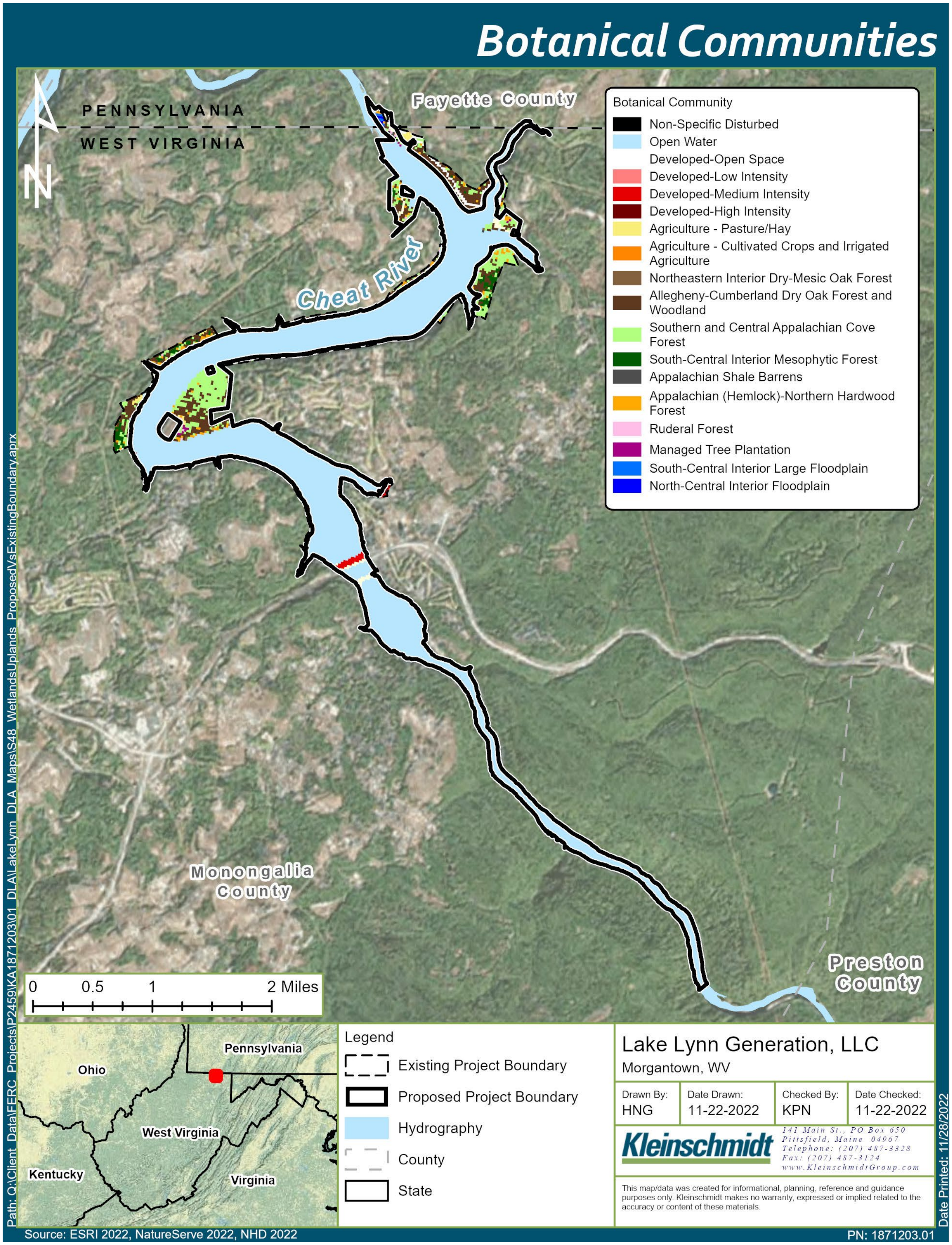


**Figure 4.16 Botanical Communities within the Proposed and Existing Project Boundaries**

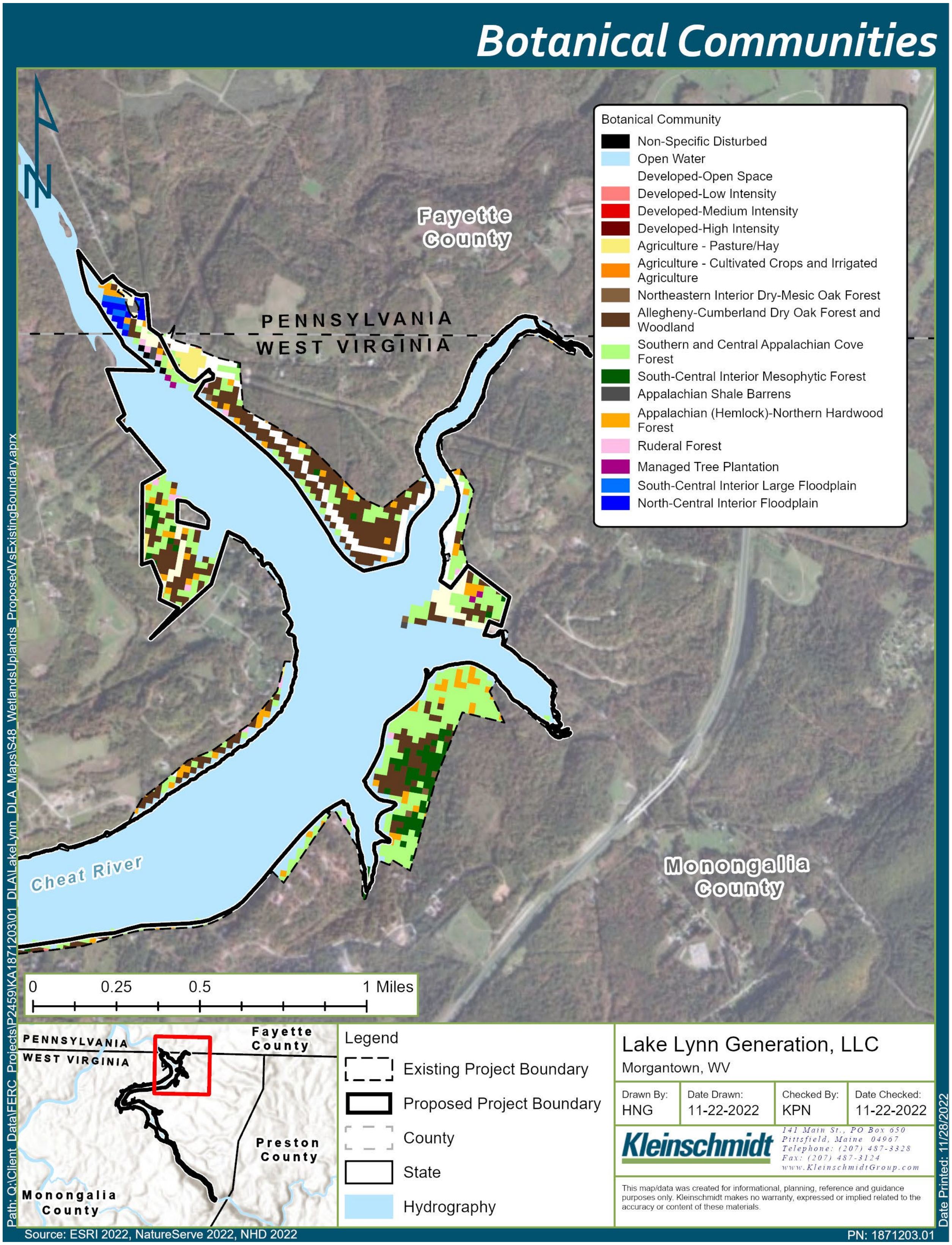


**Figure 4.17 Botanical Communities within the Proposed and Existing Project Boundaries**

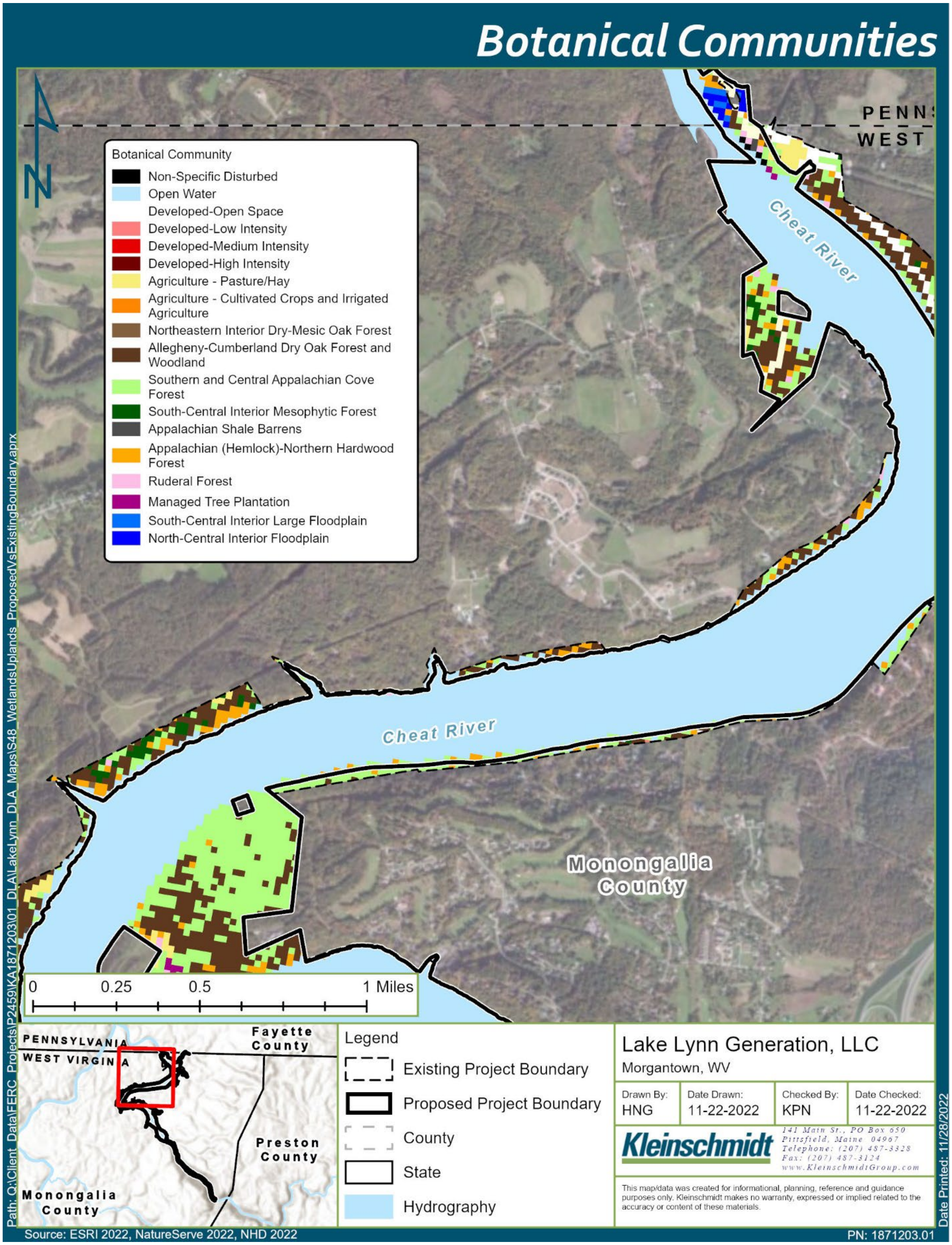


**Figure 4.18 Botanical Communities within the Proposed and Existing Project Boundaries**

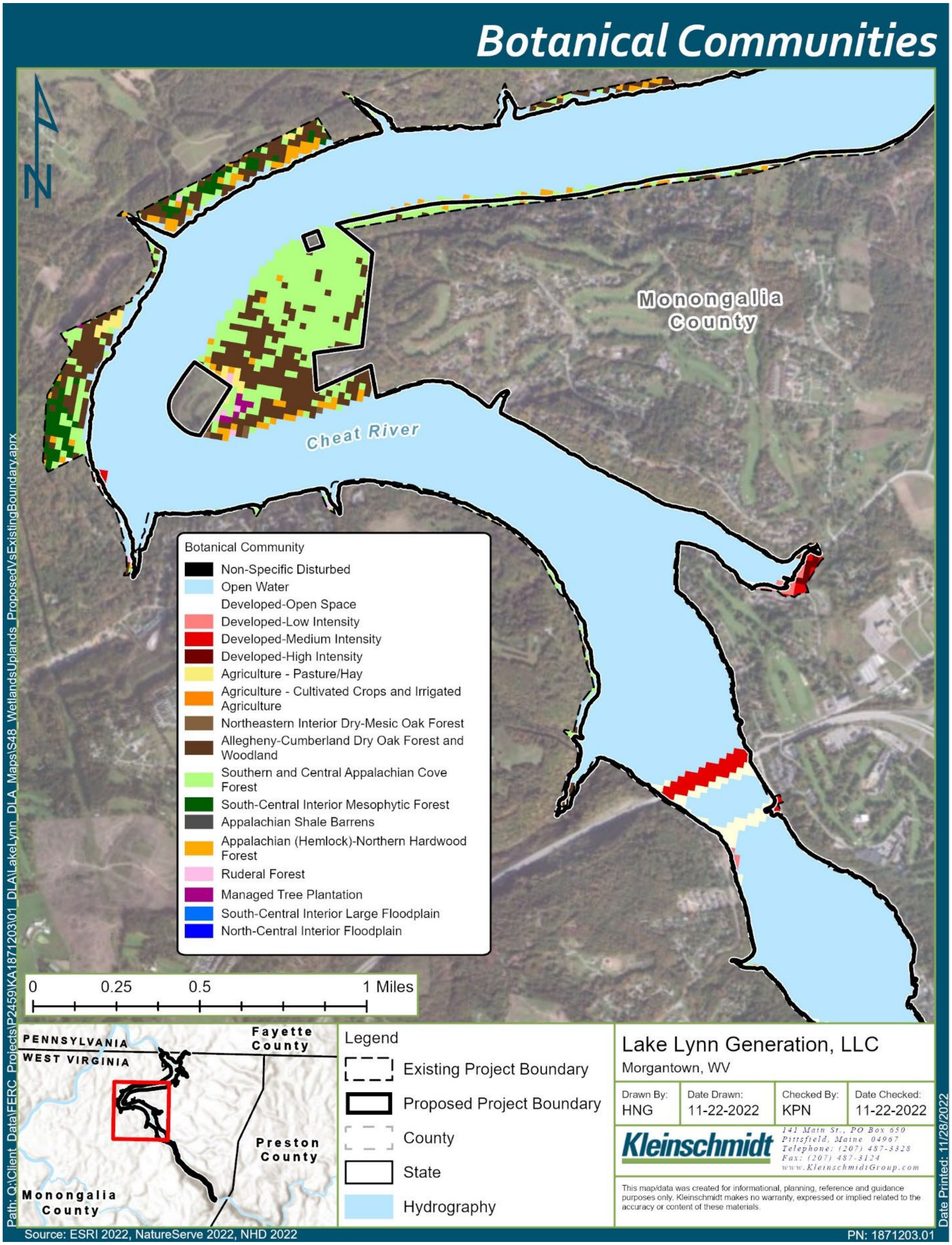


**Figure 4.19 Botanical Communities within the Proposed and Existing Project Boundaries**

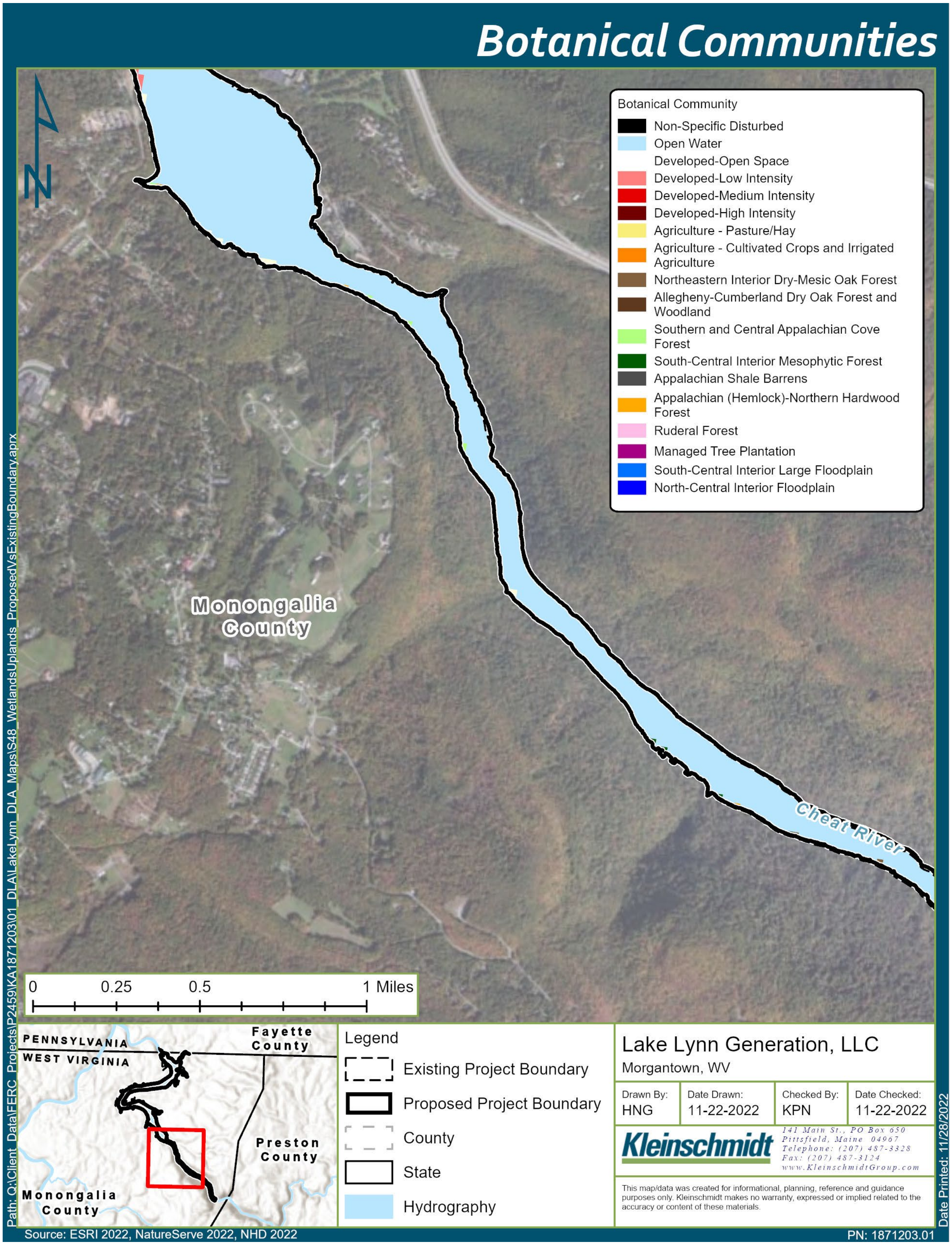


**Figure 4.20 Botanical Communities within the Proposed and Existing Project Boundaries**

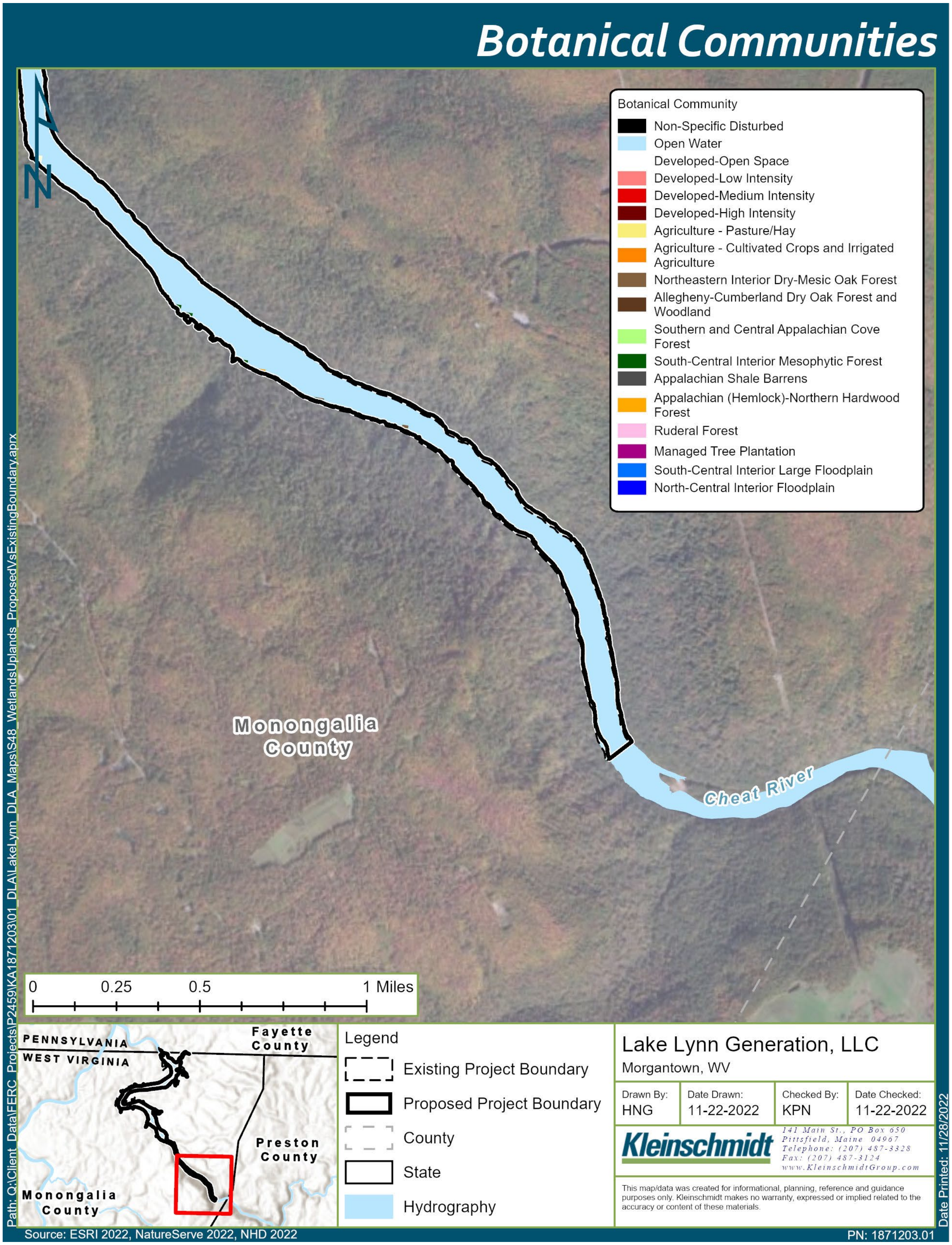


**Figure 4.21 Botanical Communities within the Proposed and Existing Project Boundaries**

### Southern and Central Appalachian Cove Forest

The southern and central Appalachian cove forest is the most abundant vegetative community within 1 mile of the Lake Lynn Project boundary accounting for over 27 percent of the overall study area (Table 4.17, Figure 4.15). This forest is generally found in protected geographic positions with concave slopes that support moist conditions. This community may include a mosaic of acidic and "rich" coves, which are distinguished by differences in the herbaceous plant communities. The acidic cove is typically found on low slope positions, but can may be positioned farther up on north-facing, sheltered slopes. The soils of the acidic cove are less fertile, and the herbaceous layer is not as diverse. The rich cove is usually found on the lowest slope positions on high-fertility soils and have a higher diversity and density of herbaceous species. Dominant tree species include yellow poplar, American basswood, white ash, yellow buckeye, sweet birch, mountain magnolia, cucumber tree, mountain silverbell, black cherry, and eastern hemlock. Herbaceous species may include blue cohosh, Clayton's sweetroot, Canadian woodnettle, bloodroot, black cohosh, and Canadian white violet (NatureServe 2009).

### South-Central Interior Mesophytic Forest

This forest community is similar to the southern and central Appalachian cove forest and is typically found on deep, enriched soils in sheltered landscape positions such as coves or lower topographic positions along slopes. The forest type is variable but is generally characterized by deciduous tree canopy and a rich herb layer with abundant spring ephemerals. Small streams often bisect this community. Common tree species include sugar maple, American beech, yellow poplar, American basswood, northern red oak, cucumber tree, black walnut, and eastern hemlock (NatureServe 2009).

### Northeastern Interior Dry-Mesic Oak Forest

This oak dominated forest is typically found a low to mid elevations on flat to gently rolling landscapes. Soils are not strongly xeric but are generally acidic and comparatively nutrient poor. This forest community is typically characterized by a closed canopy; however, this community may also include patchy-canopy woodlands. Common canopy trees include northern red oak, white oak, black oak, scarlet oak, and hickory species (NatureServe 2009).

### Allegheny-Cumberland Dry Oak Forest and Woodland

This forest type is generally characterized by a closed canopy of deciduous trees and occurs on infertile or acidic soils. Dominant overstory trees include white oak, southern red oak, swamp chestnut oak, and scarlet oak. Other species may include red maple, pignut hickory, and mockernut hickory (NatureServe 2009).

#### 4.7.1.1.1 Invasive Plants and Noxious Weeds

Invasive plants are species intentionally or accidentally introduced by human activity into a region in which they did not evolve and cause harm to natural resources, economic activity, or humans. Invasive plants proliferate and displace native plant species, reduce wildlife habitat, and alter natural processes. According to the WVDNR, there are 633 non-native species located within the State of West Virginia. The WVDNR has developed an extensive list of invasive species inclusive of invasiveness ranking. This comprehensive list is included in Appendix D. (WVDNR, 2021). Similarly, the Pennsylvania Department of Conservation and Natural Resources (PADCNR) also maintains a list of invasive species with different threat rankings. This list is also available in Appendix D (PADCNR, 2018).

Invasive species commonly present within the Lake Lynn Project area include Japanese knotweed (*Fallopia japonica*), garlic mustard (*Alliaria petiolata*) (FOC, 2019), the Tree of Heaven (*Ailanthus altissima*), and Oriental bittersweet (*Celastrus orbiculatus*) (Studio for Creative Inquiry, Carnegie Mellon, 2002).

### 4.7.1.2 Wetlands, Riparian, and Littoral Habitat

### Wetlands

Wetlands within the Lake Lynn Project boundary are primarily deep-water habitats (Figure 4.22, Table 4.19). The most common wetland types within the Lake Lynn Project boundary are lacustrine (L1UBHh) and riverine wetlands (R3UBH, R3USC, R5UBH) associated with Cheat Lake and Cheat River (USFWS 2022). The riverine and the lacustrine wetlands are classified by the National Wetland Inventory (NWI) as having unconsolidated bottoms (L1UBHh, R3UBH, R5UBH) and unconsolidated shores (R3USC). Unconsolidated bottoms are characterized by the "*lack of large stable surfaces for plant and animal attachment*" while unconsolidated shores are characterized by "*substrates lacking vegetation except for pioneer plants that become established during brief periods when growing conditions are* *favorable*"(USGS 1992). Substrate of the riverine and lacustrine wetlands likely consist of cobble, gravel, sand, mud, or organic material.

According to the NWI map, there are no palustrine wetlands within the existing or the proposed Lake Lynn Project boundary (Figure 4.22, Table 4.19). Palustrine wetlands are limited in size and quantity in this area due to the steep banks and sloping topography surrounding Cheat Lake and Cheat River.).

**Riparian Habitat**

Riparian habitat within the Lake Lynn Project area is a mix of wetlands, deciduous and mixed forest, and commercial and residential development as discussed in Section 4.7.1.1, *Upland Botanical Resources*. Dominant forest community types include southern and central Appalachian cove forest and the south-central interior mesophytic forest. Ruderal forests are also common riparian habitat. These early succession forests are often found in areas that have been disturbed by human activity such as the construction or maintenance of roads, trails, and buildings. Early successional tree species may include red cedar, pines, yellow poplar, or aspens.

Within the Lake Lynn Project area much of the riparian zone is intact, with some areas of residential development. These areas are commonly dominated by weedy or manicured herbaceous species and an underdeveloped shrub and tree canopy due to vegetation management.

**Littoral Zone**

The littoral zone is the transitional area between deep-water, aquatic habitat and terrestrial wetlands or uplands. Littoral habitats include those areas of a water body through which light penetrates resulting in primary productivity (Cowardian 1979). Within the Lake Lynn Project boundary, this zone is often unvegetated with a cobble-gravel, sand, mud, or organic bottom. The Licensee worked cooperatively with WVDNR and WVU to document the distribution and relative abundance of aquatic vegetation and to map aquatic vegetation in Cheat Lake. Twenty-two separate areas of aquatic vegetation were documented within the impoundment. These areas occur throughout the impoundment along shores and in coves or other areas with slower moving water (Figure 4.22) (Smith and Welsh, 2015). Aquatic vegetation was mostly found in depths ranging from 0.6 – 2.4 meters (2-8 feet), but some moderate patches did extend into 10 feet of water. Ten species from five genera of aquatic vegetation were in Cheat Lake. The most common species found in dense abundance during the surveys included: brittle naiad (*Najas minor*), wild celery (*Vallisneria americana*), and curly-leaf pondweed *(Potamogeton crispus*). Although several areas of substantial aquatic vegetation growth were found in Cheat Lake, overall Cheat Lake has limited coverage of aquatic vegetation.

**Table 4.19 Wetlands within the Existing and Proposed Lake Lynn Project Boundary**

| Wetland Type | Area - Existing Project Boundary (Acres) | Area - Proposed Project Boundary (Acres) | Area Change Between Existing and Proposed Project Boundary (Acres) |
|---|---|---|---|
| Lake | 2898.64 | 2916.01 | 17.37 |
| Riverine | 380.54 | 398.26 | 17.72 |
| ***Total*** | ***3279.17*** | ***3314.27*** | ***35.10*** |

Source: NWI 2022

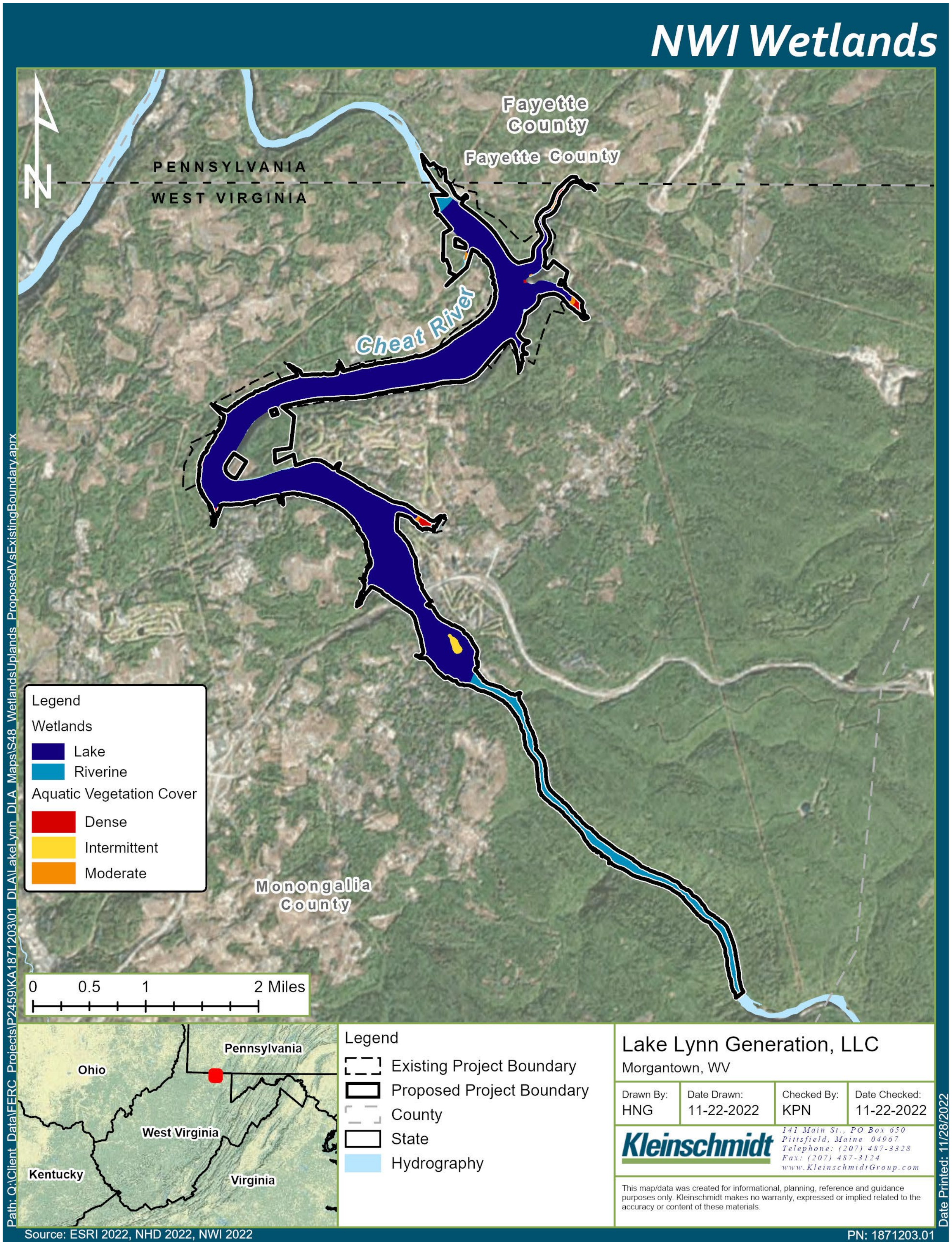


**Figure 4.22 Wetlands in the Existing and Proposed Lake Lynn Project Boundary**

### 4.7.2 Environmental Effects

#### 4.7.2.1 Effects of the Proposed Action

The Licensee is not proposing any changes to the Lake Lynn Project operations or to the Lake Lynn Project facilities (e.g., dam or powerhouse). The steep banks adjacent to Cheat River and Cheat Lake protect the botanical communities from reservoir fluctuations associated with seasonal peaking operation of the Lake Lynn Project. The proposed action does not include any ground-disturbing activities. Lake Lynn performs limited vegetation management at most of the public recreation facilities and the Lake Lynn Project powerhouse. The dam abutments are trimmed manually by hand annually. The tailrace fishing platform area and parking area and the substation parking area for the Cheat Lake Trail are sprayed with herbicide every 2 years. Lake Lynn also sprays herbicide every 2 years immediately around the public safety signage and poles for the downriver warning system (measures included in the Public Safety Plan) to ensure that these measures are visible and maintained for public safety. The Cheat Lake Trail is a maintained biking and hiking trail along an old railroad bed. The shoulders of the trail are trimmed with a weed-eater as needed. Trees and shrubs at Cheat Lake Park, including the beach, and the Upper Picnic Area are trimmed as needed and the lawn areas area mowed and trimmed as needed. The Sunset Beach Marina public boat ramp is maintained as needed by weed eating. The Cheat Lake Park nature viewing area is managed as part of the Cheat Lake Park. The other three nature viewing areas are generally not actively managed for vegetation.

As such, the proposed action is not expected to adversely affect botanical communities or wetlands in the Lake Lynn Project area. The removal of lands from the existing Lake Lynn Project boundary is not expected to adversely affect botanical communities or wetlands.

Lake Lynn is proposing to develop a SMP for the Lake Lynn Project in consultation with USFWS, WVDNR, WVDEP, PADEP, PFBC, CLEAR, FOC, Monongalia County, Fayette County, West Virginia SHPO, and Pennsylvania SHPO that would be consistent with the Standard Land Use Article of any new FERC license. The SMP would clearly outline allowed activities and procedures for Lake Lynn to grant permission for shoreline activities within the Lake Lynn Project boundary, which would balance shoreline uses with shoreline resources.

#### 4.7.2.2 Effects of the No-Action Alternative

The effects of the no-action alternative mimic the anticipated effects of the proposed action because the Licensee is proposing no changes to existing facilities or operations.

### 4.7.3 Unavoidable Adverse Effects

Continued operation and relicensing of the Lake Lynn Project as proposed are not expected to have unavoidable adverse effects on botanical or wetland resources.

### 4.7.4 References

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United States Fish and Wildlife Service (USFWS). 2022. National Wetlands Inventory: Surface Waters and Wetlands. Available online: https://www.fws.gov/wetlands/data/mapper.html. Accessed: April 21, 2022.

## 4.8 Rare, Threatened, and Endangered Species

### 4.8.1 Affected Environment

Federal and applicable state databases were used to identify rare, threatened, and endangered (RTE) species that potentially occur at the Lake Lynn Project. The Pennsylvania Natural Heritage Program (PNHP) identified 17 RTE state listed species in the entire Cheat watershed on the environmental review list (PNHP 2019). A site-specific search on the publicly available PNHP database did not identify any state-listed species within the Lake Lynn Project boundary (PNHP 2022). West Virginia does not have state threatened and endangered species legislation (WVDNR 2022). The USFWS's Information for Planning and Consultation (IPaC) identified the following federally listed species potentially occurring within the Lake Lynn Project boundary: the endangered Indiana bat (*Myotis sodalis*), the threatened[2] northern long-eared bat (NLEB; *Myotis septentrionalis*), the threatened flat-spired three-toothed snail (*Triodopsis platysayoides*), and the candidate monarch butterfly (*Danaus plexippus*) (USFWS 2022a) (Table 4.20). Also included in Table 4.20 is the tricolored bat (*Perimyotis subflavus*) which is proposed to be listed as endangered.

**Table 4.20 Potentially Occurring Rare, Threatened, Endangered, Candidate and Proposed Species in the Project Area**

| Common Name | Scientific Name | Status |
|---|---|---|
| **Mammals** | | |
| Indiana bat | *Myotis sodalis* | Federally endangered |
| Northern long-eared bat | *Myotis septentrionalis* | Federally endangered |
| Tricolored bat | *Perimyotis subflavus* | Proposed for listing as endangered[1] |
| **Snails** | | |
| Flat-spired three-toothed snail | *Triodopsis platysayoides* | Federally threatened |
| **Insects** | | |
| Monarch butterfly | *Danaus plexippus* | Candidate |

[1] On September 13, 2022 the USFWS announced a proposal to list the tricolored bat as endangered under the ESA.
Source: USFWS 2022a, through USFWS 2022f.

There are no critical habitats located within the Lake Lynn Project boundary (USFWS 2022a). General habitat information for these species is provided in Table 4.21

[2] On November 29, 2022, the USFWS reclassified the NLEB as endangered under the ESA (USFWS 2022f).

**Table 4.21 Habitat Information of Federally Listed, Candidate and Proposed Species Potentially Occurring in Lake Lynn Project Boundary**

| Family | Common Name | Scientific Name | Habitat |
|---|---|---|---|
| Vespertilionidae | Indiana bat | *Myotis sodalis* | Hibernates in caves and mines in winter, mostly in tight clusters. In summer, females form small maternity colonies in tree hollows and behind loose bark (USFWS 2022b). |
| Vespertilionidae | Northern long-eared bat | *Myotis septentrionalis* | Forested ridges appear favored over riparian woodlands. Hibernacula include caves and mines in winter, but may use crevices in walls or ceilings. Summer roosts include tree holes, birdhouses, or behind loose bark or shutters of buildings (USFWS 2022c). |
| Vespertilionidae | Tricolored bat | *Perimyotis subflavus* | Primarily roost among live and dead leaf clusters of live or recently dead deciduous hardwood trees. Will also roost in Spanish moss, lichen and among pine needles. Hibernate in caves, mines, culverts, tree cavities and abandoned water wells (USFWS 2022e). |
| Polygyridae | Flat-spired three-toothed snail | *Triodopsis platysayoides* | Only found in West Virginia, along Cheat River gorge. Lives in cracks and crevices in rocks in wooded areas. Prefers cool, moist, deep fissures and rock talus in spring to early summer (iNaturalist 2022). |
| Nymphalidae | Monarch butterfly | *Danaus plexippus* | For eastern North American populations, monarchs overwinter in oyamel fir tree roosts. Require milkweeds to lay eggs (USFWS 2022d). |

The IPaC lists 15 migratory bird species that are of concern with the potential to occur within the Lake Lynn Project area (Table 4.22). USFWS uses the following status designations: BCC Rangewide (CON) are Birds of Conservation Concern (BCC) that are of concern throughout their range anywhere within the continental United States; BCC – BCR are BCCs that are of concern only in particular Bird Conservation Regions (BCRs) in the continental United States; and Non-BCC Vulnerable are not BCC species in the Lake Lynn Project area but appear on the list because of the Eagle Act requirements (USFWS 2022).

**Table 4.22 Potentially Occurring Migratory Bird Species**

| Common Name | Scientific Name | Status |
|---|---|---|
| Bald eagle | *Haliaeetus leucocephalus* | Non-BCC Vulnerable |
| Black-billed Cuckoo | *Coccyzus erythropthalmus* | BCC Rangewide (CON) |
| Black-capped chickadee | *Poecile atricapillus practicus* | BCC - BCR |
| Bobolink | *Dolichonyx oryzivorus* | BCC Rangewide (CON) |
| Canada warbler | *Cardellina canadensis* | BCC Rangewide (CON) |
| Cerulean warbler | *Dendroica cerulea* | BCC Rangewide (CON) |
| Eastern whip-poor-will | *Antrostomus vociferous* | BCC Rangewide (CON) |
| Golden eagle | *Aquila chrysaetos* | Non-BCC Vulnerable |
| Henslow's sparrow | *Ammodramus henslowii* | BCC Rangewide (CON) |
| Kentucky warbler | *Oporornis formosus* | BCC Rangewide (CON) |
| Northern saw-whet owl | *Aegolius acadicus* | BCC - BCR |
| Prairie warbler | *Dendroica discolor* | BCC Rangewide (CON) |
| Red-headed woodpecker | *Melanerpes erythrocephalus* | BCC Rangewide (CON) |
| Rusty blackbird | *Euphagus carolinus* | BCC - BCR |
| Wood thrush | *Hylocichla mustelina* | BCC Rangewide (CON) |

In the PAD, Lake Lynn proposed to conduct presence/absence surveys for RTE species within the Lake Lynn Project area. USFWS provided comments regarding the federally listed species discussed in the PAD[3] and noted that no other federally proposed or listed species are known to exist in the Lake Lynn Project area. Lake Lynn did not perform the proposed presence/absence surveys because the USFWS noted the surveys were not warranted.

### 4.8.2 Environmental Effects

#### 4.8.2.1 Effects of the Proposed Action

Lake Lynn is not proposing any changes to Lake Lynn Project operations and therefore, the proposed action is not expected to adversely affect RTE, proposed or candidate

[3] Four federally listed species were identified with the potential to occur in the Lake Lynn Project area in the PAD filed August 2019: Indiana bat, northern-long eared bat, flat-spired three-toothed snail, and running buffalo clover. USFWS delisted running buffalo clover in September 2021.

species. The removal of land from the existing Lake Lynn Project boundary is not expected to adversely affect RTE, proposed or candidate species because those lands are being removed because they are not necessary for Lake Lynn Project operations.

Lake Lynn is proposing to develop an SMP for the Lake Lynn Project in consultation with USFWS, WVDNR, WVDEP, PADEP, PFBC, CLEAR, FOC, Monongalia County, Fayette County, West Virginia SHPO, and Pennsylvania SHPO that would be consistent with the Standard Land Use Article of any new FERC license. The SMP would clearly outline allowed activities and procedures for Lake Lynn to grant permission for shoreline activities within the Lake Lynn Project boundary, including any tree cutting.

#### 4.8.2.1.1 Bats

No studies were requested by the stakeholders and there are no specific proposed PME measures for RTE species. However, for any activities requiring clearing of trees, Lake Lynn would abide by seasonal tree clearing restrictions for bat species and only clear trees between November 1st – April 14th. Should tree clearing be required during the restricted time period (April 15th – October 31st), Lake Lynn would consult with the USFWS regarding removal needs. As a general rule, Lake Lynn only removes trees where their removal is necessary for public safety, protection of human life, or protection of property.

#### 4.8.2.1.2 Flat-spired three-toothed snail

No studies were requested by the stakeholders and there are no specific proposed PME measures for RTE species. Lake Lynn is not proposing any changes to Lake Lynn Project operations, hence the proposed action and the removal of land from the existing Lake Lynn Project boundary is not expected to adversely affect the flat-spired three toothed snail.

#### 4.8.2.1.3 Monarch butterfly

Host species have not been observed in the maintained areas within the Lake Lynn Project boundary. Lake Lynn is not proposing any changes to Lake Lynn Project operations, hence the proposed action and the removal of land from the existing Lake Lynn Boundary is not expected to adversely affect the monarch butterfly habitat.

#### 4.8.2.2 Effects of the No-Action Alternative

The effects of the no-action alternative mimic the anticipated effects of the proposed action because the Licensee is proposing no changes to existing facilities or operations.

### 4.8.3 Unavoidable Adverse Effects

Construction activities and timber management practices may cause short-term unavoidable adverse effects to the potentially occurring Indiana, NLEB and tricolor bats and the flat-spired three-toothed snail. Following the USFWS guidance for timber management and implementing construction BMPs would minimize any potential effect on these listed species.

### 4.8.4 References

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USFWS. 2022b. *Myotis sodalist*. Available online at: https://www.fws.gov/species/indiana-bat-myotis-sodalis. Accessed April 14, 2022.

USFWS. 2022c. *Myotis septentrionalis*. Available online at: https://www.fws.gov/species/northern-long-eared-bat-myotis-septentrionalis. Accessed April 14, 2022.

USFWS. 2022d. *Danaus plexippus*. Available online at: https://www.fws.gov/species/monarch-danaus-plexippus. Accessed April 14, 2022.

USFWS. 2022e. Tricolor bat (*Perimyotis subflavus*). Available online at: https://fws.gov/species/tricolored-bat-perimyotis-subflavus. Accessed November 18, 2022.

USFWS. 2022f. Press Release. Available online at: https://www.fws.gov/press-release/2022-11/northern-long-eared-bat-reclassified-endangered-under-endangered-species-act. Accessed November 19, 2022.

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## 4.9 Recreation and Land Use Resources

### 4.9.1 Affected Environment

#### 4.9.1.1 Existing Recreation Facilities and Opportunities in the Project Boundary

As part of the previous relicensing Lake Lynn developed[4] a Recreation Plan for Lake Lynn Project, and in accordance with Article 417 of the existing FERC license, Lake Lynn is required to file a Recreation Plan update every 3 years. Lake Lynn filed the most recent update on March 31, 2021, which included: (1) a description of annual recreational use numbers collected in 2020; (2) a discussion of the adequacy of the Lake Lynn Project recreation facilities to meet recreation demand; (3) a description of the methodology used to collect all recreational use data; (4) a discussion of how the recreation needs are addressed if there is demonstrated need for additional facilities; and (5) documentation of agency consultation and agency comments on the update.

Lake Lynn Project recreation sites provide fishing, boating, nature viewing, picnicking, and hiking/biking opportunities. Existing Lake Lynn Project FERC-approved recreation sites are described in the following subsections and summarized in Table 4.23. Figure 4.23 depicts the locations of the Lake Lynn Project recreation sites.

[4] Approved by FERC on April 11, 1997 - Order Modifying and Approving Recreation and Land Management Plan (79 FERC ¶ 62,017).

**Table 4.23 FERC-Approved Recreation Facilities at the Lake Lynn Project**

| Recreation Site Name | Recreation Amenities |
| --- | --- |
| Tailrace Fishing Area | 100-foot-long concrete handicap accessible fishing platform, bank fishing opportunities, gravel parking area for approximately 22 vehicles, portable toilet, trash receptables |
| Cheat Lake Trail | 4.5-mile-long hiking/biking trail (handicap accessible) consisting of northern and southern sections, parking at Substation Parking Area or Cheat Lake Park, bike rack, storm shelter, benches, interpretive historical signs, trash receptacle<br>Substation Parking Area: gravel parking area for approximately 20 vehicles, steps to the trail |
| Cheat Lake Park | Winter/car-top boat ramp with courtesy dock, 2 courtesy docks, swimming beach, 14 picnic tables including 4 in picnic area next to the beach, 8 day-use boat docks, playground area, 2 restroom facilities, 9 benches, security/maintenance station, 2,200 foot-long fishing platforms, 6 water fountains, access to the Cheat Lake Trail, interpretive historical signs, nature viewing area<br>Upper Picnic Area: picnic loop with 29 drive-in picnic sites (each with parking for up to 2 vehicles) one of which includes handicapped accessible parking, 23 grills, 20 picnic tables, restroom building, 2 water fountains, 9 trash receptables, parking lot with 11 parking spaces (of which 2 are ADA accessible)<br>Upper Parking Area: gravel parking area for approximately 50 vehicles, trash receptacle<br>Overflow Parking Area: gravel parking is for approximately 30 vehicles<br>Lower Parking Area: 6 Americans with Disabilities Act (ADA) parking spaces |
| Sunset Beach Marina Public Boat Launch | Public boat ramp, parking area for up to 85 vehicles with trailers, 2 portable toilets |
| Cheat Haven Peninsula Nature Viewing Area | Nature area, approximately 1.4-mile-long trail |
| Nature Viewing Area Across from Cheat Haven | Nature area accessible by boat only |
| Tower Run Nature Viewing Area | Pull-off parking for approximately 3 vehicles, nature area |

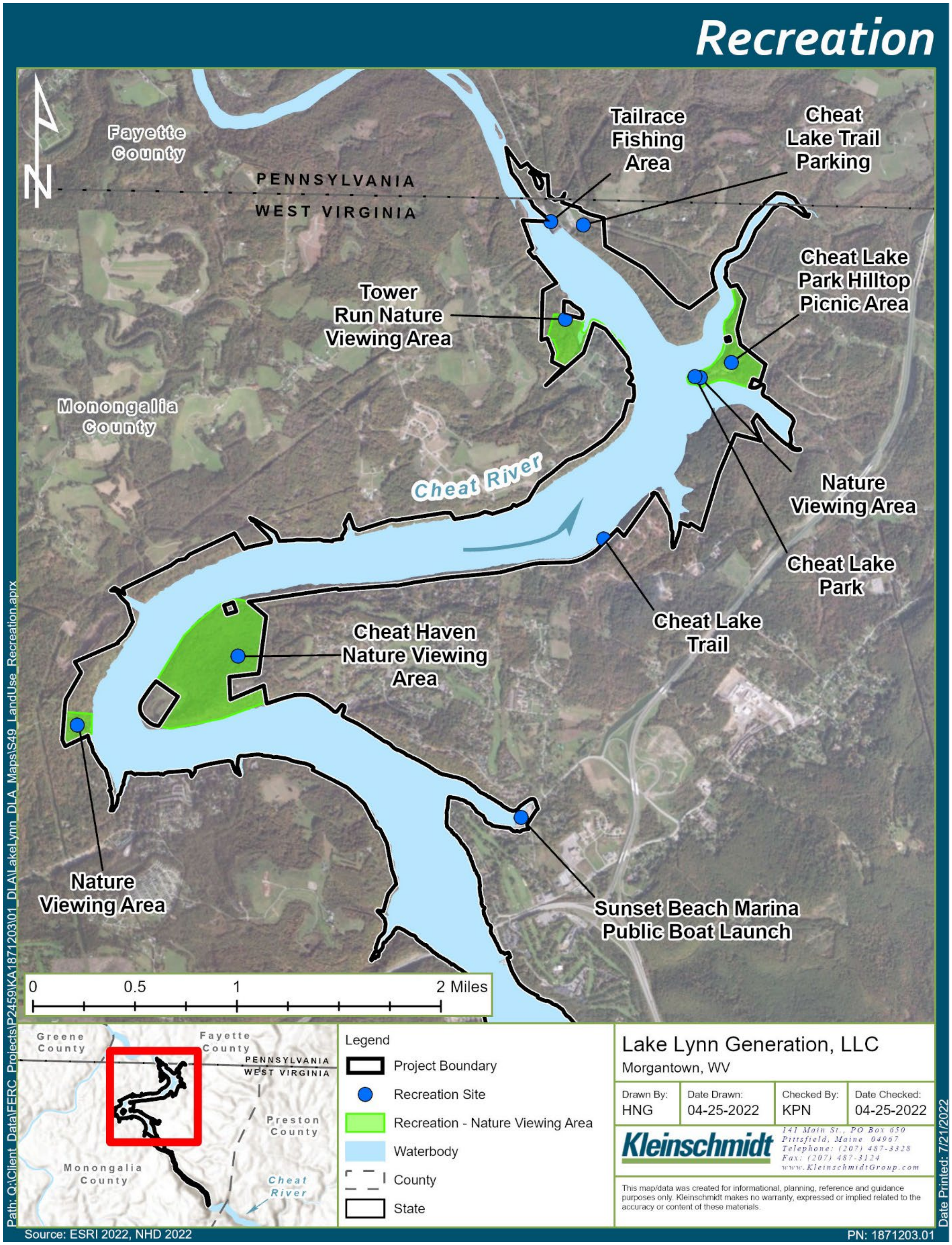



**Figure 4.23 Lake Lynn Project Recreation Sites**

#### 4.9.1.1.1 Tailrace Fishing Area

The Tailrace Fishing Area (Photo 4.4) provides public access to the Lower Cheat River below the Lake Lynn Project dam for fishing. The site consists of a fishing platform as well as bank fishing opportunities. Access to the fishing platform is provided from Lake Lynn Road along the river. A gravel parking area at the Tailrace Fishing Area can accommodate approximately 22 vehicles and includes two Americans with Disabilities Act (ADA) accessible spaces. Nighttime lighting is provided at both the fishing platform and parking area. An ADA compliant pedestrian ramp connects the parking area with the fishing platform. The fishing platform can accommodate approximately 20 anglers and has handrails constructed with barrier free cutouts to provide accessibility for persons with disabilities. An existing roadway provides easy foot access from the parking lot to the riverbank and a portable ADA accessible toilet is available at the stie. To enhance public safety, visual and audible alarms are present to provide notification of increased flow releases from the hydroelectric facility and warn the public to exit the water. In addition to the fishing platform, in September 2000 Lake Lynn installed eight rock pile structures to provide enhanced fish habitat in the first river mile downstream of the tailrace.

**Photo 4.4 Tailrace Fishing Platform**

#### 4.9.1.1.2 Cheat Lake Trail

The Cheat Lake Trail (Photo 4.5 and Photo 4.6) is a 4.5-mile hiking/biking trail that extends from a parking area near the Lake Lynn Project powerhouse to its southern terminus at the Cheat Haven Nature Viewing Area. The trail is 10-feet-wide, constructed of compacted limestone fines, and ADA accessible. The trail can be accessed from the Substation Parking Area or from Cheat Lake Park (the Upper or Lower Parking Areas). The trail consists of a northern portion and southern portion. The northern portion of the Cheat Lake Trail is approximately 1.4-miles-long and extends from the Substation Parking Area to Cheat Lake Park. The trail passes through Cheat Lake Park. The southern portion of the trail, which is 3.1-miles-long, starts at Cheat Lake Park and is accessed through a gate at Mannings Run. The gate allows Lake Lynn to close the southern portion of the trail at dusk during the recreation season and the winter months. Interpretive signs are installed at several historical sites along the Cheat Lake Trail. Additionally, there are mile-markers, every half-mile, along the length of the trail. Because of safety concerns, the trail may be temporarily closed if snow and/or ice are present or other hazardous conditions exist. Signs are posted on the Morgan Run Bridge to inform hikers of any trail closures.

**Photo 4.5 Cheat Lake Trail – Over Northern Causeway from Cheat Lake Park**

**Photo 4.6 Cheat Lake Trail – Terminus**

#### 4.9.1.1.3 Cheat Lake Park

Cheat Lake Park (Photo 4.7 and Photo 4.8) is approximately 46 acres situated on a peninsula between the Rubles Run embayment and the Morgan Run embayment on Cheat Lake. Cheat Lake Park offers an abundance of recreation amenities including a winter/car-top boat ramp with courtesy dock, 2 courtesy docks, swimming beach, picnic tables, day-use boat docks, playground area, restroom facilities, benches, security/maintenance station, 2,200 ft long fishing platforms, water fountains, access to the Cheat Lake Trail, interpretive historical signs, and a nature viewing area. Within the park there are multiple parking areas to accommodate approximately 155 vehicles. Of those 155 parking spaces, 10 are ADA accessible.

**Photo 4.7 Cheat Lake Park – Playground Area**

**Photo 4.8 Cheat Lake Park – Boat Launch**

#### 4.9.1.1.4 Sunset Beach Marina Public Boat Launch

Sunset Beach Marina is a free public boat launch and associated parking area located at on Cheat Lake. The parking area can accommodate approximately 60 boat trailers. This public boat launch is available year-round when the lake level is above 865-feet NGVD. Lake Lynn maintains the surface elevation of Cheat Lake at certain levels throughout the year.

#### 4.9.1.1.5 Wildlife and Nature Viewing Areas

In addition to the developed Lake Lynn Project recreation sites, four parcels of Lake Lynn Project lands have been designated as wildlife/nature viewing areas (NVAs) by the Licensee. These areas are open for certain public recreation uses and there are no plans to develop these areas in the future. The first NVA is a 40-acre parcel at the Cheat Lake Park between Morgan and Manning Run embayments. The second is the 140-acre Cheat Haven Peninsula, located at the end of the southern portion of the Cheat Lake Trail. There is a 1.4-mile trail through the Cheat Haven Peninsula NVA that was developed to reduce habitat destruction. This trail was developed to proactively manage users walking through the NVA since this area is located off of the popular Cheat Lake Trail. There is also a 12-acre parcel of land across from the Cheat Haven Peninsula NVA that is only accessible by boat that has been designated as an NVA. The final NVA is located at Tower Run. This NVA is a 25-acre parcel that has a pull off with space for three vehicles to park.

### 4.9.1.2 Project Recreation Use and Capacities

In accordance with Article 417 of the current FERC License, the Licensee collected recreation data at the Lake Lynn Project from 2000 through 2020 and filed Recreation Plan updates summarizing recreation use every 3 years from 2003 through 2021. Generally, recreation use remained about the same over this 20-year monitoring period (LLG 2015, 2018, 2021).

Lake Lynn collected recreation use data during 2020 as part of the Recreation Plan update. Data collection included spot counts on 40 days at each of the recreation sites for a total of 560 spot counts, as well as obtaining data from the Sunset Beach marina. Spot counts were conducted on random weekday, weekend days, and holiday weekends during each season (spring, summer, fall, and winter) (for more details see 2021 Recreation Plan Update, LLG 2021).

Based on data collected, Lake Lynn estimated a total of 143,981 recreation days were spent at the Lake Lynn Project recreation sites in 2020 (LLG 2021). Overall, at all sites, recreation use was highest in the summer (53 percent), followed by spring (25 percent), and fall (14 percent) and lowest during the winter period (7 percent). Table 4.24 provides a summary of estimated use at the primary recreation access sites (those with designated and/or on-site parking).

**Table 4.24 Estimated Annual Use of Primary Sites in 2020**

| Recreation Site | Estimated Annual Use (2020) |
|---|---|
| Tailrace Fishing Area | 5,156 |
| Substation Parking Area | 3,974 |
| Cheat Lake Park Upper Picnic Area | 723 |
| Cheat Lake Park Upper Parking Area | 89,748 |
| Cheat Lake Park Lower Parking Area | 13,524 |
| Sunset Beach Marina | 30,856 |
| Total Annual Use | 143,981 |

Source: LLG 2021

As part of the 2021 Recreation Plan update, Lake Lynn assessed the activities that recreationists participated in most frequently. It was noted that there were multiple activities in which recreationists participated in at the Lake Lynn Project. The most popular activities included walking, hiking, and jogging as they were observed at many of the Lake Lynn Project recreation sites. Other activities were popular at specific sites, such as:

Platform fishing

- Tailrace Fishing Area (83%)
- Day Use Boat Dock (33%)

Passive recreation (sightseeing, shoreline relaxation, bird watching, and photography

- Beach (59%)
- Day Use Boat Dock (36%)
- Lower Picnic Area (35%)
- Lower Parking Area (26%)

Motor boating

- Sunset Beach Marina (87%)

Spending time at the playground

- Playground (85%)

Non-motor boating

- Winter Boat Launch (51%)

Picnicking

- Lower Picnic Area (50%)

Swimming

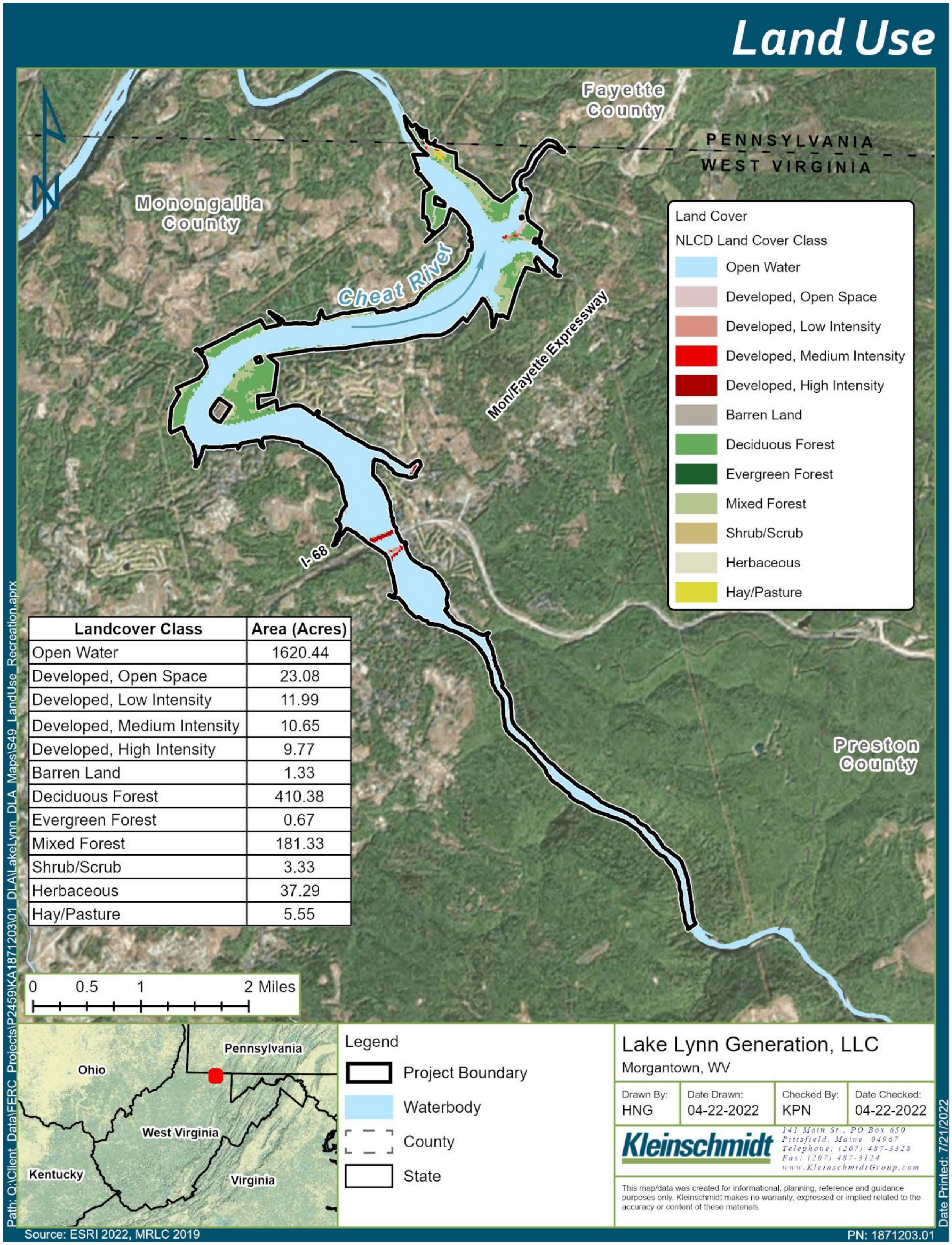
- Beach (30%)

As part of the 2021 Recreation Plan update, Lake Lynn also assessed the capacity of the existing recreation facilities based on assessment of utilization of the available amount of parking at each site versus the average number of parking spaces that were occupied during surveys during weekends during each site’s peak recreation season. Most of the Lake Lynn Project recreation facilities continue to be utilized at less than 50 percent of capacity. The Cheat Lake Park Lower Parking Area (76 percent) and Sunset Beach Marina (65 percent) were both over 50 percent of capacity. Based on the recreation site inventory, review of available facilities, annual use numbers generated in 2020 and the estimated capacity utilization rates, Lake Lynn determined that the existing recreation facilities, as operated, were adequate to meet the current demonstrated demand for recreation use at the Lake Lynn Project (LLG 2021).

#### 4.9.1.3 Land Use and Management of Project Lands

Land use and land cover inside the Lake Lynn Project boundary and acreages for each are shown in Figure 4.24. The Lake Lynn Project boundary generally follows the normal full pool elevation of the impoundment, except for several nature viewing areas, and includes certain lands immediately surrounding the Lake Lynn Project facilities including the dam, powerhouse, access roads, and appurtenant facilities.

The Licensee historically granted leases and permits (“privilege permits”) for private recreation access to Lake Lynn Project lands and waters in accordance with the standard land use article in the FERC License. There are approximately 200 privilege permits around the Cheat Lake shoreline that allow permittees to install and maintain boat docks within their shoreline property. Each permit holder is responsible for the installation and maintenance of any boat docks and the property; however, permits must be approved by the Licensee prior to any improvements being conducted at a privilege permit site. Currently, the Licensee is not issuing any new permits for private piers or boat docks and will not issue any new permits until after relicensing.




| Landcover Class | Area (Acres) |
|---|---|
| Open Water | 1620.44 |
| Developed, Open Space | 23.08 |
| Developed, Low Intensity | 11.99 |
| Developed, Medium Intensity | 10.65 |
| Developed, High Intensity | 9.77 |
| Barren Land | 1.33 |
| Deciduous Forest | 410.38 |
| Evergreen Forest | 0.67 |
| Mixed Forest | 181.33 |
| Shrub/Scrub | 3.33 |
| Herbaceous | 37.29 |
| Hay/Pasture | 5.55 |

**Figure 4.24 Land Use in the Lake Lynn Project Boundary**

### 4.9.2 Environmental Effects

#### 4.9.2.1 Effects of the Proposed Action

**Recreation**

During the prefiling consultation, WVDNR and other stakeholders provided comments with respect to recreation. WVDNR commented on boating on Cheat Lake and indicated that law enforcement records do not show any significant increase in boating incidents. WVDNR also commented that it was not opposed to the temporary (or to a continued) moratorium on new private piers/boat docks. WVDNR commented that it was opposed to creating public access to the upper reaches of Cheat Lake through a road in the Snake Hill Wildlife Management Area (WMA). Other stakeholder comments were more specific to recreation PMEs including: extending Cheat Lake Trail to the south; connecting Cheat Lake Trail to the Sheepskin Trail; creating public access to the upper reaches of Cheat Lake through the Snake Hill WMA; creating a dog beach; establishing boating guidelines and limits consistent with WVDNR regulations; improving guidance on boating guidelines, public dock maintenance, dredging, and parking lot criteria; improved and clear procedures for trail maintenance and repair; improved guidelines and procedures for Sunset Beach Marina and other marinas; supporting lake cleanup activities; making swimming beach season consistent with boating season; improved debris management at beach; improved guidelines for the fishing pier; reiterate the recreation season dates and open the Trail year-round; description of the functions of recreation personnel, security personnel, park maintenance personnel and guidelines for the interaction of these people with public; and hiring on-site recreation staff.

Based on the comments received, Lake Lynn developed a Study Plan in consultation with stakeholders and conducted a Recreation Site Enhancement Feasibility and Assessment that examined the feasibility of making recreation site/facility enhancements at the Lake Lynn Project, as requested during the prefiling consultation. The assessment results will inform the development of a new Recreation Plan.

Lake Lynn is proposing no changes to Lake Lynn Project facilities or operations. As such, the proposed action is not expected to adversely affect recreational resources at the Lake Lynn Project. The proposed action will result in the continued provision of recreational facilities that adequately meets demonstrated use in the Lake Lynn Project area. The Recreation Plan was most recently updated in 2021 and Lake Lynn requested in the

Recreation Plan Update that the 2021 update would be the last update under the existing license. Lake Lynn is proposing to develop a new Recreation Plan for the new license term in consultation with USFWS, WVDNR, PFBC, WVDEP, PADEP, Monongalia County, Fayette County, CLEAR, FOC, and MRTC that would include a review and update of the Recreation Plan every 10 years. At this time, Lake Lynn does not anticipate any new recreation facilities under the new Recreation Plan developed. The Recreation Plan would include measures to measure water depths at the Sunset Beach Marina public boat launch on an annual basis prior to the recreation season. If warranted, a bathymetric survey in the vicinity of the Sunset Beach Marina Public Boat Ramp would be conducted every 10 years along with excavation to maintain the boat ramp usability.

Lake Lynn is proposing to formally remove the 12-acre water-accessible only NVA across from the Cheat Haven Peninsula NVA from the Lake Lynn Project boundary and to no longer designate this area as a NVA. Lake Lynn is proposing to remove the NVA due to the fact that the area is accessible only by boat. The shoreline is forested and steep in this area making safe access difficult. Lake Lynn reached out to WVDNR in regards to the proposed removal on November 4, 2022 but no response has been received as of the filing of this FLA. Please see Photo 4.9 below for an image of the viewing area from the water. Due to the inaccessible nature of the NVA, visitor usage has not been collected by Lake Lynn. There is no existing infrastructure for boaters to the NVA. This area was designated as a NVA with the intent to preserve it as a natural area (with no infrastructure) as described in FERC's EA during the previous relicensing, which Lake Lynn intends to continue. However, the area is not necessary for Lake Lynn Project purposes. Lake Lynn will post the removal of the NVA on the relicensing website to inform members of the public that the site has been removed from the Lake Lynn Project.

**Photo 4.9 Water Accessible NVA**

**Land Use**

During the prefiling consultation, no agencies or stakeholders expressed concern, provided comments, or requested studies with respect to land use. Lands surrounding the Lake Lynn Project are residential, commercial and recreational. Lake Lynn is proposing no changes in operations at the Lake Lynn Project and does not anticipate that continued operation of the Lake Lynn Project will adversely affect land use in the vicinity of the Lake Lynn Project.

Lake Lynn is proposing to develop a SMP in consultation with USFWS, WVDNR, WVDEP, PADEP, PFBC, CLEAR, FOC, Monongalia County, Fayette County, West Virginia SHPO, and Pennsylvania SHPO that would be consistent with the Standard Land Use Article of any new FERC license. The SMP would manage shoreline activities within the Lake Lynn Project boundary. The SMP would clearly outline allowed activities and procedures for granting permission for shoreline activities.

#### 4.9.2.2 Effects of the No-Action Alternative

The effects of the no-action alternative mimic the anticipated effects of the proposed action because the Licensee is proposing no changes to existing facilities or operations.

### 4.9.3 Unavoidable Adverse Effects

Continued operation of the Lake Lynn Project is not expected to have any unavoidable adverse effects on recreation or land use resources.

### 4.9.4 References

Lake Lynn Generation, LLC (LLG). 2015. Lake Lynn Hydroelectric Project 2018 Recreation Plan Update. March 2015.

Lake Lynn Generation, LLC (LLG). 2018. Lake Lynn Hydroelectric Project 2018 Recreation Plan Update. April 2018.

Lake Lynn Generation, LLC (LLG). 2021. Lake Lynn Hydroelectric Project 2021 Recreation Plan Update. March 2021.

## 4.10 Aesthetic Resources

### 4.10.1 Affected Environment

Cheat Lake and the Cheat River are popular destinations for water recreation activities. The 1,730-acre picturesque Cheat Lake attracts thousands of users each year (WVDNR 2011). Most views of the Lake Lynn Project are aesthetically pleasing and provide views of Cheat Lake (Photo 4.10 and Photo 4.11). None of the Lake Lynn Project waters are designated as Wild and Scenic Rivers (NWSRS 2019). There are no scenic highways or byways within the Lake Lynn Project boundary.

There are several roads that provide limited views of the Lake Lynn Project waters. Lake Lynn Road runs along the northeast side of the Lake Lynn Project boundary near the powerhouse and the tailrace of the dam. This road provides a view of the Lake Lynn dam and tailrace area in addition to a parking area for the Tailrace Fishing Area. Several other roads provide limited views of Cheat Lake that change with the seasons. Most notably, the I-68 bridge and Ices Ferry Bridge (SR 857) provide views of upper Cheat Lake. As the deciduous trees lose their leaves, the views become less obstructed, and areas with no view in summer may offer limited or clear views of the Lake Lynn Project in winter.

In addition to views from local roads, the recreation facilities offer aesthetic views of the Lake Lynn Project. Cheat Lake Trail offers aesthetics views of Cheat Lake (the Lake Lynn Project reservoir) Lake Lynn Project in multiple locations (Photo 4.10 and Photo 4.11). Cheat Lake Park (Photo 4.12) and the beach at Cheat Lake Park (Photo 4.13). The Tailrace Fishing Pier provides a view of the Lake Lynn Project dam and tailwater area (Photo 4.14).

**Photo 4.10 View of Lower Cheat Lake from the Cheat Lake Trail**

**Photo 4.11 View of Upper Cheat Lake from the Cheat Lake Trail South**

**Photo 4.12 View of Lower Cheat Lake from Cheat Lake Park**

**Photo 4.13 View of Lower Cheat Lake from the beach at Cheat Lake Park**

**Photo 4.14 View of Project Dam from Tailwater Fishing Pier**

### 4.10.2 Environmental Effects

During prefiling consultation, agencies and stakeholders raised no issues or study requests related to aesthetic resources.

#### 4.10.2.1 Effects of the Proposed Action

Lake Lynn is proposing no changes to Lake Lynn Project facilities or operations which would affect the viewshed. As such, the proposed action is not expected to adversely affect aesthetic resources at the Lake Lynn Project.

#### 4.10.2.2 Effects of the No-Action Alternative

The effects of the no-action alternative mimic the anticipated effects of the proposed action because the Licensee is proposing no changes to existing facilities or operations.

### 4.10.3 Unavoidable Adverse Effects

No unavoidable adverse impacts to aesthetic resources are expected to occur as a result of the continued operation of the Lake Lynn Project.

### 4.10.4 References

National Wild and Scenic Rivers System (NWSRS). 2019. West Virginia Rivers. Available Online: https://www.rivers.gov/west-virginia.php. Accessed: April 5, 2019.

West Virginia Division of Natural Resources (WVDNR). 2011. The Recovery of Cheat Lake: A Success Story. Available Online: https://docs.wixstatic.com/ugd/ec6de6_e68c97639dd0442b863f6a6d9a2c051d.pdf. Accessed: March 29, 2019.

## 4.11 Historical and Cultural Resources

### 4.11.1 Affected Environment

#### 4.11.1.1 Historical Overview

During the Middle Archaic period (6,500 – 3,000 B.C.), some archaeologists suggest that a major economic shift toward increased specialization in hunting and gathering resources occurred perhaps in response to continued Early Holocene environmental changes. Middle Archaic populations are poorly understood in the upper Ohia Valley with the typology based, for the most part, on stratified sites in West Virginia where the full range of tool types may have not been identified. The adaptive responses in place during the Middle Archaic period seem coupled with some increase in population and may correlate with the trend towards territoriality and more sedentary lifeways observed in Late Archaic (Phase I Cultural Resource Survey, 1996).

The Lake Archaic period include an emerging widespread interaction sphere in which objects such as copper, marine shell and chert were traded with long distance networks. Woodworking, weaving, and hide working tools are evident on larger base and settlement camps where ceremonial and domestic activities may have occurred. Base camps were located on major rivers and may have at least partially functioned to take advantage of riverine links with cultures outside of the Ohia Valley for the purpose of trade, group hunting activities, ceremonies and/or the exchange of ritual and marriage partners (Phase I Cultural Resource Survey, 1996).

Corresponding with the Lake Archaic period is the xerothermic climactic interval accompanied by an increased potential for oak-hickory forest development. Such specialized subsistence practices as the collection of mussel shell and hickory nuts as well as an increased use of fish and avian resources seem to have been intensified during the Late Archaic, although data for increase in subsistence diversity is difficult to assess because of the lack of archaeological date for this period. (Phase I Cultural Resource Survey, 1996)

The Early woodland period (1,000 B.C. - 100 B.C.) is characterized by a shift to ceramic production, the introduction of cultivated plants, and a more sedentary settlement system. However, some early Woodland sites suggest a persistence of the Archaic hunting, gather and fishing lifeway. One significant Early Woodland component with an important influence in the Lake Lynn Project area is the Adena culture. Numerous Adena points have been identified in the Lake Lynn Project area as have Half-Moon ceramics. Major ceremonial complexes were present throughout core Adena territory in the central Ohia Valley from eastern Indiana to Western Pennsylvania (Phase I Cultural Resource Survey, 1996).

A continuation of the Late Archaic subsistence and procurement patterns may be indicated by the presence of both Early Woodland and Late Archaic artifacts on the same sites. However, ceramics tend to occur only on base camps or habitation sites. In southern West Virginia, Early Woodland pottery is characterized by the thin ceramics with quartz, siltstone and claystone tempering (Phase I Cultural Resource Survey, 1996).

Although there may have been a major shift in subsistence and settlement system during Middle Woodland times in Illinois, Draggo (1963) suspected that the Adena and Hopewell preferred similar environmental zones on major floodplains and terraces where high yields of seed plants and riverine resources could be supplemented by upland natural resources. Gradually, cultigens such as squash, pumpkin, gourd and corn were introduced from the south and west, although the evidence for cultivated plants in both local Adena and hopewell sites is unimpressive. This gap in the archaeological record relates as much to the problem of preservation of microflora and faunal artifacts as to the lack of controlled excavation on key sites.

Based on the archaeological record, Middle Woodland populations relied on a broad spectrum of subsistence pattern including the harvesting of wild or quasi-domesticated crops near rich hunting and gathering sites. Evidence for domesticated plants is not impressive. Of particular importance in the subsistence strategies during this period was the use of aquatic resources. Although deer provided the most significant food sources, fish, birds, turtles, and amphibians were components of the subsistence system (Phase I Cultural Resource Survey, 1996).

The Hopewell cultures of the Middle Woodland Period, 100 B.C. to A.D. 400, continued to occupy sites associated with major riverine systems throughout the northeast. Seeman (1979) defined eight major regional traditions which seem to be correlated with ecological and physiographical features. Interregional trade in raw materials was significant but may have been on a mor limited bases that previously suggested.

The decline of the Hopewell culture occurred during the period of climatic deterioration. The terminal Middle Woodland period reflects a decrease in long distance interaction and an increase in a more provincial cultural expression.

Topographic settings utilized by Middle Woodland cultures include floodplains, terraces, upland flats and hilltops, and promontories bracketing drainage heads. Habitation sites are present on both high and low order streams. Middle Woodland artifacts including ceramics and diagnostic Cheers, Maker, Snyders, Jack's Reef, Fox Creek, Garver's Ferry, and Kiski notched points have been recovered from sites in the general Lake Lynn Project area.

During the Late Woodland period, subsistence strategies (A.D.) 900 – 1,650) shifted to a reliance on domesticated plants including corn, beans and squash cultivated primarily on the large floodplains and terraces of major rivers. Many sites occur in similar areas as the earlier Middle Woodland villages. Continued occupation of upland sites including rock shelters as hunting and gathering stations, winter campsites, or small farmsteads can be demonstrated by the late Woodland period, a climatic episode known as the NeoBoreal brought cool, moist conditions to the general region. The effect of such climatic changes on the growing season for Late Woodland crops is difficult to assess without additional studies particularly data relating to the significance of cultigens during this period. Late Woodland pottery in southern West Virginia is a characteristically thick ware with cord marking and incising, and siltstone and claystone temper. Other Late Woodland traits include folded rims, Jacks Reef points, and small triangulars (Phase I Cultural Resource Survey, 1996).

Native American culture in northern West Virginia changed dramatically around A.D. 1,200. Large horticultural villages appeared in the large river walleye while upland areas were used infrequently. Social and economic elements of the culture relate to some of the drastic changes that occurred. The Cheat River scarcely resembles the stream where native Americans once fished, nettled mussels, and crossed on foot. Canoes navigated the river except where bars, shoals, and shallow rapids (known as ripples) formed in the channel. Shoals were shallow places in the stream created when sand or gravel bars became submerged. Bars, created by the river current deposited sand and silt below tributary stream junctures, were once common along the river. In places, back channels formed and the bars emerged as islands. These were places of fordings, of collecting many species of mussels, and of creating fish weirs (Phase I Cultural Resource Survey, 1996).

Historical documentation of the Lake Lynn Project area is significant in understanding past land use patterns and cultural events relating with the regional cultural history. The recorded history of the Lake Lynn Project area begins with French and English fur traders and explorers who penetrated the Cheat River region in the late 17$^{th}$ century during a prolonged period of internecine warfare among native Americans. The conflict continued until the first half of the 18$^{th}$ century when the Iroquis held the balance of power between the French and English in American (Wallace 1965). During this period, indigenous prehistoric populations dispersed from the region. Contemporaneously, Native Americans from the eastern seaboard became refuges as they were uprooted by European colonization. These native American refugees established villages, cabins, farmsteads and trading stations associated with major rivers and trading paths throughout the region.

An examination of the state sites files, located at the West Virginia Division of Culture and History in Charleston, was conducted on March 28, 1996. This research indicated that there are no previously recorded archaeological sites and no properties listed on the National Register of Historical Places located within or adjacent to the Lake Lynn Project area.

Stream terraces were the preferred site situation during all periods of prehistory although hilltops, benches, hill bases, and hillslopes were occupied throughout the entire cultural sequence. Upland village sites were situated on either salles or benches with southern exposures located east of the hilltop. Archaeological potential was enhanced whenever a known Indian path paralleled the stream or terrace particularly at crossings or portages (Phase I Cultural Resource Survey, 1996).

Predicting prehistoric site locations in the region presents significant issues because the region was not densely occupied considering the 17,000 year time span in which human populations exploited the area. Since all high probability sites were not utilized in the prehistoric past, predicting site locations involves problems that are difficult to address within the scope of our current predictive models (Phase I Cultural Resource Survey, 1996).

The Lake Lynn Project area was considered a high probability area for archaeological sites based on the following factors;

1. The Lake Lynn Project area is bisected by tributaries of the Cheat River
2. Slopes of less than 8% are present in some segments
3. Previously recorded archaeological sites occur in similar topographic situations in the general region

4. Rubles Run and Morgan Run provided waterpower for early industries

#### 4.11.1.2 Prior Cultural Resource Investigations

The general Lake Lynn Project area was significantly modified when the level of the Cheat River was raised and the floodplain/terrace system inundated. Heavy equipment impacts were noted along the west portion of the proposed recreation area. Other disturbance factors that affect the probability of archeological sites included the construction of a railroad and the clear cutting of woodland environments resulting in land surface modifications (Phase I Cultural Resource Survey, 1996).

The Phase I field methodology conforms to the approach developed by the West Virginia Division of Cultural and History, Historic Preservation Unit's Guidelines for Phase I Surveys, Phase II Testing, Phase III Mitigation and Cultural Resources Reports. The Phase I study was divided into three segments for the initial pedestrian survey. 1) The Recreation Area, where no artifactual materials or other evidence of archaeological resources were found during subsurface testing procedures in the proposed recreation area, 2) The Woodland campground sites with no indications of rock shelters or other unusual conditions were identified during the surface survey of this area and 3) The hiking/biking trail where four historic archaeological resources were identified during the surface surveillance of the Lake Lynn Project area, two associated 10$^{th}$/20$^{th}$ century foundations, six millstones, coal tipple and former Baltimore and Ohio Railroad right-of-way .

Article 414 of the current license requires Lake Lynn to consult with the appropriate SHPO and file a cultural resource management plan for FERC approval prior to any ground-disturbing activities. Prior to the construction of Cheat Lake Park and the Cheat Lake Trail, Lake Lynn conducted a Phase 1 Cultural Resources Survey in 1996 and an addendum in 1998 to survey the additional 3.1-mile section of the Cheat Lake Trail. The 1996 survey identified two associated 19$^{th}$ and 20$^{th}$ century foundations, six millstones, a coal tipple, and a railroad right-of-way (Christine Davis Consultants 1996). The 1998 addendum revealed no additional cultural resources (Christine Davis Consultants 1998). In letters filed June 12, 1996, and June 11, 1998, the WVSHPO stated the proposed trail would have no effect on any historic properties at the Lake Lynn Project (WVSHPO 1996, WVSHPO 1998).

There are two known potentially significant cultural resources within the Lake Lynn Project boundary: the railroad right-of-way (a historic archaeologic site identified above) and the Lake Lynn powerhouse and dam which are potentially eligible for listing on the National

Register of Historic Places (NRHP). Prior to filing the PAD, Lake Lynn submitted the Lake Lynn Project information to the Pennsylvania State Historic Preservation Office (PASHPO), or Pennsylvania Historical and Museum Commission (PHMC), for review. In its June 2019 preliminary review, the PASHPO identified a potential NRHP-eligible above ground resource within the Lake Lynn Project area that may require surveying prior to developing final plans. The NRHP Interactive Map and WVSHPO Interactive Map were searched, and no NRHP-eligible or potentially eligible cultural resources were identified within the Lake Lynn project boundary (NPS 2020, WVSHPO 2022).

Lake Lynn is also submitting Lake Lynn Project-specific information related to relicensing to WVSHPO and the PASHPO for a formal review.

#### 4.11.1.3 Area of Potential Affect

The Lake Lynn Project relicensing is subject to Section 106 review under the NHPA (36 CFR Part 800) since any new license for the Lake Lynn Project would be issued by the FERC. Lake Lynn initiated consultation with the West Virginia SHPO and the Pennsylvania SHPO with an initial letter on May 20, 2019 and the distribution of the NOI and PAD for the Lake Lynn Project on August 29, 2019. The PASHPO indicated that a preliminary review of the Lake Lynn Project indicates that there may be National Register-eligible aboveground resources in the Lake Lynn Project area and that if changes are proposed surveys must be conducted.  Lake Lynn consulted with the WVSHPO and PASHPO on a draft Study Plan. No study requests or comments related to cultural resources or historic structures were received. Lake Lynn submitted a formal Lake Lynn Project review request to the WVSHPO and PASHPO on October 26, 2020. The DLA was distributed to the WVSHPO and PASHPO concurrent with filing the DLA with FERC.  To date, neither the WVSHPO or the PASHPO have provided comments on the APE for the Lake Lynn Project relicensing.

### 4.11.2 Environmental Effects

#### 4.11.2.1 Effects of the Proposed Action

Lake Lynn is not proposing any changes to the Lake Lynn Project operations or to the potentially NRHP-eligible Lake Lynn dam or powerhouse. The proposed action does not include any ground-disturbing activities. Therefore, the proposed action is not expected to adversely affect cultural or historical resources. Since there are two known potentially significant cultural resources within the Lake Lynn Project boundary: the railroad right-of-way (a historic archaeologic site identified above) and the Lake Lynn powerhouse and dam which are potentially eligible for listing on the National Register of Historic Places (NRHP), Lake Lynn is proposing to develop an HPMP in consultation with the WVSHPO, PASHPO, and Tribes.

#### 4.11.2.2 Effects of the No-Action Alternative

The effects of the no-action alternative mimic the anticipated effects of the proposed action because the Licensee is proposing no changes to existing facilities or operations.

### 4.11.3 Unavoidable Adverse Effects

Undiscovered cultural resources could be adversely affected by future activities related to the Lake Lynn Project; however, Lake Lynn would continue to consult with appropriate SHPOs prior to any ground-disturbing construction activities to minimize these effects.

### 4.11.4 References

Christine Davis Consultants, Inc. 1996. Phase I Cultural Resource Survey: Cheat Lake Recreational Project, Monongalia County, West Virginia. Prepared for Allegheny Power System. April 1996.

Christine Davis Consultants, Inc. 1998. Addendum Report: Phase I Cultural Resource Survey Cheat Lake Recreational Project, Monongalia County, West Virginia. Prepared for Allegheny Power. March 1998.

Dragoo, Don W. 1963. Mounds of the Dead. Annals of Carnegie Museum37: 1-315.

National Park Service. 2020. National Register of Historic Places. Available online at: https://www.nps.gov/maps/full.html?mapId=7ad17cc9-b808-4ff8-a2f9-a99909164466. Accessed April 18, 2022.

Seeman, Mark F. 1979. The Hopewell Interaction Sphere: The Evidence for Inter-regional Trade and Structural Complexity. Indiana Historical Society

Wallace, Paul. (1965. Indian Paths of Pennsylvania. Pennsylvania Historical Museum Commission, Harrisburg.

West Virginia State Historic Preservation Office (WVSHPO). 1996. Letter Responding to Phase I Cultural Resources Survey. March 11, 1996.

West Virginia State Historic Preservation Office (WVSHPO). 1998. Letter Responding to Phase I Cultural Resources Survey Addendum. May 26, 1998.

West Virginia State Historic Preservation Office (WVSHPO). 2022. Interactive Map. Available online at: https://mapwv.gov/shpo/viewer/index.html. Accessed April 18, 2022.

## 4.12 Tribal Resources

### 4.12.1 Affected Environment

On June 27, 2019, FERC sent letters to the tribal leaders inviting the Delaware Nation, the Delaware Tribe of Indians, and the Osage Nation to participate in the relicensing process of the Lake Lynn Project (FERC 2019 a,b,c). As of the filing date of this FLA, Lake Lynn is not aware of FERC receiving responses from the Native American tribes regarding the Lake Lynn Project. In addition, Lake Lynn included the following Native American tribes on the Lake Lynn Project distribution list and sent an information request for the PAD on May 20, 2019:

- Absentee-Shawnee Tribe of Oklahoma
- Cayuga Nation
- Cherokee Nation
- Delaware Nation, Oklahoma
- Delaware Tribe of Indians
- Eastern Band of Cherokee Indians
- Eastern Shawnee Tribe of Oklahoma
- Oneida Indian Nation
- Oneida Indian Nation of Wisconsin
- Onondaga Nation
- Osage Nation
- Seneca-Cayuga Tribe of Oklahoma
- Seneca Nation of Indians
- Shawnee Tribe
- Stockbridge-Munsee Band of the Mohican Nation of Wisconsin
- St. Regis Mohawk Tribe
- Tonawanda Band of Seneca
- Tuscarora Nation
- United Keetoowah Band of Cherokee Indians in Oklahoma

On June 19, 2019, the Cherokee Nation stated that the Lake Lynn Project is outside their Area of Interest and deferred to federally recognized tribes that may have an interest in the area. On July 10, 2019, the Delaware Nation stated that the location of the proposed Lake Lynn Project does not endanger cultural or religious sites of interest and requested to be contacted within 24 hours if any artifacts are discovered. No other tribes have responded to the information request. On October 24, 2019, the Stockbridge-Munsee Community indicated that it did not wish to participate in the Lake Lynn Project relicensing and stated that the Lake Lynn Project is outside their area of cultural interest.

On September 9, 2022, the Bureau of Indian Affairs submitted comments on the DLA indicating that the Catawba Indian Nation was not listed as one of the American Indian tribes contacted in the application. Lake Lynn has included the Catawba Indian Nation on the distribution list of the FLA to include them as part of tribal consultation as required under 36 CFR Part 800.2(c)(2)(ii). On August 12, 2022, the Oneida Nation noted that it did not have comments on the DLA.

### 4.12.2 Environmental Effects

#### 4.12.2.1 Effects of the Proposed Action

Lake Lynn is not proposing any changes to Lake Lynn Project operations and no tribal interests or issues have been identified. No groundbreaking activities are proposed. As such, the proposed action is not expected to adversely affect tribal resources. There are no specific proposed PME measures for tribal resources, however, Lake Lynn would continue to inform the tribes throughout the relicensing process.

#### 4.12.2.2 Effects of the No-Action Alternative

The effects of the no-action alternative mimic the anticipated effects of the proposed action because the Licensee is proposing no changes to existing facilities or operations.

### 4.12.3 Unavoidable Adverse Effects

There are no unavoidable adverse effects identified for tribal resources.

#### 4.12.4 References

Federal Energy Regulatory Commission (FERC). 2019a. Delaware Nation. Consultation with Tribes for the Lake Lynn Hydroelectric Project No. 2459. June 27, 2019.

FERC. 2019b. Delaware Tribe of Indians. Consultation with Tribes for the Lake Lynn Hydroelectric Project No. 2459. June 27, 2019.

FERC. 2019c. Osage Nation. Consultation with Tribes for the Lake Lynn Hydroelectric Project No. 2459. June 27, 2019.

## 4.13 Socioeconomics

### 4.13.1 Affected Environment

The Lake Lynn Project is located on the Cheat River in Monongalia County, West Virginia near the city of Morgantown, and along the Fayette County, Pennsylvania border, near the borough of Point Marion. Monongalia County is in north-central West Virginia while Fayette County is in southwestern Pennsylvania. The following sections provide a summary of socioeconomic characteristics for Morgantown, West Virginia, and for Point Marion, Pennsylvania, as they are available. The socioeconomic characteristics of the region discussed include land use patterns, population patterns, and sources of employment.

#### 4.13.1.1 General Land Use Patterns

Land use near the Lake Lynn Project is primarily urban in West Virginia and rural in Pennsylvania. Table 4.25 summarizes the rural and urban nature in Morgantown and Point Marion, Monongalia County, Fayette County, West Virginia, and Pennsylvania for comparative purposes.

**Table 4.25 Proportion of the Population Living in Urban and Rural Areas, 2010***

| Land Use | Morgantown | Point Marion | Monongalia Co. | Fayette Co. | West Virginia | Pennsylvania |
|---|---|---|---|---|---|---|
| Urban | 99% | 0% | 74% | 52% | 48% | 77% |
| Rural | 1% | 100% | 26% | 48% | 52% | 23% |

Source: U.S Census Bureau 2010a,b,c,d,e,f
*The most recent population pattern analysis for urban and rural areas was done in 2010.

#### 4.13.1.2 Population Patterns

Data provided by the US Census Bureau shows that over a ten-year period the population of Morgantown increased by 2.2 percent while Point Marion decreased marginally by 0.3 precent. The population of Monongalia County, West Virginia, increased by 10.0 percent while the growth rate of West Virginia decreased by 3.2 percent. The growth rate in Fayette County, Pennsylvania, decreased by 6.3 percent while the growth rate of Pennsylvania increased marginally by 2.4 percent. The land area of Fayette County is larger than the area of Monongalia County. The population density is highest in the City of Morgantown, West Virginia. Table 4.26 summarizes population statistics in the Lake Lynn Project vicinity in 2010 and 2020, as well as recent population patterns.

**Table 4.26 Population Statistics for the Lake Lynn Project Vicinity**

| Population Statistics | Morgantown | Point Marion | Monongalia Co. | Fayette Co. | West Virginia | Pennsylvania |
|---|---|---|---|---|---|---|
| Population (2010) | 29,660 | 1,159 | 96,189 | 136,606 | 1,852,994 | 12,702,379 |
| Population (2020) | 30,347 | 1,156 | 105,822 | 128,073 | 1,793,716 | 13,002,700 |
| % Change 2010 to 2020 | 2.3% | -0.3% | 10.0% | -6.3% | -3.2% | 2.4% |
| Land Area in sq. mi., 2010 | 10.2 | 0.4 | 360.1 | 790.3 | 24,038.2 | 44,742.7 |
| Population per sq. mi., 2020 | 2,984.0 | 2,752.4 | 293.9 | 162.0 | 74.6 | 290.6 |

Source: City Data 2022, U.S. Census Bureau 2010a, 2010b, 2010c, 2010d, 2010e, 2010f, 2010g 2022a, 2022b, 2022c, 2022d, 2022e, 2022f.

#### 4.13.1.3 Economic Indicators and Employment

Income, poverty, and employment data from the American Community Survey (based on estimates from 2020 U.S. Census Bureau data) are provided in Table 4.27.

**Table 4.27 Economic Characteristics of the Lake Lynn Project Region (2020 Estimates)**

| Economic Class | Morgantown | Point Marion | Monongalia Co. | Fayette Co. |
|---|---|---|---|---|
| Median Household Income | $42,474 | $57,125 | $54,198 | $49,075 |
| Mean Household Income | $66,377 | $63,752 | $82,948 | $64,658 |
| Per Capita Income | $25,248 | $23,716 | $33,527 | $27,778 |
| Persons Below the Poverty Level | 34.7% | 20.0% | 20.4% | 16.5% |
| Population in Labor Force | 57.8% | 69.8% | 62.5% | 54.7% |
| Unemployment Rate | 10.9% | 7.4% | 6.6% | 7.3% |

Source: U.S. Census Bureau 2022g-2022u

Table 4.28 summarizes employment by industry in the Lake Lynn Project vicinity. Educational services, and health care and social assistance has the highest employment rate surrounding the in the area.

**Table 4.28 Employment by Industry in the Lake Lynn Project Vicinity**

| Employment Type | Morgantown | Point Marion | Monongalia Co. | Fayette Co. |
|---|---|---|---|---|
| Agriculture, forestry, fishing and hunting, and mining | 0.6% | 2.5% | 2.6% | 3.5% |
| Construction | 2.2% | 5.1% | 3.6% | 8.1% |
| Manufacturing | 3.6% | 6.5% | 5.1% | 10.3% |
| Wholesale trade | 0.5% | 0.0% | 1.1% | 2.1% |
| Retail trade | 11.2% | 16.0% | 10.1% | 12.9% |
| Transportation and warehousing, and utilities | 1.5% | 3.2% | 2.9% | 7.2% |
| Information | 0.6% | 0.8% | 1.2% | 1.1% |
| Finance and insurance, real estate, rental, leasing | 4.7% | 1.0% | 4.6% | 2.9% |
| Professional, scientific, and management, administrative and waste management services | 12.5% | 10.5% | 11.2% | 6.8% |
| Educational services, and health care and social assistance | 37.4% | 28.1% | 37.6% | 28.4% |
| Arts, entertainment, and recreation, and accommodation and food services | 19.2% | 18.0% | 12.0% | 9.0% |
| Other services, except public administration | 2.5% | 2.8% | 3.1% | 4.2% |
| Public administration | 3.6% | 5.5% | 5.0% | 3.5% |

Source: U.S. Census Bureau, 2022j,

### 4.13.2 Environmental Effects

#### 4.13.2.1 Effects of the Proposed Action

The Licensee is not proposing any changes to the Lake Lynn Project facilities or operations. The Licensee will continue to employ staff to operate the facilities as well as contract work for service and maintenance at the Lake Lynn Project. Because no changes are proposed, socioeconomic resources are not expected to be adversely affected. Continued operations of the Lake Lynn Project will continue to provide clean and reliable renewable energy for consumers in the area for the term of any new license.

#### 4.13.2.2 Effects of the No-Action Alternative

The effects of the no-action alternative mimic the anticipated effects of the proposed action because the Licensee is proposing no changes to existing facilities or operations.

### 4.13.3 Unavoidable Adverse Effects

Continued operation and relicensing of the Lake Lynn Project and associated PME measures as proposed is not expected to result in unavoidable adverse effects on socioeconomic resources.

### 4.13.4 References

City Data. 2022. Point Marion, PA Available online: http://www.city-data.com/city/Point-Marion-Pennsylvania.html. Accessed: April 12, 2022.

U.S. Census Bureau. 2010a. DEC Summary File 1, P2 Urban and Rural Total Population, Morgantown City, West Virginia. Available online: https://data.census.gov/cedsci/table?q=morgantown%20city%20west%20virginia%20urban&y=2010&tid=DECENNIALSF12010.P2. Accessed: April 12, 2022.

U.S. Census Bureau. 2010b. DEC Summary File 1, P2 Urban and Rural Total Population, Point Marion borough, Pennsylvania. Available online: https://data.census.gov/cedsci/table?q=Point%20Marion%20borough,%20Pennsylvania%20urban&tid=DECENNIALSF12010.P2 . Accessed: April 12, 2022.

U.S. Census Bureau. 2010c. DEC Summary File 1, P2 Urban and Rural Total Population, Monongalia County, West Virginia. Available online: https://data.census.gov/cedsci/table?q=monongalia%20county%20west%20virginia%20urban&y=2010&tid=DECENNIALSF12010.P2. Accessed: April 12, 2022.

U.S. Census Bureau. 2010d. DEC 113th Congressional District Summary File, P2 Urban and Rural Total Population, West Virginia. Available online: https://data.census.gov/cedsci/table?q=fayette%20county%20pa%20urban&tid=DECENNIALSF12010.P2. Accessed: April 12, 2022.

U.S. Census Bureau. 2010e. DEC 113th Congressional District Summary File, P2 Urban and Rural Total Population, West Virginia. Available online: https://data.census.gov/cedsci/table?q=west%20virginia%20urban&y=2010&tid=DECENNIALCD1132010.P2. Accessed: April 12, 2022.

U.S. Census Bureau. 2010f. DEC 113th Congressional District Summary File, P2 Urban and Rural Total Population, Pennsylvania. Available online: https://data.census.gov/cedsci/table?q=Pennsylvania%20rural&tid=DECENNIALCD1132010.P2. Accessed: April 12, 2022.

U.S. Census Bureau. 2010g. QuickFacts. Available online: https://www.census.gov/quickfacts/fact/table/PA,WV,fayettecountypennsylvania,morgantowncitywestvirginia,monongaliacountywestvirginia/BZA110219. Accessed: April 12, 2022.

U.S. Census Bureau. 2022a. DEC Redistricting Data (PL 94-171), P1 Race. Available online: https://data.census.gov/cedsci/table?q=morgantown%20wv%20popullation&tid=DECENNIALPL2020.P1 . Accessed: April 12, 2022.

U.S. Census Bureau. 2022b. DEC Redistricting Data (PL 94-171), P1 Race. Available online: https://data.census.gov/cedsci/table?q=point%20marion. Accessed: April 12, 2022.

U.S. Census Bureau. 2022c. DEC Redistricting Data (PL 94-171), P1 Race. Available online: https://data.census.gov/cedsci/table?q=monongalia%20county%20population. Accessed: April 12, 2022.

U.S. Census Bureau. 2022d. DEC Redistricting Data (PL 94-171), P1 Race. Available online: https://data.census.gov/cedsci/table?q=fayette%20county,%20PA%20population. Accessed: April 12, 2022.

U.S. Census Bureau. 2022e. DEC Redistricting Data (PL 94-171), P1 Race. Available online: https://data.census.gov/cedsci/table?q=west%20virginia%20population. Accessed: April 12, 2022.

U.S. Census Bureau. 2022f. DEC Redistricting Data (PL 94-171), P1 Race. Available online: https://data.census.gov/cedsci/table?q=pennsylvania%20population. Accessed: April 12, 2022.

U.S. Census Bureau. 2022g. ACS 5-Year Estimates Subject Tables. S1901 Income in the Past 12 Months (in 2020 Inflation-Adjusted Dollars). Available online: https://data.census.gov/cedsci/table?q=%20morgantown%20west%20virginia%20incom. Accessed: April 12, 2022.

U.S. Census Bureau. 2022h. ACS 5-Year Estimates Detailed Tables. B19301 Per Capita Income in the Past 12 Months (in 2020 Inflation-Adjusted Dollars). Available online: https://data.census.gov/cedsci/table?q=%20morgantown%20west%20virginia%20per%20capita%20income&tid=ACSDT5Y2020.B19301. Accessed: April 12, 2022.

U.S. Census Bureau. 2022i. ACS 5-Year Estimates Detailed Tables. S1701 Poverty Status in the Past 12 Months. Available online: https://data.census.gov/cedsci/table?q=%20morgantown%20west%20virginia%20poverty%20line. Accessed: April 12, 2022.

U.S. Census Bureau. 2022j. ACS 5-Year Estimates Detailed Tables. DP03 Selected Economic Characteristics. Available online: https://data.census.gov/cedsci/table?q=%20morgantown%20west%20virginia%20selected%20economic&tid=ACSDP5Y2020.DP03. Accessed: April 12, 2022.

U.S. Census Bureau. 2022k. ACS 5-Year Estimates Subject Tables. S1901 Income in the Past 12 Months (in 2020 Inflation-Adjusted Dollars). Available online: https://data.census.gov/cedsci/table?q=point%20marion%20income. Accessed: April 12, 2022.

U.S. Census Bureau. 2022l. ACS 5-Year Estimates Detailed Tables. B19301 Per Capita Income in the Past 12 Months (in 2020 Inflation-Adjusted Dollars). Available online: https://data.census.gov/cedsci/table?q=point%20marion%20per%20capita%20income&tid=ACSDT5Y2020.B19301. Accessed: April 12, 2022.

U.S. Census Bureau. 2022m. ACS 5-Year Estimates Detailed Tables. S1701 Poverty Status in the Past 12 Months. Available online: https://data.census.gov/cedsci/table?q=point%20marion%20poverty. Accessed: April 12, 2022.

U.S. Census Bureau. 2022n. ACS 5-Year Estimates Subject Tables. S1901 Income in the Past 12 Months (in 2020 Inflation-Adjusted Dollars). Available online:

https://data.census.gov/cedsci/table?q=monongalia%20county%20income. Accessed: April 12, 2022.

U.S. Census Bureau. 2022o. ACS 5-Year Estimates Detailed Tables. B19301 Per Capita Income in the Past 12 Months (in 2020 Inflation-Adjusted Dollars). Available online: https://data.census.gov/cedsci/table?q=monongalia%20county%20per%20capita%20income&tid=ACSDT5Y2020.B19301. Accessed: April 12, 2022.

U.S. Census Bureau. 2022p. ACS 5-Year Estimates Detailed Tables. DP03 Selected Economic Characteristics. Available online: https://data.census.gov/cedsci/table?q=point%20marion%20selected%20economic. Accessed: April 12, 2022.

U.S. Census Bureau. 2022q. ACS 5-Year Estimates Detailed Tables. DP03 Selected Economic Characteristics. Available online: https://data.census.gov/cedsci/table?q=monongalia%20county%20selected%20economic&tid=ACSDP5Y2020.DP03. Accessed: April 12, 2022.

U.S. Census Bureau. 2022r. ACS 5-Year Estimates Subject Tables. S1901 Income in the Past 12 Months (in 2020 Inflation-Adjusted Dollars). Available online: https://data.census.gov/cedsci/table?q=%20Fayette%20County,%20Pennsylvania%20income&tid=ACSST5Y2020.S1901. Accessed: April 12, 2022.

U.S. Census Bureau. 2022s. ACS 5-Year Estimates Detailed Tables. B19301 Per Capita Income in the Past 12 Months (in 2020 Inflation-Adjusted Dollars). Available online: https://data.census.gov/cedsci/table?q=%20Fayette%20County,%20Pennsylvania%20per%20capita%20income&tid=ACSDT5Y2020.B19301. Accessed: April 12, 2022.

U.S. Census Bureau. 2022t. ACS 5-Year Estimates Detailed Tables. S1701 Poverty Status in the Past 12 Months. Available online: https://data.census.gov/cedsci/table?q=%20Fayette%20County,%20Pennsylvania%20poverty. Accessed: April 12, 2022.

U.S. Census Bureau. 2022u. ACS 5-Year Estimates Detailed Tables. DP03 Selected Economic Characteristics. Available online: https://data.census.gov/cedsci/table?q=%20Fayette%20County,%20Pennsylvania%20selected%20economics&tid=ACSDP5Y2020.DP03. Accessed: April 12, 2022.

## 4.14 Environmental Justice

Pursuant to Executive Orders 12898[5] and 14008[6] the FERC is required to complete an analysis of potential impacts from Lake Lynn Project operations on the local community in the vicinity of the Lake Lynn Project to understand the impacts to human health and the environment as they relate to environmental justice communities, or communities that stand to be disproportionately impacted by construction of a new facility or the continued operation of an existing facility, including socioeconomic and/or sociocultural impacts.

Additionally, the FERC understands that it plays an integral role in regulating large parts of the United States energy industry, having far-reaching impacts to the nation, especially regarding the move toward cleaner energy (FERC 2022). Although the FERC is not required to comply with Executive Order 13985[7] the Commission has voluntarily elected to participate in the process, in an effort to ensure everyone can benefit from the clean energy transition (FERC 2022). Pursuant to Executive Order 13985, the FERC has developed an Equity Action Plan based on five focus areas, discussing barriers traditionally experienced by underserved and environmental justice communities regarding FERC practices, and outlines actions to remove those barriers and foster a commitment to equity (FERC 2022).

The FERC recognizes that many of the licensed hydropower projects were constructed prior to implementation of the NEPA, or the issuance of executive orders related to equity or environmental justice (FERC 2022). The steps taken by FERC related to the three executive orders will include equity considerations when making decisions regarding hydropower relicensing and consider environmental justice communities as they relate to the relicensing process.

[5] Exec. Order No. 12898, 59 Fed. Reg. 7629 (Feb. 16, 1994). Federal Actions to Address Environmental Justice in Minority and Low-Income Populations.

[6] Exec. Order No. 14008, 86 Fed. Reg. 7619-7633 (Jan. 27, 2021) Tackling the Climate Change Crisis at Home and Abroad.

[7] Exec. Order No. 13985 (June 2021). Advancing Racial Equity and Support for Underserved Communities Through the Federal Government.

**Identification of Environmental Justice Communities**

The thresholds used for populations meeting environmental justice status are as follows:

- For minority populations, the meaningfully greater analysis method was used, where the total minority population for a block group is at least 10 percent greater than that of the county population:

    (County minority population) x (1.10) = threshold above which a block group minority population must be for inclusion as an environmental justice community

- The "low-income threshold criteria" was used to identify environmental justice communities based on income level, where the block group must have a higher percentage of low-income households than the county.

### 4.14.1 Affected Environment

The Lake Lynn Project is located on the Cheat River in the City of Morgantown, Monongalia County, West Virginia. The Lake Lynn Project tailrace crosses the state border into Fayette County, Pennsylvania, near the borough of Point Marion. Within a one-mile zone around the Lake Lynn Project boundary there are seventeen census block groups that could potentially be impacted by relicensing, including two block groups in Preston County, West Virginia. All of the seventeen census block groups within the Lake Lynn Project area include minority populations, three of which meet requirements for status as environmental justice communities.

In addition to race, environmental justice communities include groups of individuals with income levels below poverty level, measured by household. Within the Lake Lynn Project area there are six communities meeting environmental justice status related to household income level (Table 4.29).

The final community analyzed for environmental justice includes individuals that are unable to speak English. Within the Lake Lynn Project there are no such individuals in any block groups (United States Census 2022).

There are ten block groups that border Lake Lynn Project lands; within those ten groups, one block group has a minority environmental justice community, and one block group has both minority and low-income environmental justice communities. (Table 4.29) (Figure 4.25).

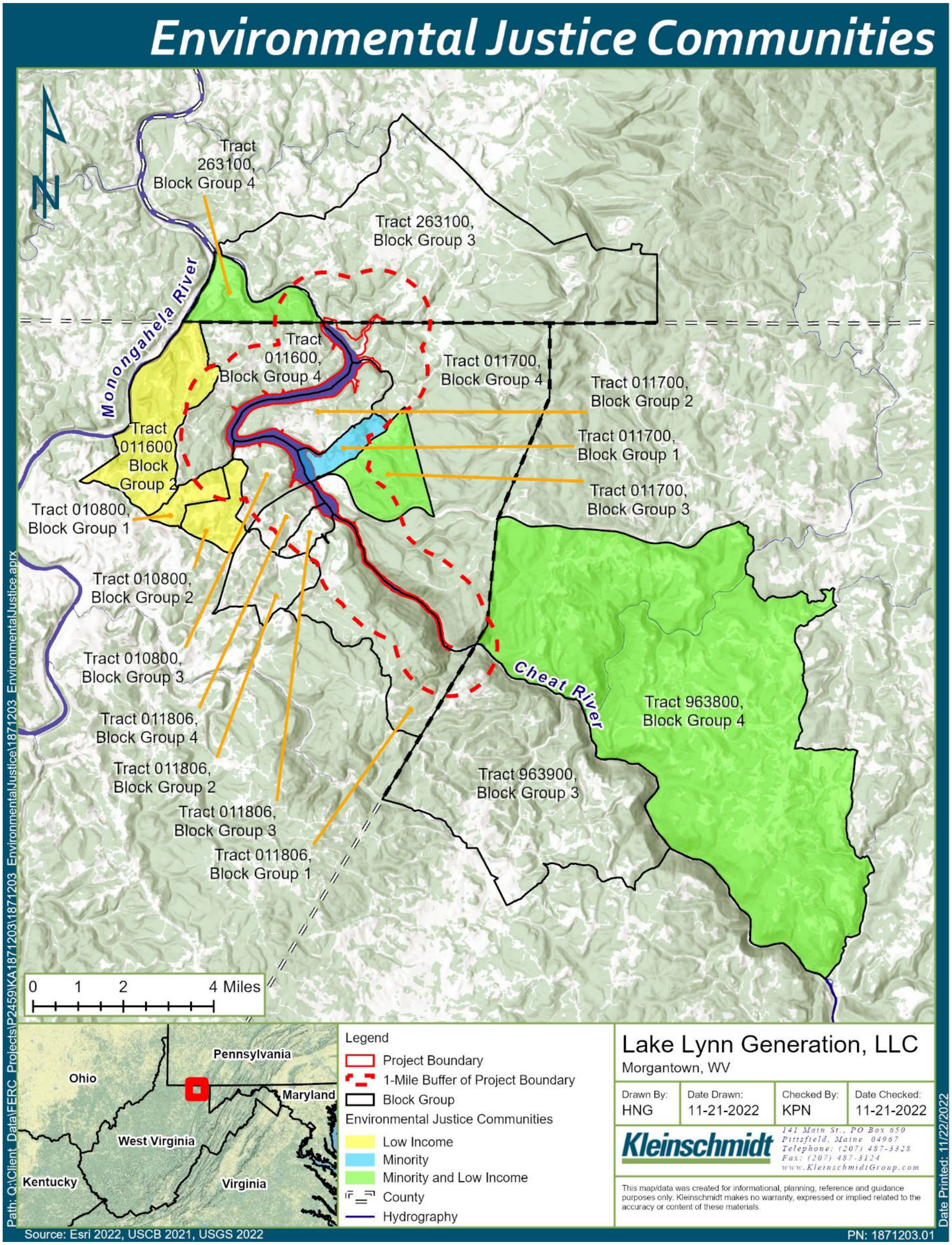



**Figure 4.25 Environmental Justice Communities within one mile of the Lake Lynn Project.**

**Table 4.29 Current Community Data within one mile of the Lake Lynn Project Boundary**

| Geographic Area | RACE AND ETHNICITY DATA | | | | | | | | | | LOW-INCOME DATA |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | Total Population (count)[a] | White Alone, not Hispanic (count)[a] | African American/ Black (count)[a] | American Indian/ Alaska Native (count)[a] | Asian (count)[a] | Native HI & Other Pacific Islander (count)[a] | Some Other Race (count)[a] | Two or More Races (count)[a] | Hispanic Origin (any race) (count)[a] | Total Minority Population (%) | Below Poverty Data (%)[b] |
| **Pennsylvania** | 12791530 | 10300602 | 1430664 | 24691 | 436324 | 4198 | 275177 | 319874 | 935216 | 27% | 12% |
| **Fayette County** | 131302 | 121435 | 5502 | 55 | 474 | 81 | 615 | 3140 | 1611 | 9% | 17% |
| Census Tract 263100, Block Group 4 | 1371 | 1259 | 16 | 0 | 0 | 45 | 26 | 25 | 39 | **11%** | **17%** |
| Census Tract 263100, Block Group 3 | 1729 | 1729 | 0 | 0 | 0 | 0 | 0 | 0 | 27 | 2% | 4% |
| **West Virginia** | 1817305 | 1691600 | 66990 | 3667 | 14523 | 419 | 7971 | 32135 | 28368 | 8% | 17% |
| **Monongalia County** | 105474 | 94397 | 3781 | 80 | 3644 | 0 | 741 | 2831 | 2246 | 13% | 20% |
| Census Tract 011700, Block Group 1 | 850 | 699 | 14 | 0 | 137 | 0 | 0 | 0 | 29 | **21%** | 12% |
| Census Tract 011700, Block Group 3 | 897 | 768 | 65 | 0 | 0 | 0 | 0 | 64 | 0 | 14% | **31%** |
| Census Tract 011600, Block Group 4 | 2064 | 1875 | 50 | 0 | 17 | 0 | 0 | 122 | 42 | 11% | 4% |
| Census Tract 011806, Block Group 2 | 1505 | 1433 | 27 | 0 | 21 | 0 | 13 | 11 | 35 | 7% | 2% |
| Census Tract 011806, Block Group 1 | 1392 | 1378 | 0 | 0 | 0 | 0 | 0 | 14 | 60 | 5% | 8% |
| Census Tract 010800, Block Group 3 | 1198 | 1047 | 37 | 0 | 91 | 0 | 0 | 23 | 0 | 13% | 9% |
| Census Tract 011700, Block Group 2 | 1444 | 1280 | 138 | 0 | 6 | 0 | 0 | 20 | 0 | 11% | 1% |

| Geographic Area | RACE AND ETHNICITY DATA | | | | | | | | | | LOW-INCOME DATA |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | Total Population (count)[a] | White Alone, not Hispanic (count)[a] | African American/ Black (count)[a] | American Indian/ Alaska Native (count)[a] | Asian (count)[a] | Native HI & Other Pacific Islander (count)[a] | Some Other Race (count)[a] | Two or More Races (count)[a] | Hispanic Origin (any race) (count)[a] | Total Minority Population (%) | Below Poverty Data (%)[b] |
| Census Tract 010800, Block Group 1 | 1323 | 1211 | 13 | 0 | 44 | 0 | 10 | 45 | 8 | 9% | **32%** |
| Census Tract 011600, Block Group 2 | 2062 | 1830 | 15 | 0 | 137 | 0 | 43 | 37 | 43 | 13% | **26%** |
| Census Tract 011700, Block Group 4 | 793 | 707 | 69 | 0 | 0 | 0 | 11 | 6 | 0 | 11% | 0% |
| Census Tract 011806, Block Group 3 | 938 | 847 | 43 | 0 | 9 | 0 | 0 | 39 | 1 | 10% | 8% |
| Census Tract 011806, Block Group 4 | 1635 | 1453 | 12 | 0 | 155 | 0 | 0 | 15 | 0 | 11% | 11% |
| Census Tract 010800, Block Group 2 | 1613 | 1519 | 67 | 0 | 0 | 0 | 6 | 21 | 6 | 6% | **25%** |
| **Preston County** | 33683 | 31044 | 1717 | 240 | 85 | 8 | 190 | 399 | 849 | 10% | 14% |
| Census Tract 963900, Block Group 3 | 1260 | 1220 | 0 | 0 | 0 | 0 | 12 | 28 | 0 | 3% | 5% |
| Census Tract 963800, Block Group 4 | 1006 | 871 | 0 | 135 | 0 | 0 | 0 | 0 | 0 | **13%** | **22%** |

[a] Percent of total population (Table B03002 - Hispanic or Latino Origin by Race American Community Survey. 2020 ACS 5-Year Estimates Detailed Tables. U.S. Census Bureau

[b] Percent of Households (Table B17017 - Poverty Status in the Past 12 Months by Household Type by Age of Householder. 2020 ACS 5-Year Estimated Detailed Tables.

#### 4.14.2 Environmental Effects

To address environmental justice concerns at the Commission level, the FERC has implemented an Equity Action Plan, allowing for environmental justice considerations in Commission-level decisions and actions (FERC 2022). For this relicensing application, the USEPA's 2016 guidance document for assessing environmental justice within a regulatory context has been used to analyze potential impacts to environmental justice communities from relicensing, and although the environmental stressors are different, the following three questions posed by the USEPA document are transferable:

- Are there potential environmental justice concerns associated with environmental stressors affected by the regulatory action for the population groups of concern in the baseline?
- For the regulatory option(s) under consideration, are potential environmental justice concerns created or mitigated compared to the baseline?
- Are there potential environmental justice concerns associated with environmental stressors affected by the regulatory action for population groups of concern for the regulatory option(s) under consideration?

**Baseline Conditions**

The Lake Lynn Project has been in place since 1926, providing safe and renewable power to the region, as well as recreational opportunities to the public. Primary water uses in the Lake Lynn Project area (both consumptive and non-consumptive) include hydropower production, wastewater assimilation, aquatic and wildlife habitat, and recreation. Please see section 4.0 of this exhibit for additional baseline conditions for the region.

##### 4.14.2.1 Effects of the Proposed Action

The Licensee is not proposing changes to Lake Lynn Project operations or facilities as part of this relicensing process, and there are no known entities in possession of water rights within the Lake Lynn Project boundary. Additionally, water within the Lake Lynn Project boundary is not used for domestic water supply or irrigation, and there are no active water withdrawals. Therefore, new impacts to shoreline property or archaeological or tribal sites within the Lake Lynn Project area are not anticipated, nor are impacts to recreation, aesthetics, or wildlife habitat potentially impacting environmental justice communities.

#### 4.14.2.2 Effects of the No-Action Alternative

The no-action alternative represents the baseline conditions at the Lake Lynn Project. There would be no changes to Lake Lynn Project operation or facilities, and therefore no change in effect to environmental justice communities.

### 4.14.3 Unavoidable Adverse Effects

No infrastructure or operational changes are proposed as part of this relicensing; therefore, relicensing, and continued operation of the Lake Lynn Project is not expected to have any new unavoidable adverse effects on environmental justice communities.

#### 4.14.4 References

Federal Energy Regulatory Commission (FERC). 2022. Equity Action Plan. Retrieved from file:///J:/012/217/Docs/FLA/Exhibit%20E/Environmental%20Justice/Equity%20Action%20Plan%20for%20FERC%20EO13985.pdf on November 22, 2022.

United States Environmental Protection Agency (USEPA). 2016. Technical Guidance for Assessing Environmental Justice in Regulatory Analysis. Retrieved from https://www.epa.gov/sites/default/files/2016-06/documents/ejtg_5_6_16_v5.1.pdf on November 22, 2022.

# 5.0 CONSISTENCY WITH COMPREHENSIVE PLANS

## 5.1 Consistency with Comprehensive Plans

Section 10(a)(2)(A) of the FPA, 16 U.S.C. section 803 (a)(2)(A), requires FERC to consider the extent to which a project is consistent with federal or state comprehensive plans for improving, developing, or conserving a waterway or waterways affected by a hydropower project. On April 27, 1988, the Commission issued Order No. 481-A, revising Order No. 481, issued October 26, 1987, establishing that the Commission will accord FPA section 10(a)(2)(A) comprehensive plan status to any federal or state plan that: (1) is a comprehensive study of one or more of the beneficial uses of a waterway or waterways; (2) specifies the standards, the data, and the methodology used; and (3) is filed with the Secretary of the Commission.

### 5.1.1 FERC-Approved Federal and State Comprehensive Plans

FERC currently lists 66 federal and state comprehensive plans and of those, the following 8 comprehensive plans are identified as pertaining to waters in the vicinity of the Lake Lynn Project:

- National Park Service. The Nationwide Rivers Inventory. Department of the Interior, Washington, D.C. 1993.
- Pennsylvania Department of Environmental Resources. 1983. Pennsylvania State water plan. Harrisburg, Pennsylvania. January 1983. 20 volumes.
- Pennsylvania Department of Environmental Resources. 1986. Pennsylvania's recreation plan, 1986-1990. Harrisburg, Pennsylvania.
- Pennsylvania Department of Environmental Resources. 1988. Pennsylvania 1988 water quality assessment. Harrisburg, Pennsylvania. April 1988.
- West Virginia Division of Natural Resources. 1982. Monongahela River Basin plan. Charleston, West Virginia.
- West Virginia Division of Natural Resources. 2015 West Virginia State Wildlife Action Plan. Charleston, West Virginia. September 1, 2015
- West Virginia Governor's Office of Community and Industrial Development. West Virginia State Comprehensive Outdoor Recreation Plan: 1988-1992. Charleston, West Virginia.

- U.S. Fish and Wildlife Service. n.d. Fisheries USA: the recreational fisheries policy of the U.S. Fish and Wildlife Service. Washington, D.C.

Based on a review of these plans, Lake Lynn has determined that current and proposed operations of the Lake Lynn Project facilities are consistent with these plans.

# APPENDIX A

# CONSULTATION SUMMARY

A summary of key consultation conducted during the Lake Lynn Traditional Licensing Process is provided in the table provided in this appendix. Copies of relevant documents are provided after the table.

| Date | From | To | Description |
|---|---|---|---|
| May 20, 2019 | Licensee | Distribution List | Letter to Federal and state agencies and non-governmental organizations to initiate information gathering for the PAD, consultation for Relicensing, and to request input on the use of the TLP for the relicensing of the Project. |
| June 10, 2019 | Licensee | Cheat Lake Environment & Recreation Association (CLEAR) | Provided a summary comparing/contrasting the TLP vs. the Integrated Licensing Process (ILP). |
| June 12, 2019 | Licensee | Distribution List | Reminder for request for information gathering for the PAD for Relicensing and to request input on the use of the TLP for the relicensing of the Project. |
| June 12, 2019 | Licensee | Greystone-on-the-Cheat | Clarified that the Information Request for the PAD was directed to Greystone-on-the-Cheat. Ms. Carter forwarded the Information Request for the PAD to the appropriate contacts in the organization and confirmed that she should continue to be listed as the main contact for the organization. |
| June 18, 2019 | WVDEP | Licensee | Email providing water quality data from WVDEP stations (online database retrieval tool was not working) |
| June 19, 2019 | Cherokee Nation | Licensee | In response to Information Request for the PAD, stated that Monongalia County and Fayette County are outside the Cherokee Nation's Area of Interest, thus, they defer to federally-recognized Tribes that have an interest in this land base. |
| June 19, 2019 | Friends of the Cheat (FOC) | Licensee | In response to Information Request for the PAD, emailed questions about docket number and filing comments in FERC docket. |
| June 19, 2019 | Licensee | FOC | Responded to Amanda Pitzer's email indicating that comments/information should be submitted directly to Jody Smet and that copies of submittals received will be included with the PAD that will be filed with |

| Date | From | To | Description |
|---|---|---|---|
| | | | FERC. Instructions were also provided for filing comments in the FERC docket. |
| June 19, 2019 | Janet Norman, USFWS | Licensee | In response to Information Request for the PAD, Ms. Norman contacted Licensee to discuss IPaC process. |
| June 19, 2019 | Licensee | Janet Norman, USFWS | Call to explain that the IPaC was completed informally for the PAD and that no formal consultation had been requested through the IPaC review process. Ms. Norman requested a shapefile of the Project area used for the IPaC. |
| June 19, 2019 | WVDNR | Licensee | In response to Information Request for the PAD, requested clarification that this request is related to information for the PAD and that study requests would be submitted at a later date. |
| June 19, 2019 | Licensee | WVDNR | Responded that the information request is related to information for the PAD. |
| June 19, 2019 | Division of Environmental Review , PA SHPO, PA Historical and Museum Commission | Licensee | In response to Information Request for the PAD, stated that a preliminary review of the Project indicates that there may be National Register-eligible aboveground resources in the Project area and that in order to facilitate the review process, surveys must be conducted if changes proposed to identify these resources before final plans are developed. |
| June 20, 2019 | Licensee | USFWS | Provided Licensee contact information and an update on availability of shapefile for the Project area. |
| June 20, 2019 | USFWS | Licensee | Acknowledged receipt of Licensee contact information. |
| June 20, 2019 | PFBC | Licensee | In response to Information Request for the PAD, stated that the PFBC agrees with the use of the TLP. Ms. Smiles stated that PFBC has been involved in the review of biological monitoring information and has had opportunities to provide comments on future monitoring; and therefore, does not have any additional information requests at this time. |
| June 20, 2019 | CLEAR | Licensee | In response to Information Request for the PAD, provided issues and recommendations relating to carrying capacity, buoys, Cheat River beach sand, large woody debris, vegetation clearing, debris clean-up, and permanent structures along the shoreline. |

| Date | From | To | Description |
|---|---|---|---|
| June 20, 2019 | CLEAR | Licensee | In response to Information Request for the PAD, requested various recreation, safety, and security measures for inclusion in the relicensing of the Lake Lynn Project and for incorporation into the operation and maintenance of the facility and surroundings. |
| June 20, 2019 | Friends of the Cheat (Board Member and Treasurer) American Whitewater (Lifetime Member) | Licensee, FERC | Proposed recreation access and improvements to Upper Cheat Lake through Buzzards Road improvements. |
| June 20, 2019 | FOC | Licensee, FERC | In response to Information Request for the PAD, requested improvement of recreational opportunities that should be considered as part of this next re-licensing process, including public access to the upper reaches of Cheat Lake and extending the southern end of Cheat Lake Trail. |
| June 21, 2019 | Rotary Club of Cheat Lake | Licensee, FERC | Stated that he would like to see an extension of the pedestrian trail system especially from the dam to the Monongahela River, and along other areas to connect to other trails. |
| June 25, 2019 | Licensee | USFWS | As follow-up to June 19 call, provided shapefile for the Project boundary used for IPaC search. |
| June 26, 2019 | Pennsylvania Game Commission (PGC) | Licensee | In response to Information Request for the PAD, requested Project mapping that illustrates the location and boundary of the Project area as well as any proposed improvements that may be proposed as part of the relicensing effort. |
| June 27, 2019 | Licensee | PGC | Provided a figure of the Project boundary and clarified that, at this time, the Licensee is not proposing any changes or improvements at the Project. |
| June 27, 2019 | FERC | Delaware Nation, Delaware Tribe of Indians, | FERC letter to Tribal Leaders inviting participation in the relicensing process for the Lake Lynn Hydroelectric Project. |

| Date | From | To | Description |
|---|---|---|---|
| | | Osage Nation | |
| July 2, 2019 | PGC | Licensee | In response to Information Request for the PAD, provided comments noting that, at this time, given that no activities are proposed, the PGC does not have any information to provide for inclusion in the PAD. |
| July 8, 2019 | Licensee | WVDNR | Email inquiring whether WVDNR has any concerns about the proposed use of the TLP. |
| July 8, 2019 | WVDNR | Licensee | Email indicating that WVDNR would not object to the TLP and that the Licensee does a fairly good job at working with the resource agencies. |
| July 9, 2019 | Licensee | USFWS | Follow-up to confirm that there were no issues with shapefile provided on June 25. |
| July 10, 2019 | Delaware Nation | Licensee | In response to Information Request for the PAD, stated that the proposed Project location does not endanger cultural or religious sites of interest to the Delaware Nation. Requested that if any artifacts are discovered that the Licensee contact their office within 24 hours. |
| August 29, 2019 | Licensee | FERC and Distribution List | Filed request to use TLP, NOI and PAD with FERC and distributed to distribution list |
| October 24, 2019 | Stockbridge Munsee Community | Licensee | Email indicating that the Stockbridge Munsee Community does not wish to participate in the project relicensing |
| October 18, 2019 | Licensee | Distribution List | Email update on process and request for availability for Joint Agency Meeting and Site Visit |
| November 21, 2019 | Licensee | FERC and Distribution List | Notice and agenda for Joint Agency Meeting and Site Visit |
| December 12, 2019 | | | Joint Agency Meeting and Site Visit |
| January 23, 2020 | Licensee | FERC and Distribution List | Provided summaries of Joint Agency Meeting and Site Visit and proof of public notice in newspaper |
| February 12, 2020 | WVDNR | Licensee, FERC | Provided comments on the PAD and study requests |

| Date | From | To | Description |
|---|---|---|---|
| February 10, 2020 | CLEAR | Licensee | Provided comments on the PAD and study requests |
| February 13, 2020 | USFWS | FERC, Licensee | Provided comments on the PAD and study requests |
| February 9 2020 | Monongahela River Trails Conservancy (MRTC) | Licensee, FERC | Provided comments on the PAD and study requests |
| January 8, 2020 | FOC | FERC | Provided comments on the PAD |
| January 9, 2020 | Gary Marlin | FERC | Provided comments on the PAD |
| April 15, 2020 | Licensee | Distribution List | Emailed Draft Study Plan for review and comment and requested availability for a conference call. |
| April 24, 2020 | | | Conference Call to discuss Draft Study Plan |
| May 8, 2020 | Licensee | Distribution List | Emailed revised Draft Study Plan for review and comment along with draft notes from the April 24, 2020 Conference call |
| May 15, 2020 | Licensee | USFWS, WVDNR, WVDEP, PDEP, PFBC | Call to collaborate on Streamflow Data and provided background/history and Instream Flow Study to the agencies. Discussed the USFWS request for revisions to the Flow Duration Curves in Appendix E of the PAD |
| May 18, 2020, Lake | Licensee | USFWS, PBFC, WVDNR | Draft Mussel survey plan distributed to agencies and scheduled a call to discuss the study plan |
| May 20, 2020 | | | Call with USFWS, PBFC, WVDNR to discuss Mussel Survey |
| July 9, 2020 | Licensee | USFWS, PBFC, WVDNR | Revised Draft Mussel survey plan distributed |
| July 9,,2020 | Licensee | Distribution List | Emailed final Study Plan |
| July 21, 2020 | WVDNR | Licensee | Comments on Draft Mussel survey plan |
| August 3,,2020 | PFBC | Licensee | Comments on Draft Mussel survey plan |

| Date | From | To | Description |
|---|---|---|---|
| August 25, 2020 | Licensee | USFWS, WVDNR, WVDEP, PDEP, PFBC | Provided revised Flow Duration Curves as part of collaborate on Streamflow Data and suggested that another call could be scheduled if there were further comments or requests |
| September 9,2020 | WVDNR | Licensee | WVDNR approved the Mussel Survey Study Plan |
| September 11,,2020 | PFBC | Licensee | PFBC approved the Mussel Survey Study Plan |
| October 26,,2020 | Licensee | WVSHPO | Submitted request for Section 106 Review for Compliance |
| October 26,,2020 | Licensee | PASHPO | Submitted Section 106 Review for Compliance |
| January 29, 2021 | Licensee | Distribution List | Provided draft entrainment for review and comment |
| January 29, 2021 | Licensee | Distribution List | Provided draft mussel survey report for review and comment |
| July 30, 2021 | Licensee | Distribution List | Provided draft recreation assessment for review and comment |
| August 5, 2022 | Licensee | FERC and Distribution List | Filed DLA with FERC and distributed DLA to Distribution List |
| August 12, 2022 | Oneida Nation | Licensee | Email indicating they have no comments on the DLA |
| November 3, 2022 | FERC | Licensee | Comments on DLA |
| November 4, 2022 | Licensee | WVDNR | Email requesting concurrence with nature viewing area removal |
| November 7, 2022 | WVDNR | FERC. Licensee | Comments on DLA |
| November 8, 2022 | CLEAR | Licensee | Comments on DLA |
| November 11, 2022 | Licensee | PA Coast Resources Program | Email requesting concurrence that project is not located within coastal zone |

## Foster, Joyce

**From:** Blair, Michelle A.
**Sent:** Monday, May 20, 2019 3:06 PM
**To:** Absentee-Shawnee Tribe of Oklahoma; Amanda Pitzer; Anita Carter; Betty Wiley; Bob Irvin; Bonney Hartley; Brett Barnes; Brian Bridgewater; Brice Obermeyer; Bryan Printup; Cassie Harper; Clint Halftown; Colleen McNally-Murphy; Coopers Rock State Forest; Cosmo Servidio; Curtis Schreffler; Dana Kelly; Danny Bennett; Darren Bonaparte; David Wellman; Delaware Nation, Oklahoma; Delaware Tribe of Indians; Duane Nichols; Eastern Shawnee Tribe of Oklahoma; Edgewater Marina; Ella Belling; Heather Smiles; Jacob Harrell; Jay Toth; Jesse Bergevin; John



**To:** Spain; Kevin Colburn; Kevin Mendik; Laura Misita; Megan Gottlieb; Mike Strager; Oneida Indian Nation; Oneida Tribe of Indians of Wisconsin; Onondaga Nation; Rennetta McClure; Richard McCorkle; Sean P McDermott; Shannon Holsey; Shaun Wicklein; Steve Moyer; Steve Moyer (smoyer@tu.org); Stuart Welsh; Sunset Beach Marina; Susan Bachor; Susan Pierce; Tonawanda Band of Seneca; Tonya Tipton; Vincent Vicites; William Fisher; William Tarrant
**Cc:** jsmet@cubehydro.com; Foster, Joyce
**Subject:** Information Request for the Pre-Application Document for Relicensing of the Lake Lynn Hydroelectric Project (FERC No. 2459)
**Attachments:** LLG PAD Info-TLP Request Letter_5-20-19.pdf

Good afternoon-

Attached is an Information Request for the Pre-Application Document for the FERC relicensing of the Lake Lynn Hydroelectric Project (FERC No. 2459).

Please provide your comments within 30 days of this letter. If you have any questions regarding this request please contact Jody Smet at jsmet@cubehydro.com or Joyce Foster at jfoster@trccompanies.com.

Thank you,
Michelle

**Michelle Blair**
Project Coordinator



TRC
14 Gabriel Drive, Augusta, ME 04330
**T** 207.620.3845 | **F** 207.621.8226 | mblair@trccompanies.com
LinkedIn | Twitter | Blog | TRCcompanies.com

Lake Lynn Generation, LLC
Two Bethesda Metro Center, Suite
1330 Bethesda, MD 20814

May 20, 2019

DISTRIBUTION LIST

*RE: Information Request for the Pre-Application Document for Relicensing of the Lake Lynn Hydroelectric Project (FERC No. 2459)*

Dear Recipient:

The current Federal Energy Regulatory Commission (FERC) license for the Lake Lynn Hydroelectric Project (Project) expires on November 30, 2024. The Project is owned and operated by Lake Lynn Generation, LLC (LLG). In accordance with FERC's regulations, LLG must file a Notice of Intent (NOI) to relicense the Project with FERC between May 30, 2019 and November 30, 2019. At the same time, LLG is required to file a Pre-Application Document (PAD) for the Project. The PAD will provide FERC, agencies, local governments, and interested parties with existing, relevant, and reasonably available information that pertains to the Project. The information will then be used to identify potential issues and help identify any information needs and related study plans for the relicensing.

The Project is located on the Cheat River in Monongalia County, West Virginia and Fayette County, Pennsylvania approximately 8 miles northeast of Morgantown, West Virginia and about 3.7 miles upstream of the confluence of the Cheat River with the Monongahela River. The Project dam is located in Monongalia County, West Virginia, while most of the tailrace area is in Fayette County, Pennsylvania. Major features of the Project include a 1,000-foot long concrete gravity dam, a 624-foot long spillway, a powerhouse near the east abutment of the dam with four generating units, and a reservoir that is approximately 13 miles long with a surface area of approximately 1,700 acres. The Project operates as a daily peaking facility and the current Project license requires that the Project release into the Cheat River a minimum flow of 212 cubic feet per second (cfs), or inflow to the Project reservoir, whichever is less, with an absolute minimum release flow of 100 cfs regardless of reservoir inflow, evaporation or other withdrawals. The current Project license also requires that the Licensee maintain the Project reservoir at a surface elevation between 868 feet National Geodetic Vertical Datum (NGVD) and 870 feet NGVD from May 1 to October 31, between 857 feet NGVD and 870 feet NGVD from November 1 to March 31, and between 863 feet NGVD and 870 feet NGVD from April 1 to April 30.

We are writing to initiate additional information gathering for the Project and to request your input. The purpose of this letter is to request your assistance in identifying existing relevant and reasonably available information, which cannot be obtained online, that describes either the existing environmental conditions at the Project or any known or potential effects of continuing Project operations. Project resources that will be described in the PAD, and which we would be interested in information about, include water use and water quality, fish and aquatics, wildlife resources, terrestrial resources, rare species, recreation use and facilities, and cultural and tribal resources. We will compile this information with information already in our possession for incorporation into the PAD. Your response to this request for information within 30 days would be appreciated.

In addition, LLG plans to request FERC approval to use FERC's Traditional Licensing Process (TLP) for the relicensing instead of the Integrated Licensing Process (ILP) (FERC's default process for relicensing) because we believe the TLP will be the most efficient, effective, and least burdensome process for relicensing the Project. Both the TLP and ILP processes provide opportunities for agency/stakeholder/public engagement and input. The TLP is more streamlined and less complex with fewer process steps and; therefore, is less demanding of agency/stakeholder's time and resources. The TLP does not have a strict timeline and provides more flexibility for completion of the various steps of the licensing process. The Project is an existing FERC-licensed project with existing requirements for minimum flow and reservoir surface elevation that has well-known and understood impacts. There is a large amount of resource information and data available for the Project based on monitoring and reporting efforts that have occurred since the most recent relicensing of the Project in 1995, including shoreline erosion surveys, water quality monitoring (including dissolved oxygen, temperature, pH, and conductivity in Cheat Lake and downstream of the Project), recreation use monitoring, and information collected and reported in accordance with the Biological Monitoring Plan. The resource agencies that will be involved in the relicensing process for the Project have knowledge of the Project from the various resource monitoring and reporting efforts that have occurred under the existing FERC license. LLG and the agencies are aware of the issues likely to be raised during the relicensing. LLG does not anticipate that the relicensing will involve complex issues, study needs, or controversy that cannot be resolved with a properly implemented cooperative TLP.

Please provide your comments within 30 days of this letter on the use of the TLP for the relicensing of this Project.

We thank you in advance for providing any pertinent information that meets the criteria for inclusion in the PAD. We look forward to working with you throughout the process. If you have any questions regarding the Project or the relicensing process, please contact either me at jsmet@cubehydro.com or Joyce Foster at TRC Companies at jfoster@trccompanies.com.

Sincerely,

Jody J Smet

Jody Smet
Lake Lynn Generation, LLC

**Lake Lynn Generation, LLC**
**Lake Lynn Project (P-2459)**
**Distribution List May 20, 2019**

## ELECTED OFFICIALS

Governor Jim Justice
West Virginia Office of the Governor
State Capitol
1900 Kanawha Blvd. E
Charleston, WV 25305

Patrick Morrisey
West Virginia Office of the Attorney General
State Capitol Complex, Bldg. 1, Room E-26
Charleston, WV 25305

The Honorable Joe Manchin III
United States Senate
306 Hart Senate Office Building
Washington D.C. 20510

The Honorable Shelley Capito
United States Senate
172 Russell Senate Office Building
Washington, DC 20510

The Honorable David McKinley
United States House of Representatives
2239 Rayburn HOB
Washington, DC 20515

Governor Tom Wolf
Commonwealth of Pennsylvania
Office of the Governor
508 Main Capitol Building
Harrisburg, PA 17120

Josh Shapiro
Pennsylvania Office of the Attorney General
16th Floor, Strawberry Square
Harrisburg, PA 17120

The Honorable Pat Toomey
United States Senate
248 Russell Senate Office Building
Washington, DC 20510

The Honorable Bob Casey
United States Senate
393 Russell Senate Office Building
Washington, DC 20510

The Honorable Guy Reschenthaler
United States House of Representatives
531 Cannon House Office Building
Washington, DC 20515

## FEDERAL AGENCIES

Rick McCorkle
U.S. Fish and Wildlife Service
Pennsylvania Field Office
110 Radnor Road, Ste 101
State College, PA 16801
richard_mccorkle@fws.gov

Megan Gottlieb, P.E.
Water Management Unit
U.S. Army Corps of Engineers
Pittsburgh District
2200 William S. Moorhead Federal Building
1000 Liberty Avenue
Pittsburgh, PA 15222-4186
Megan.K.Gottlieb@usace.army.mil

Sean McDermott
Regional Hydropower Coordinator
National Marine Fisheries Service
Northeast Regional Office
1 Blackburn Dr.
Gloucester, MA 01930-2298
sean.mcdermott@noaa.gov

Kevin Mendik
Hydropower Program Coordinator
National Park Service
15 State St, Floor 10
Boston, MA 02109-3502
Kevin_Mendik@nps.gov

Cosmo Servidio
Region 3 Administrator
US Environmental Protection Agency
1650 Arch Street
Philadelphia, PA 19103-2029
rudnick.barbara@epa.gov

Curtis Schreffler
Associate Director, Northeast Region
US Geological Survey
Pennsylvania Water Science Center
215 Limekiln Road
New Cumberland, PA 17070
clschref@usgs.gov

Shaun Wicklein
Virginia and West Virginia Water Science Center
US Geological Survey
1730 East Parham Road
Richmond, VA 23228
smwickle@usgs.gov

Director
Federal Emergency Management Agency
500 C Street, SW
Washington, DC 20472

**STATE**

Jacob Harrell
Wildlife Resources Section Coordination Unit
West Virginia Division of Natural Resources
Elkins Operations Center
PO Box 67
Elkins, WV 26241
Jacob.D.Harrell@wv.gov

Danny Bennett
West Virginia Division of Natural Resources
Elkins Operations Center
PO Box 67
Elkins, WV 26241
Danny.A.Bennett@wv.gov

David Wellman
Fisheries Management
West Virginia Division of Natural Resources
James Plaza 1110 Railroad St.
Farmington, WV 26571-0099
David.I.Wellman@wv.gov

Coopers Rock State Forest
61 County Line Dr.
Bruceton Mills, WV, 26525
coopersrocksf@wv.gov

Brian Bridgewater
West Virginia Department of Environmental Protection
Division of Water and Waste Management
601 57th Street, SE
Charleston, WV 25304
Brian.L.Bridgewater@wv.gov

Susan Pierce
Director and Deputy State Historic Preservation Officer
West Virginia Division of Culture and History
1900 Kanawha Boulevard East
Charleston, WV 25305
susan.m.pierce@wv.gov

Ronald Schwartz
Regional Director, Southwest Regional Office
Pennsylvania Department of Environmental Protection
400 Waterfront Drive
Pittsburgh, PA 15222-4745

Secretary Cindy Adams Dunn
Pennsylvania Department of Conservation and Natural Resources
Rachel Carson State Office Building
400 Market Street
Harrisburg, PA 17105

Heather Smiles
Chief, Division of Environmental Services
Pennsylvania Fish and Boat Commission
595 East Rolling Ridge Drive,
Bellefonte, PA 16823
hsmiles@pa.gov

Bryan Burhans
Executive Director
Pennsylvania Game Commission
2001 Elmerton Avenue
Harrisburg, PA 17110-9797

Andrea Lowery
State Historic Preservation Officer
Pennsylvania Historical and Museum Commission
State Historic Preservation Office
Commonwealth Keystone Building, Second Floor
400 North Street
Harrisburg, PA 17120-0093

**MUNICIPAL**

4Rennetta McClure
County Administrator
Monongalia County Commission
243 High Street, Room 202
Morgantown, WV 26505
rmcclure@moncommission.com

Vincent Vicites
Chairman, County Commissioner
Fayette County, PA
61 East Main Street
Uniontown, PA 15401
vvicites@fayettepa.org

Albert Gallatin Municipal Authority
PO Box 211
Point Marion, PA 15474-0211

**TRIBAL**

US Bureau of Indian Affairs
Eastern Regional Office
545 Marriott Drive, Suite 700
Nashville, TN 37214

Absentee-Shawnee Tribe of Oklahoma
Edwina Butler-Wolfe, Governor
2025 S. Gordon Cooper Drive
Shawnee, OK 74801

Cayuga Nation
Clint Halftown
P.O. Box 803
Seneca Falls, NY 13148
clint.halftown@gmail.com

Delaware Nation, Oklahoma
Deborah Dotson, President
PO Box 825
Anadarko, OK 73005
ec@delawarenation.com

Delaware Tribe of Indians
Chester “Chet” Brooks, Chief
5100 Tuxedo Blvd.
Bartletsville, OK 74006
cbrooks@delawaretribe.org

Eastern Shawnee Tribe of Oklahoma
Glenna Wallace, Chief
PO Box 350
Seneca, MO 64865
estochief@hotmail.com

Oneida Indian Nation
Raymond Halbritter, Nation Representative
2037 Dream Catcher Plaza
Oneida, NY 13421
info@oneida-nation.org

Oneida Indian Nation of Wisconsin
Tehassi Hill, Chair
P. O. Box 365
N7210 Seminary Rd
Oneida, WI 54155-0365

Onondaga Nation
Sidney Hill, Chief
4040 Route 11
Nedrow, NY 13120
admin@onondaganation.org

Osage Nation
Geoffrey Standing Bear, Principal Chief
627 Grandview Avenue
PO Box 779
Pawhuska, OK 74056

Seneca Nation of Indians
Rickey Amstrong, Sr., President
90 O:hi’yoh Way
Salamanca, NY 14779

Seneca-Cayuga Tribe of Oklahoma
William L. Fisher, Chief
P.O. Box 453220
23701 S. 655 Rd.
Grove, OK 74344
wfisher@sctribe.com

Shawnee Tribe
Cassie Harper, Tribal Administrator
P.O. Box 189
29 South Highway 69a
Miami OK 74355
cassie@shawnee-tribe.com

St. Regis Mohawk Tribe
Chief Beverly Kiohawiton Cook
71 Margaret Terrance Memorial Way
Akwesasne, NY 13655

Stockbridge-Munsee Band of the Mohican Nation of Wisconsin
Shannon Holsey, Tribal President
N8476 MohHeConNuck Road
Bowler, WI 54416
shannon.holsey@mohican-nsn.gov

Tonawanda Band of Seneca
Roger Hill, Chief
P.O. Box 795
7027 Meadville Road
Basom, NY 14013
tonseneca@aol.com

Tuscarora Nation
Leo Henry, Chief
2006 Mt. Hope Road
Lewiston, NY 14092

Eastern Band of Cherokee Indians
Richard Sneed, Principal Chief
P.O. Box 1927
Cherokee, NC 28719

Cherokee Nation
Principal Chief Bill John Baker
P.O. Box 948
Tahlequah, OK 74465

United Keetoowah Band of Cherokee Indians in Oklahoma
Chief Joe Bunch
P.O Box 746
Tahlequah, OK 74465

Absentee-Shawnee Tribe of Oklahoma
Devon Frazier, THPO
2025 S. Gordon Cooper Drive
Shawnee, OK 74801
106NAGPRA@astribe.com

Delaware Nation, Oklahoma
Dana Kelly
Cultural Resources/106 Department
31064 State Highway 281
Anadarko, OK 73005
dkelly@delawarenation.com

Dr. Brice Obermeyer
Delaware Tribe of Indians
1200 Commercial Street
Roosevelt Hall Room 212, Emporia State University
Emporia, KS 66801
bobermeyer@delawaretribe.org

Susan Bachor
Delaware Tribe of Indians
P.O. Box 64
Pocono Lake, PA 18347
sbachor@delawaretribe.org

Brett Barnes, THPO
Eastern Shawnee Tribe of Oklahoma
PO Box 350
Seneca, MO 64865
bbarnes@estoo.net

Roxanne Weldon
Eastern Shawnee Tribe of Oklahoma
PO Box 350
Seneca, MO 64865

Oneida Indian Nation
Jesse Bergevin, Historic Preservation Specialist
2037 Dream Catcher Plaza
Oneida, NY 13421
jbergevin@oneida-nation.org

Oneida Indian Nation
Laura Misita, Land Administrator
Oneida Indian Nation Legal Dept.
5218 Patrick Road
Verona, New York 13478
lmisita@oneida-nation.org

Oneida Indian Nation of Wisconsin
Corina Williams, THPO
P. O. Box 365
N7210 Seminary Rd
Oneida, WI 54155-0365
cwilliam@oneidanation.org

Onondaga Nation
Tony Gonyea, Faithkeeper 4040
Route 11
Administrative Building
Nedrow, NY 13120

Osage Nation
Dr. Andrea Hunter, THPO
627 Grandview Avenue
Pawhuska, OK 74056

Seneca Nation of Indians
Jay Toth, THPO 90 O:hi'yoh Way
Salamanca, NY 14779
jay.toth@sni.org

Seneca-Cayuga Tribe of Oklahoma
William Tarrant, Cultural Director
P.O. Box 453220
23701 S. 655 Rd.
Grove, OK 74344
wtarrant@sctribe.com

Shawnee Tribe
Tonya Tipton, THPO
P.O. Box 189
29 South Highway 69a
Miami OK 74355
tonya@shawnee-tribe.com

St. Regis Mohawk Tribe
Darren Bonaparte, THPO
71 Margaret Terrance Memorial Way
Community Building
Akwesansne, NY 13655
darren.bonaparte@srmt-nsn.gov

Stockbridge-Munsee Band of the Mohican
Nation of Wisconsin
Bonney Hartley, THPO New York Office
65 1st St
Troy, NY 12180
bonney.hartley@mohican-nsn.gov

Tuscarora Nation
Bryan Printup
5226 Walmore Road
Lewiston, NY 14092
bprintup@hetf.org

**NGOs**

Duane Nichols, President
Cheat Lake Environment & Recreation
Association
330 Dream Catcher Circle
Morgantown, WV 26508
duane330@aol.com

Mike Strager, Ph.D., Vice President
Cheat Lake Environment & Recreation
Association
102 Lakepointe
Morgantown, WV 26508
mstrager@gmail.com

Ella Belling
Executive Director
Mon River Trails Conservancy
P.O. Box 282
Morgantown, WV 26507
ella@montrails.org

Amanda J. Pitzer
Friends of the Cheat
1343 North Preston Highway
Kingwood, WV 26537
amanda@cheat.org

Betty L. Wiley
Upper Monongahela River Association
373 Dunkard Avenue
Westover, WV 26501
betty.w304@gmail.com

Anita Carter, Property Manager
Greystone-On-The-Cheat Property Owners Association, Inc.
706 Sunset Beach Road
Morgantown, WV 26508
greystone.poa@hotmail.com

Adam Polinski
The Coopers Rock Foundation
P.O. Box 505
Morgantown, WV 26507

Kevin R Colburn
American Whitewater
20 Battery Park Ave Suite 302
Asheville, NC 28801-2879
kevin@americanwhitewater.org

Bob Irvin
President
American Rivers
1101 14th Street NW, Suite 1400
Washington, DC 20005
birvin@americanrivers.org

Steve Moyer
Trout Unlimited
1777 N. Kent Street, Suite 100
Arlington, VA 22209
smoyer@tu.org

Colleen McNally-Murphy
National Coordinator
Hydropower Reform Coalition
1101 14th St. NW, Suite 1400
Washington, DC 20005
colleen@hydroreform.org

Angie Rosser
Executive Director
West Virginia Rivers Coalition
3501 MacCorkle Ave. SE #129
Charleston WV 25304

**OTHER INTERESTED PARTIES**

Sunset Beach Marina
177 Sunset Beach Road
Morgantown, WV 26508
info@sunsetbeach-marina.com

Stuart Welsh
West Virginia Cooperative Fish and Wildlife Research Unit
West Virginia University
322 Percival Hall
Morgantown, WV 26506
swelsh@wvu.edu

The Lakehouse Restaurant and Marina
165 Sunset Beach Road
Cheat Lake, WV 26508

Edgewater Marina
239 Fairchance Road
Morgantown, WV 26508
edgewater@cheatlakedocks.com

**FERC**

John Spain, P.E.
Regional Engineer
Federal Energy Regulatory Commission
Division of Dam Safety and Inspections – New York Regional Office
19 West 34th Street, Suite 400
New York, NY 10001
john.spain@ferc.gov

## Foster, Joyce

**From:** Jody Smet <jsmet@cubehydro.com>
**Sent:** Monday, June 10, 2019 10:40 AM
**To:** Foster, Joyce
**Subject:** FW: Lake Lynn Relicensing - Relicensing Process ILP v. TLP

Jody J. Smet, AICP
Director, FERC Licensing and Compliance
(O) 804-739-0654



(C) 804-382-1764
jsmet@cubehydro.com (Please note new email address)

CUBE HYDRO CAROLINAS

**From:** Jody Smet
**Sent:** Thursday, May 30, 2019 10:45 AM
**To:** 'Duane Nichols' <duane330@aol.com>
**Subject:** Lake Lynn Relicensing - Relicensing Process ILP v. TLP

Duane,

I'm sorry that we did not connect on Tuesday, and I understand that you were out yesterday. I have a pretty full day today, so I wanted to email you about your question in case we don't find a time to connect today. The following bullets compare/contrast the Integrated Licensing Process (ILP) and the Traditional Licensing Process (TLP). The ILP is FERC's default process, but we are considering requesting FERC's approval to use the TLP, and are interested in your, and others', feedback.



- The TLP and ILP differ mainly in how they coordinate the applicant's pre-filing activities (i.e., before filing the license application), especially study plan development, with National Environmental Policy Act (NEPA) review
- The ILP combines pre-filing consultation with FERC's scoping in accordance with NEPA while these are conducted sequentially in the TLP
- Both the TLP and ILP provide opportunities for stakeholder and public participation throughout the process (and before the filing of the license application)
- The ILP has strict deadlines for FERC, stakeholders, and the applicant. The TLP provides more flexibility for the applicant and stakeholders to complete various steps in the licensing process because it does not have a strict timeline. Although strict deadlines imposed by the ILP may be helpful to keep participating stakeholders on task, these deadlines may also prove unworkable under some circumstances.

- The ILP process is more complex with more process steps and, therefore, is more demanding of stakeholder's time and resources.  The TLP has less required process steps.
- The ILP has a structured, intensive, and time-constrained study plan development process and study review process.  Although the TLP does not have a required study plan development process, we intend for the Lake Lynn relicensing to be collaborative with stakeholders.
- FERC staff is involved early and throughout the ILP while FERC involvement in the TLP is later (after the license application is filed).  However, FERC is available for guidance throughout the TLP.
- Of the 19 hydro projects licensed by FERC in the past 4 years in PA and WV, 12 of those used the TLP and 7 used the ILP.   Therefore, the WV and PA resource agencies are more likely to be familiar with the TLP.



Please let me know if you would like to discuss further and we can schedule a time to talk.

Thanks,

Jody J. Smet, AICP
Director, FERC Licensing and Compliance
(O) 804-739-0654
(C) 804-382-1764
jsmet@cubehydro.com (Please note new email address)

CUBE HYDRO
CAROLINAS

## Foster, Joyce

**From:** Blair, Michelle A.
**Sent:** Wednesday, June 12, 2019 9:53 AM
**To:** Absentee-Shawnee Tribe of Oklahoma; Amanda Pitzer; Anita Carter; Betty Wiley; Bob Irvin; Bonney Hartley; Brett Barnes; Brian Bridgewater; Brice Obermeyer; Bryan Printup; Cassie Harper; Clint Halftown; Colleen McNally-Murphy; Coopers Rock State Forest; Cosmo Servidio; Curtis Schreffler; Dana Kelly; Danny Bennett; Darren Bonaparte; David Wellman; Delaware Nation, Oklahoma; Delaware Tribe of Indians; Duane Nichols; Eastern Shawnee Tribe of Oklahoma; Edgewater Marina; Ella Belling; Heather Smiles; Jacob Harrell; Jay Toth; Jesse Bergevin; John



**To:** Spain; Kevin Colburn; Kevin Mendik; Laura Misita; Megan Gottlieb; Mike Strager; Oneida Indian Nation; Oneida Tribe of Indians of Wisconsin; Onondaga Nation; Rennetta McClure; Richard McCorkle; Sean P McDermott; Shannon Holsey; Shaun Wicklein; Steve Moyer; Steve Moyer (smoyer@tu.org); Stuart Welsh; Sunset Beach Marina; Susan Bachor; Susan Pierce; Tonawanda Band of Seneca; Tonya Tipton; Vincent Vicites; William Fisher; William Tarrant
**Cc:** jsmet@cubehydro.com; Foster, Joyce
**Subject:** REMINDER: Information Request for the Pre-Application Document for Relicensing of the Lake Lynn Hydroelectric Project (FERC No. 2459)
**Attachments:** LLG PAD Info-TLP Request Letter_5-20-19.pdf

**Importance:** High

Good morning -

Attached is an Information Request for the Pre-Application Document for the FERC relicensing of the Lake Lynn Hydroelectric Project (FERC No. 2459).

As a reminder, please provide your comments within 30 days of this letter (by June 20). If you have any questions regarding this request please contact Jody Smet at jsmet@cubehydro.com or Joyce Foster at jfoster@trccompanies.com.

Thank you,
Michelle



**Michelle Blair**
Project Coordinator

14 Gabriel Drive, Augusta, ME 04330
**T** 207.620.3845 | **F** 207.621.8226 | mblair@trccompanies.com
LinkedIn | Twitter | Blog | TRCcompanies.com

Lake Lynn Generation, LLC
Two Bethesda Metro Center, Suite
1330 Bethesda, MD 20814

May 20, 2019

DISTRIBUTION LIST

*RE: Information Request for the Pre-Application Document for Relicensing of the Lake Lynn Hydroelectric Project (FERC No. 2459)*

Dear Recipient:

The current Federal Energy Regulatory Commission (FERC) license for the Lake Lynn Hydroelectric Project (Project) expires on November 30, 2024. The Project is owned and operated by Lake Lynn Generation, LLC (LLG). In accordance with FERC's regulations, LLG must file a Notice of Intent (NOI) to relicense the Project with FERC between May 30, 2019 and November 30, 2019. At the same time, LLG is required to file a Pre-Application Document (PAD) for the Project. The PAD will provide FERC, agencies, local governments, and interested parties with existing, relevant, and reasonably available information that pertains to the Project. The information will then be used to identify potential issues and help identify any information needs and related study plans for the relicensing.

The Project is located on the Cheat River in Monongalia County, West Virginia and Fayette County, Pennsylvania approximately 8 miles northeast of Morgantown, West Virginia and about 3.7 miles upstream of the confluence of the Cheat River with the Monongahela River. The Project dam is located in Monongalia County, West Virginia, while most of the tailrace area is in Fayette County, Pennsylvania. Major features of the Project include a 1,000-foot long concrete gravity dam, a 624-foot long spillway, a powerhouse near the east abutment of the dam with four generating units, and a reservoir that is approximately 13 miles long with a surface area of approximately 1,700 acres. The Project operates as a daily peaking facility and the current Project license requires that the Project release into the Cheat River a minimum flow of 212 cubic feet per second (cfs), or inflow to the Project reservoir, whichever is less, with an absolute minimum release flow of 100 cfs regardless of reservoir inflow, evaporation or other withdrawals. The current Project license also requires that the Licensee maintain the Project reservoir at a surface elevation between 868 feet National Geodetic Vertical Datum (NGVD) and 870 feet NGVD from May 1 to October 31, between 857 feet NGVD and 870 feet NGVD from November 1 to March 31, and between 863 feet NGVD and 870 feet NGVD from April 1 to April 30.

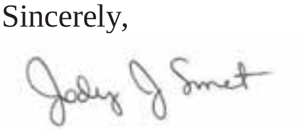
We are writing to initiate additional information gathering for the Project and to request your input. The purpose of this letter is to request your assistance in identifying existing relevant and reasonably available information, which cannot be obtained online, that describes either the existing environmental conditions at the Project or any known or potential effects of continuing Project operations. Project resources that will be described in the PAD, and which we would be interested in information about, include water use and water quality, fish and aquatics, wildlife resources, terrestrial resources, rare species, recreation use and facilities, and cultural and tribal resources. We will compile this information with information already in our possession for incorporation into the PAD. Your response to this request for information within 30 days would be appreciated.

In addition, LLG plans to request FERC approval to use FERC's Traditional Licensing Process (TLP) for the relicensing instead of the Integrated Licensing Process (ILP) (FERC's default process for relicensing) because we believe the TLP will be the most efficient, effective, and least burdensome process for relicensing the Project. Both the TLP and ILP processes provide opportunities for agency/stakeholder/public engagement and input. The TLP is more streamlined and less complex with fewer process steps and; therefore, is less demanding of agency/stakeholder's time and resources. The TLP does not have a strict timeline and provides more flexibility for completion of the various steps of the licensing process. The Project is an existing FERC-licensed project with existing requirements for minimum flow and reservoir surface elevation that has well-known and understood impacts. There is a large amount of resource information and data available for the Project based on monitoring and reporting efforts that have occurred since the most recent relicensing of the Project in 1995, including shoreline erosion surveys, water quality monitoring (including dissolved oxygen, temperature, pH, and conductivity in Cheat Lake and downstream of the Project), recreation use monitoring, and information collected and reported in accordance with the Biological Monitoring Plan. The resource agencies that will be involved in the relicensing process for the Project have knowledge of the Project from the various resource monitoring and reporting efforts that have occurred under the existing FERC license. LLG and the agencies are aware of the issues likely to be raised during the relicensing. LLG does not anticipate that the relicensing will involve complex issues, study needs, or controversy that cannot be resolved with a properly implemented cooperative TLP.

Please provide your comments within 30 days of this letter on the use of the TLP for the relicensing of this Project.

We thank you in advance for providing any pertinent information that meets the criteria for inclusion in the PAD. We look forward to working with you throughout the process. If you have any questions regarding the Project or the relicensing process, please contact either me at jsmet@cubehydro.com or Joyce Foster at TRC Companies at jfoster@trccompanies.com.

Sincerely,



Jody Smet
Lake Lynn Generation, LLC

**Lake Lynn Generation, LLC**
**Lake Lynn Project (P-2459)**
**Distribution List May 20, 2019**

## ELECTED OFFICIALS

Governor Jim Justice
West Virginia Office of the Governor
State Capitol
1900 Kanawha Blvd. E
Charleston, WV 25305

Patrick Morrisey
West Virginia Office of the Attorney General
State Capitol Complex, Bldg. 1, Room E-26
Charleston, WV 25305

The Honorable Joe Manchin III
United States Senate
306 Hart Senate Office Building
Washington D.C. 20510

The Honorable Shelley Capito
United States Senate
172 Russell Senate Office Building
Washington, DC 20510

The Honorable David McKinley
United States House of Representatives
2239 Rayburn HOB
Washington, DC 20515

Governor Tom Wolf
Commonwealth of Pennsylvania
Office of the Governor
508 Main Capitol Building
Harrisburg, PA 17120

Josh Shapiro
Pennsylvania Office of the Attorney General
16th Floor, Strawberry Square
Harrisburg, PA 17120

The Honorable Pat Toomey
United States Senate
248 Russell Senate Office Building
Washington, DC 20510

The Honorable Bob Casey
United States Senate
393 Russell Senate Office Building
Washington, DC 20510

The Honorable Guy Reschenthaler
United States House of Representatives
531 Cannon House Office Building
Washington, DC 20515

## FEDERAL AGENCIES

Rick McCorkle
U.S. Fish and Wildlife Service
Pennsylvania Field Office
110 Radnor Road, Ste 101
State College, PA 16801
richard_mccorkle@fws.gov

Megan Gottlieb, P.E.
Water Management Unit
U.S. Army Corps of Engineers
Pittsburgh District
2200 William S. Moorhead Federal Building
1000 Liberty Avenue
Pittsburgh, PA 15222-4186
Megan.K.Gottlieb@usace.army.mil

Sean McDermott
Regional Hydropower Coordinator
National Marine Fisheries Service
Northeast Regional Office
1 Blackburn Dr.
Gloucester, MA 01930-2298
sean.mcdermott@noaa.gov

Kevin Mendik
Hydropower Program Coordinator
National Park Service
15 State St, Floor 10
Boston, MA 02109-3502
Kevin_Mendik@nps.gov

Cosmo Servidio
Region 3 Administrator
US Environmental Protection Agency
1650 Arch Street
Philadelphia, PA 19103-2029
rudnick.barbara@epa.gov

Curtis Schreffler
Associate Director, Northeast Region
US Geological Survey
Pennsylvania Water Science Center
215 Limekiln Road
New Cumberland, PA 17070
clschref@usgs.gov

Shaun Wicklein
Virginia and West Virginia Water Science Center
US Geological Survey
1730 East Parham Road
Richmond, VA 23228
smwickle@usgs.gov

Director
Federal Emergency Management Agency
500 C Street, SW
Washington, DC 20472

**STATE**

Jacob Harrell
Wildlife Resources Section Coordination Unit
West Virginia Division of Natural Resources
Elkins Operations Center
PO Box 67
Elkins, WV 26241
Jacob.D.Harrell@wv.gov

Danny Bennett
West Virginia Division of Natural Resources
Elkins Operations Center
PO Box 67
Elkins, WV 26241
Danny.A.Bennett@wv.gov

David Wellman
Fisheries Management
West Virginia Division of Natural Resources
James Plaza 1110 Railroad St.
Farmington, WV 26571-0099
David.I.Wellman@wv.gov

Coopers Rock State Forest
61 County Line Dr.
Bruceton Mills, WV, 26525
coopersrocksf@wv.gov

Brian Bridgewater
West Virginia Department of Environmental Protection
Division of Water and Waste Management
601 57th Street, SE
Charleston, WV 25304
Brian.L.Bridgewater@wv.gov

Susan Pierce
Director and Deputy State Historic Preservation Officer
West Virginia Division of Culture and History
1900 Kanawha Boulevard East
Charleston, WV 25305
susan.m.pierce@wv.gov

Ronald Schwartz
Regional Director, Southwest Regional Office
Pennsylvania Department of Environmental Protection
400 Waterfront Drive
Pittsburgh, PA 15222-4745

Secretary Cindy Adams Dunn
Pennsylvania Department of Conservation and Natural Resources
Rachel Carson State Office Building
400 Market Street
Harrisburg, PA 17105

Heather Smiles
Chief, Division of Environmental Services
Pennsylvania Fish and Boat Commission
595 East Rolling Ridge Drive,
Bellefonte, PA 16823
hsmiles@pa.gov

Bryan Burhans
Executive Director
Pennsylvania Game Commission
2001 Elmerton Avenue
Harrisburg, PA 17110-9797

Andrea Lowery
State Historic Preservation Officer
Pennsylvania Historical and Museum Commission
State Historic Preservation Office
Commonwealth Keystone Building, Second Floor
400 North Street
Harrisburg, PA 17120-0093

**MUNICIPAL**

4Rennetta McClure
County Administrator
Monongalia County Commission
243 High Street, Room 202
Morgantown, WV 26505
rmcclure@moncommission.com

Vincent Vicites
Chairman, County Commissioner
Fayette County, PA
61 East Main Street
Uniontown, PA 15401
vvicites@fayettepa.org

Albert Gallatin Municipal Authority
PO Box 211
Point Marion, PA 15474-0211

**TRIBAL**

US Bureau of Indian Affairs
Eastern Regional Office
545 Marriott Drive, Suite 700
Nashville, TN 37214

Absentee-Shawnee Tribe of Oklahoma
Edwina Butler-Wolfe, Governor
2025 S. Gordon Cooper Drive
Shawnee, OK 74801

Cayuga Nation
Clint Halftown
P.O. Box 803
Seneca Falls, NY 13148
clint.halftown@gmail.com

Delaware Nation, Oklahoma
Deborah Dotson, President
PO Box 825
Anadarko, OK 73005
ec@delawarenation.com

Delaware Tribe of Indians
Chester "Chet" Brooks, Chief
5100 Tuxedo Blvd.
Bartletsville, OK 74006
cbrooks@delawaretribe.org

Eastern Shawnee Tribe of Oklahoma
Glenna Wallace, Chief
PO Box 350
Seneca, MO 64865
estochief@hotmail.com

Oneida Indian Nation
Raymond Halbritter, Nation Representative
2037 Dream Catcher Plaza
Oneida, NY 13421
info@oneida-nation.org

Oneida Indian Nation of Wisconsin
Tehassi Hill, Chair
P. O. Box 365
N7210 Seminary Rd
Oneida, WI 54155-0365

Onondaga Nation
Sidney Hill, Chief
4040 Route 11
Nedrow, NY 13120
admin@onondaganation.org

Osage Nation
Geoffrey Standing Bear, Principal Chief
627 Grandview Avenue
PO Box 779
Pawhuska, OK 74056

Seneca Nation of Indians
Rickey Amstrong, Sr., President
90 O:hi'yoh Way
Salamanca, NY 14779

Seneca-Cayuga Tribe of Oklahoma
William L. Fisher, Chief
P.O. Box 453220
23701 S. 655 Rd.
Grove, OK 74344
wfisher@sctribe.com

Shawnee Tribe
Cassie Harper, Tribal Administrator
P.O. Box 189
29 South Highway 69a
Miami OK 74355
cassie@shawnee-tribe.com

St. Regis Mohawk Tribe
Chief Beverly Kiohawiton Cook
71 Margaret Terrance Memorial Way
Akwesasne, NY 13655

Stockbridge-Munsee Band of the Mohican Nation of Wisconsin
Shannon Holsey, Tribal President
N8476 MohHeConNuck Road
Bowler, WI 54416
shannon.holsey@mohican-nsn.gov

Tonawanda Band of Seneca
Roger Hill, Chief
P.O. Box 795
7027 Meadville Road
Basom, NY 14013
tonseneca@aol.com

Tuscarora Nation
Leo Henry, Chief
2006 Mt. Hope Road
Lewiston, NY 14092

Eastern Band of Cherokee Indians
Richard Sneed, Principal Chief
P.O. Box 1927
Cherokee, NC 28719

Cherokee Nation
Principal Chief Bill John Baker
P.O. Box 948
Tahlequah, OK 74465

United Keetoowah Band of Cherokee Indians in Oklahoma
Chief Joe Bunch
P.O Box 746
Tahlequah, OK 74465

Absentee-Shawnee Tribe of Oklahoma
Devon Frazier, THPO
2025 S. Gordon Cooper Drive
Shawnee, OK 74801
106NAGPRA@astribe.com

Delaware Nation, Oklahoma
Dana Kelly
Cultural Resources/106 Department
31064 State Highway 281
Anadarko, OK 73005
dkelly@delawarenation.com

Dr. Brice Obermeyer
Delaware Tribe of Indians
1200 Commercial Street
Roosevelt Hall Room 212, Emporia State University
Emporia, KS 66801
bobermeyer@delawaretribe.org

Susan Bachor
Delaware Tribe of Indians
P.O. Box 64
Pocono Lake, PA 18347
sbachor@delawaretribe.org

Brett Barnes, THPO
Eastern Shawnee Tribe of Oklahoma
PO Box 350
Seneca, MO 64865
bbarnes@estoo.net

Roxanne Weldon
Eastern Shawnee Tribe of Oklahoma
PO Box 350
Seneca, MO 64865

Oneida Indian Nation
Jesse Bergevin, Historic Preservation Specialist
2037 Dream Catcher Plaza
Oneida, NY 13421
jbergevin@oneida-nation.org

Oneida Indian Nation
Laura Misita, Land Administrator
Oneida Indian Nation Legal Dept.
5218 Patrick Road
Verona, New York 13478
lmisita@oneida-nation.org

Oneida Indian Nation of Wisconsin
Corina Williams, THPO
P. O. Box 365
N7210 Seminary Rd
Oneida, WI 54155-0365
cwilliam@oneidanation.org

Onondaga Nation
Tony Gonyea, Faithkeeper 4040
Route 11
Administrative Building
Nedrow, NY 13120

Osage Nation
Dr. Andrea Hunter, THPO
627 Grandview Avenue
Pawhuska, OK 74056

Seneca Nation of Indians
Jay Toth, THPO 90 O:hi'yoh Way
Salamanca, NY 14779
jay.toth@sni.org

Seneca-Cayuga Tribe of Oklahoma
William Tarrant, Cultural Director
P.O. Box 453220
23701 S. 655 Rd.
Grove, OK 74344
wtarrant@sctribe.com

Shawnee Tribe
Tonya Tipton, THPO
P.O. Box 189
29 South Highway 69a
Miami OK 74355
tonya@shawnee-tribe.com

St. Regis Mohawk Tribe
Darren Bonaparte, THPO
71 Margaret Terrance Memorial Way
Community Building
Akwesansne, NY 13655
darren.bonaparte@srmt-nsn.gov

Stockbridge-Munsee Band of the Mohican
Nation of Wisconsin
Bonney Hartley, THPO New York Office
65 1st St
Troy, NY 12180
bonney.hartley@mohican-nsn.gov

Tuscarora Nation
Bryan Printup
5226 Walmore Road
Lewiston, NY 14092
bprintup@hetf.org

**NGOs**

Duane Nichols, President
Cheat Lake Environment & Recreation
Association
330 Dream Catcher Circle
Morgantown, WV 26508
duane330@aol.com

Mike Strager, Ph.D., Vice President
Cheat Lake Environment & Recreation
Association
102 Lakepointe
Morgantown, WV 26508
mstrager@gmail.com

Ella Belling
Executive Director
Mon River Trails Conservancy
P.O. Box 282
Morgantown, WV 26507
ella@montrails.org

Amanda J. Pitzer
Friends of the Cheat
1343 North Preston Highway
Kingwood, WV 26537
amanda@cheat.org

Betty L. Wiley
Upper Monongahela River Association
373 Dunkard Avenue
Westover, WV 26501
betty.w304@gmail.com

Anita Carter, Property Manager
Greystone-On-The-Cheat Property Owners Association, Inc.
706 Sunset Beach Road
Morgantown, WV 26508
greystone.poa@hotmail.com

Adam Polinski
The Coopers Rock Foundation
P.O. Box 505
Morgantown, WV 26507

Kevin R Colburn
American Whitewater
20 Battery Park Ave Suite 302
Asheville, NC 28801-2879
kevin@americanwhitewater.org

Bob Irvin
President
American Rivers
1101 14th Street NW, Suite 1400
Washington, DC 20005
birvin@americanrivers.org

Steve Moyer
Trout Unlimited
1777 N. Kent Street, Suite 100
Arlington, VA 22209
smoyer@tu.org

Colleen McNally-Murphy
National Coordinator
Hydropower Reform Coalition
1101 14th St. NW, Suite 1400
Washington, DC 20005
colleen@hydroreform.org

Angie Rosser
Executive Director
West Virginia Rivers Coalition
3501 MacCorkle Ave. SE #129
Charleston WV 25304

**OTHER INTERESTED PARTIES**

Sunset Beach Marina
177 Sunset Beach Road
Morgantown, WV 26508
info@sunsetbeach-marina.com

Stuart Welsh
West Virginia Cooperative Fish and Wildlife Research Unit
West Virginia University
322 Percival Hall
Morgantown, WV 26506
swelsh@wvu.edu

The Lakehouse Restaurant and Marina
165 Sunset Beach Road
Cheat Lake, WV 26508

Edgewater Marina
239 Fairchance Road
Morgantown, WV 26508
edgewater@cheatlakedocks.com

**FERC**

John Spain, P.E.
Regional Engineer
Federal Energy Regulatory Commission
Division of Dam Safety and Inspections – New York Regional Office
19 West 34th Street, Suite 400
New York, NY 10001
john.spain@ferc.gov

# PHONE LOG

**Date:** June 12, 2019

**Participants:** Joyce Foster, TRC for Licensee
Anita Carter, Greystone-on-the Cheat

**Subject:** Lake Lynn Project Relicensing – Information Request for the PAD

**Prepared by:** Joyce Foster

**Conversation Summary:**

Joyce Foster returned a call from Anita Carter. Ms. Carter received the Information Request for the PAD and wanted to clarify that this was intended for Greystone-on-the Cheat. Joyce explained that the letter/email was sent to her as the contact for the Greystone-on-the Cheat. Ms. Carter indicated that she is forwarding the letter to the President of the Greystone-on-the-Cheat but asked that we keep her on the list as the main contact for the association. Joyce stated that copies of what is filed with FERC and other communications with stakeholder will be sent to her as the contact.

## Foster, Joyce

**From:** Murray, Nick S <Nick.S.Murray@wv.gov>
**Sent:** Tuesday, June 18, 2019 9:23 AM
**To:** Effler, Hayley
**Cc:** Foster, Joyce
**Subject:** RE: WV ambient water quality
**Attachments:** Cheat River TRC.xlsx; Blank Facts Sheet Form TRC.docx

Hayley,



Please see that attached spreadsheet and Word document. This is data from our database for all years of data from these sites. It was just as easy to select all years as the last 10.

Please feel free to contact me again with any questions,

**Nicholas Murray**
**Environmental Resource Specialist Supervisor**
**WV DEP - Watershed Assessment Branch**
**601 57th Street S.E.**
**Charleston WV 25304**
**Office:(304)926-0499 Ext 1034**
**Cell: (304) 389-8716**

| | |
|---|---|
| **From:** | Elizabeth Toombs |
| **To:** | jsmet@cubehydro.com; Foster, Joyce |
| **Subject:** | FERC 2459, Lake Lynn Hydroelectric Project |
| **Date:** | Wednesday, June 19, 2019 11:54:31 AM |

Good Morning, Ms. Smet and Ms. Foster:

The Cherokee Nation recently received a review request for the Relicensing of the Lake Lynn Hydroelectric Project in Monongalia County, West Virginia and Fayette County, Pennsylvania. Both Monongalia County and Fayette County are outside the Cherokee Nation's Area of Interest. Thus, this Office respectfully defers to federally recognized Tribes that have an interest in this landbase.

Thank you for the opportunity to comment upon this proposed undertaking. Please contact me if there are any questions or concerns.

Wado,

Elizabeth Toombs, Tribal Historic Preservation Officer
Cherokee Nation
Tribal Historic Preservation Office
PO Box 948
Tahlequah, OK  74465-0948
918.453.5389

**From:** Amanda Pitzer <amanda@cheat.org>
**Sent:** Wednesday, June 19, 2019 3:05 PM
**To:** Robert Flickner <rflickner@cubehydro.com
**Cc:** Garrett Thompson <gthompson@cheat.org
**Subject:** FERC docket number

Hi Bob,

FOC wants to submit comments on the pre-application but the docket # (2459) doesn't include a letter at the beginning, so the e-file system won't work for us.

Do we have the correct docket number? Do we use e-file or send them directly to you?

Sincerely,

Amanda

--
*Amanda J. Pitzer*
**Executive Director**
Friends of the Cheat

**NEW ADDRESS EFFECTIVE IMMEDIATELY!**
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**www.cheatriverwatertrail.org**
**www.cheatfest.org**

| | |
|---|---|
| **From:** | Foster, Joyce |
| **To:** | amanda@cheat.org |
| **Cc:** | Jody Smet; Robert Flickner - MAH; gthompson@cheat.org |
| **Subject:** | RE: FERC docket number |
| **Date:** | Wednesday, June 19, 2019 4:39:00 PM |
| **Attachments:** | image003.png |

Good afternoon,

Your request to Bob Flickner was forwarded to me since I am the consultant assisting with the FERC relicensing process for the Lake Lynn Hydroelectric Project. Since this request is for information or data that you would like to see included in the Pre-application Document (PAD) and comments on the use of the Traditional Licensing Process, please submit this directly to Jody Smet (the Licensee's FERC Licensing Director for the Lake Lynn Project) at jsmet@cubehydro.com and me at jfoster@trccompanies.com. Copies of submittals received will be included with the PAD that will be filed with the Federal Energy Regulatory Commission (FERC) in the Project docket.

If you would also like to file a copy of your response in the FERC docket, you can use the link below to register with FERC for an account: https://www.ferc.gov/docs-filing/eregistration.asp?csrt=5854337081307807941. Once you have registered for a FERC account, you can file comments using the link below and referencing the FERC project number, using the prefix "P-" (e.g., use P-2459) in the submission: https://www.ferc.gov/docs-filing/efiling.asp?csrt=5854337081307807941.

We look forward to working with you throughout the relicensing process. If you have any questions regarding the Project or the relicensing process, please feel free to contact Jody Smet at jsmet@cubehydro.com or me at jfoster@trccompanies.com.

Thanks,

**Joyce Foster**
Planner

TRC

179 Clarks Lane, Aylett, VA 23009
**T** 804.769.1667 | **C** 804.338.5110
LinkedIn | Twitter | Blog | TRCcompanies.com

**Please note that our domain name and email addresses have changed**

---

**From:** Amanda Pitzer <amanda@cheat.org>
**Sent:** Wednesday, June 19, 2019 3:05 PM
**To:** Robert Flickner <rflickner@cubehydro.com>
**Cc:** Garrett Thompson <gthompson@cheat.org>
**Subject:** FERC docket number

Hi Bob,

FOC wants to submit comments on the pre-application but the docket # (2459) doesn't include a letter at the beginning, so the e-file system won't work for us.

Do we have the correct docket number? Do we use e-file or send them directly to you?

Sincerely,

Amanda

--
*Amanda J. Pitzer*
**Executive Director**
Friends of the Cheat

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**www.cheat.org**
**www.cheatriverwatertrail.org**
**www.cheatfest.org**

**From:** "Norman, Janet" <janet_norman@fws.gov>
**Date:** June 19, 2019 at 6:06:25 PM GMT+2
**To:** <jsmet@cubehydro.com>
**Subject: Ipac consultation done?**

CAUTION: This email originated from outside your organization. Exercise caution when opening attachments or clicking links, especially from unknown senders.

Hi Jody,

I don't have your phone number, and was hoping to talk to you regarding the Lake Lynn re-licensing information search. Wanted to go over some of the specifics of the Ipac process, if we can?

Here is my phone, below, and I will be back in the office by 1pmish.

Thanks.

Janet

--

Janet Norman
Biologist
U.S. Fish and Wildlife Service
Chesapeake Bay Field Office
177 Admiral Cochrane Dr.
Annapolis, MD 21401
Office:  410-573-4533
Fax:  410-269-0832
Janet_Norman@fws.gov
www.fws.gov/chesapeakebay

# PHONE LOG

**Date:** June 19, 2019

**Participants:** Joyce Foster, TRC for Licensee
Janet Norman, USFWS

**Subject:** Lake Lynn Project Relicensing – Information Request for the PAD

**Prepared by:** Joyce Foster

**Conversation Summary:**

Joyce Foster returned a call I spoke to Janet Norman. Ms. Normal asked if the Licensee completed the IPaC review as an official consultation (with log in to receive a consultation number) or as unofficial. Joyce explained that TRC performed the IPaC review as unofficial for the PAD. Ms. Norman asked if we could provide her with the Shapefile for the Project area that was used for the IPaC review. Joyce indicated that she would provide her with a Project boundary shapefile, once the revised file was available. Ms. Norman requested the Licensee's contact information/phone number.

**From:** Harrell, Jacob D <Jacob.D.Harrell@wv.gov>
**Sent:** Wednesday, June 19, 2019 2:57 PM
**To:** Jody Smet <jsmet@cubehydro.com>
**Subject:** Information request: Lake Lynn



Jody,

Just for clarification purposes on our end, regarding the information request for the Lake Lynn Hydroelectric Project, this request is for information from WVDNR to use in informing the NOI/PAD, correct? There may be some confusion here that the request is for studies that we might request for the relicensing, though I think that would come after the PAD has been submitted and following the first scoping meeting. I want to make sure I have this correct.

Thanks,

Jacob Harrell

Coordination Unit
WVDNR – Wildlife Resources Section
1110 Railroad Street
Farmington, WV 26571
(304)704-9328
Jacob.D.Harrell@wv.gov

## Foster, Joyce

**From:** Jody Smet <jsmet@cubehydro.com>
**Sent:** Wednesday, June 19, 2019 3:41 PM
**To:** Harrell, Jacob D
**Cc:** Foster, Joyce
**Subject:** RE: Information request: Lake Lynn

Jacob,

Good to hear from you. This request is just for information or data that you would like to see included in the PAD; study requests will come a little later in the process.



Thanks for checking,

Jody J. Smet, AICP
Director, FERC Licensing and Compliance
(O) 804-739-0654
(C) 804-382-1764
jsmet@cubehydro.com (Please note new email address)

CUBE HYDRO CAROLINAS

---

**From:** Harrell, Jacob D <Jacob.D.Harrell@wv.gov>
**Sent:** Wednesday, June 19, 2019 2:57 PM
**To:** Jody Smet <jsmet@cubehydro.com>
**Subject:** Information request: Lake Lynn





Jody,

Just for clarification purposes on our end, regarding the information request for the Lake Lynn Hydroelectric Project, this request is for information from WVDNR to use in informing the NOI/PAD, correct? There may be some confusion here that the request is for studies that we might request for the relicensing, though I think that would come after the PAD has been submitted and following the first scoping meeting. I want to make sure I have this correct.

Thanks,

Jacob Harrell

Coordination Unit

WVDNR – Wildlife Resources Section
1110 Railroad Street
Farmington, WV 26571
(304)704-9328
Jacob.D.Harrell@wv.gov

**From:** Webber, Tina <twebber@pa.gov>
**Sent:** Wednesday, June 19, 2019 12:52 PM
**To:** jfoster@trccompanies.com
**Cc:** Jody Smet <jsmet@cubehydro.com>
**Subject:** C_19891217051MM.pdf

CAUTION: This email originated from outside your organization. Exercise caution when opening attachments or clicking links, especially from unknown senders.

Thank you for contacting the Pennsylvania State Historic Preservation Office (SHPO) for project review in accordance with state and federal laws. Our response is attached to this email. A hard copy will not follow in the mail unless requested. If this review requires a response, please mail to the address below; we cannot accept electronic submissions. This message is being sent on behalf of the SHPO review staff. If you have any questions about this review, please contact the appropriate reviewer. A list of reviewers by region and discipline is available at: http://www.phmc.pa.gov/Preservation/Project-Review/Pages/Contact-Information.aspx

**If you have questions regarding our review for above ground, please contact Cheryl Nagle at chnagle@pa.gov.**

***Tina Webber****/Clerk Typist II*
*PHMC/PA State Historic Preservation Office*
*400 North Street, 2nd Floor/Harrisburg, PA 17120-0093*
*Phone: (717) 705-4036/Fax: (717) 772-0920*
*twebber@pa.gov*

***Pennsylvania has a new statewide historic preservation plan! Check it out and learn how we can work together to make sure #preservationhappenshere in Pennsylvania every day.***

Pennsylvania State Historic Preservation Office
PENNSYLVANIA HISTORICAL AND MUSEUM COMMISSION

June 19, 2019

Jody Smet
Lake Lynn Generation, LLC
Two Bethesda Metro Center, Suite 1330
Bethesda, MD 20814

Re: File No. ER 1989-1217-051-MM
FERC No. 2459: Information Request for Pre-Application Document for Relicensing of Lake Lynn Hydroelectric Project, Lake Lynn, Fayette County

Dear Ms. Smet:

Thank you for submitting information concerning the above referenced project. The Pennsylvania State Historic Preservation Office (PA SHPO) reviews projects in accordance with state and federal laws. Section 106 of the National Historic Preservation Act of 1966, and the implementing regulations (36 CFR Part 800) of the Advisory Council on Historic Preservation, is the primary federal legislation. The Environmental Rights amendment, Article 1, Section 27 of the Pennsylvania Constitution and the Pennsylvania History Code, 37 Pa. Cons. Stat. Section 500 et seq. (1988) is the primary state legislation. These laws include consideration of the project's potential effects on both historic and archaeological resources.

**Above Ground Resources**

A preliminary review of this project indicates that there may be National Register-eligible above ground resources in the project area. In order to facilitate the review process, the agency, or applicant acting on their behalf, must conduct surveys to identify these resources before final plans are developed. For more information on survey strategies and methodologies, please consult the *Guidelines for Architectural Investigations in Pennsylvania* and/or other relevant guidelines available here:
http://www.phmc.pa.gov/Preservation/About/Pages/Forms-Guidance.aspx.

**Archaeological Resources**

There is a high probability that archaeological resources are located in this project area. In our opinion, the activity described in your proposal should have no effect on such resources. Should the scope of the project be amended to include additional ground disturbing activity this office should be contacted immediately and a Phase I Archaeological Survey may be necessary to locate all potentially significant archaeological resources.

If you need further information in this matter, please contact Cheryl L. Nagle at chnagle@pa.gov or (717) 772-4519.

Sincerely,

Douglas C. McLearen, Chief
Division of Environmental Review

DCM/tmw

## Foster, Joyce

**From:** Foster, Joyce
**Sent:** Thursday, June 20, 2019 8:48 AM
**To:** janet_norman@fws.gov
**Cc:** Jody Smet
**Subject:** Lake Lynn Project (FERC No. 2459) - Ipac consultation done

Janet,

As follow-up to our conversation related to the Lake Lynn Project FERC relicensing, I will send you the Shapefile for the Project that we used for the IPaC unofficial resource/species



list as soon as it is available, hopefully later today. Our GIS staff is currently correcting an error in the Project area polygon and we will rerun the IPaC unofficial review using this corrected Shapefile.

As we discussed, I am also sending you the contact information for Jody Smet, the Project Licensee:

Jody J. Smet, AICP
Director, FERC Licensing and Compliance
(O) 804-739-0654
(C) 804-382-1764
jsmet@cubehydro.com

As I mentioned, I am the consultant assisting with the relicensing process. My contact information is below:
Joyce Foster
TRC
804-769-1667 (office)
804-338-5110 (cell)
jfoster@trccompanies.com

We are looking forward to working with you.

**Joyce Foster**
Planner



179 Clarks Lane, Aylett, VA 23009
**T** 804.769.1667 | **C** 804.338.5110
LinkedIn | Twitter | Blog | TRCcompanies.com

**Please note that our domain name and email addresses have changed**

Begin forwarded message:

**From:** "Norman, Janet" <janet_norman@fws.gov>
**Date:** June 19, 2019 at 6:06:25 PM GMT+2
**To:** <jsmet@cubehydro.com>
**Subject: Ipac consultation done?**

CAUTION: This email originated from outside your organization. Exercise caution when opening attachments or clicking links, especially from unknown senders.

Hi Jody,

I don't have your phone number, and was hoping to talk to you regarding the Lake Lynn re-licensing information search.  Wanted to go over some of the specifics of the Ipac process, if we can?
Here is my phone, below, and I will be back in the office by 1pmish.
Thanks.
Janet



--
Janet Norman
Biologist
U.S. Fish and Wildlife Service
Chesapeake Bay Field Office
177 Admiral Cochrane Dr.
Annapolis, MD 21401
Office:  410-573-4533
Fax:  410-269-0832
Janet_Norman@fws.gov
www.fws.gov/chesapeakebay

## Foster, Joyce

**From:** Norman, Janet <janet_norman@fws.gov>
**Sent:** Thursday, June 20, 2019 11:18 AM
**To:** Foster, Joyce
**Cc:** Jody Smet
**Subject:** Re: [EXTERNAL] Lake Lynn Project (FERC No. 2459) - Ipac consultation done

Terrific, thank you Joyce.



I appreciate the follow up information.

Janet

On Thu, Jun 20, 2019 at 8:48 AM Foster, Joyce <JFoster@trccompanies.com> wrote:

> Janet,
>
> As follow-up to our conversation related to the Lake Lynn Project FERC relicensing, I will send you the Shapefile for the Project that we used for the IPaC unofficial resource/species list as soon as it is available, hopefully later today. Our GIS staff is currently correcting an

error in the Project area polygon and we will rerun the IPaC unofficial review using this corrected Shapefile.

As we discussed, I am also sending you the contact information for Jody Smet, the Project Licensee:

Jody J. Smet, AICP

Director, FERC Licensing and Compliance



(O) 804-739-0654

(C) 804-382-1764

jsmet@cubehydro.com

As I mentioned, I am the consultant assisting with the relicensing process.  My contact information is below:

Joyce Foster

TRC

804-769-1667 (office)

804-338-5110 (cell)

jfoster@trccompanies.com

We are looking forward to working with you.



**Joyce Foster**
Planner

179 Clarks Lane, Aylett, VA 23009

**T** 804.769.1667 | **C** 804.338.5110

LinkedIn | Twitter | Blog | TRCcompanies.com

**Please note that our domain name and email addresses have changed**

Begin forwarded message:

**From:** "Norman, Janet" <janet_norman@fws.gov>
**Date:** June 19, 2019 at 6:06:25 PM GMT+2
**To:** <jsmet@cubehydro.com>
**Subject: Ipac consultation done?**

CAUTION: This email originated from outside your organization. Exercise caution when opening attachments or clicking links, especially from unknown senders.



Hi Jody,

I don't have your phone number, and was hoping to talk to you regarding the Lake Lynn re-licensing information search. Wanted to go over some of the specifics of the Ipac process, if we can?

Here is my phone, below, and I will be back in the office by 1pmish.

Thanks.

Janet

--

Janet Norman

Biologist

U.S. Fish and Wildlife Service

Chesapeake Bay Field Office

177 Admiral Cochrane Dr.



Annapolis, MD 21401

Office:  410-573-4533

Fax:  410-269-0832

Janet_Norman@fws.gov

www.fws.gov/chesapeakebay

--
Janet Norman
Biologist
U.S. Fish and Wildlife Service
Chesapeake Bay Field Office
177 Admiral Cochrane Dr.
Annapolis, MD 21401
Office:  410-573-4533
Fax:  410-269-0832
Janet_Norman@fws.gov
www.fws.gov/chesapeakebay

## Foster, Joyce

**From:** Blair, Michelle A.
**Sent:** Thursday, June 20, 2019 1:58 PM
**To:** Foster, Joyce; jsmet@cubehydro.com
**Subject:** FW: [External] REMINDER: Information Request for the Pre-Application Document for Relicensing of the Lake Lynn Hydroelectric Project (FERC No. 2459)



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**From:** Smiles, Heather A <hsmiles@pa.gov>
**Sent:** Thursday, June 20, 2019 1:52 PM
**To:** Blair, Michelle A. <mblair@trccompanies.com>
**Subject:** RE: [External] REMINDER: Information Request for the Pre-Application Document for Relicensing of the Lake Lynn Hydroelectric Project (FERC No. 2459)

Michelle,

The PFBC agrees with the use of the Traditional Licensing Process (TLP) for the relicensing of the Lake Lynn Hydroelectric Project. Additionally, the PFBC has been involved in the review of biological monitoring information and has had opportunities to provide comments on future monitoring. Therefore, the PFBC does not have any additional information requests at this time.

Thanks in advance,

**Heather A. Smiles |** Chief, Division of Environmental Services
PA Fish and Boat Commission
595 East Rolling Ridge Drive **|** Bellefonte, PA 16823
Phone: 814.359.5194
Email: hsmiles@pa.gov
www.fishandboat.com

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**From:** Blair, Michelle A. <mblair@trccompanies.com>
**Sent:** Wednesday, June 12, 2019 9:53 AM
**To:** Absentee-Shawnee Tribe of Oklahoma <106NAGPRA@astribe.com>; Amanda Pitzer



<amanda@cheat.org>; Anita Carter <greystone.poa@hotmail.com>; Betty Wiley <betty.w304@gmail.com>; Bob Irvin <birvin@americanrivers.org>; Bonney Hartley <bonney.hartley@mohican-nsn.gov>; Brett Barnes <bbarnes@estoo.net>; Brian Bridgewater <Brian.L.Bridgewater@wv.gov>; Brice Obermeyer <bobermeyer@delawaretribe.org>; Bryan Printup <bprintup@hetf.org>; Cassie Harper <cassie@shawnee-tribe.com>; Clint Halftown <clint.halftown@gmail.com>; Colleen McNally-Murphy <colleen@hydroreform.org>; Coopers Rock State Forest <coopersrocksf@wv.gov>; Cosmo Servidio <cosmo.servidio@epa.gov>; Curtis Schreffler <clschref@usgs.gov>; Dana Kelly <dkelly@delawarenation.com>; Danny Bennett <Danny.A.Bennett@wv.gov>; Darren Bonaparte <darren.bonaparte@srmt-nsn.gov>; David Wellman <David.I.Wellman@wv.gov>; Delaware Nation, Oklahoma <ec@delawarenation.com>; Delaware Tribe of Indians <cbrooks@delawaretribe.org>; Duane Nichols <duane330@aol.com>; Eastern Shawnee Tribe of Oklahoma

<estochief@hotmail.com>; Edgewater Marina <edgewater@cheatlakedocks.com>; Ella Belling <ella@montrails.org>; Smiles, Heather A <hsmiles@pa.gov>; Jacob Harrell <Jacob.D.Harrell@wv.gov>; jay.toth@sni.org; Jesse Bergevin <jbergevin@oneida-nation.org>; John Spain <john.spain@ferc.gov>; Kevin Colburn <kevin@americanwhitewater.org>; Kevin Mendik <Kevin_Mendik@nps.gov>; Laura Misita <lmisita@oneida-nation.org>; Megan Gottlieb <Megan.K.Gottlieb@usace.army.mil>; Mike Strager <mstrager@gmail.com>; Oneida Indian Nation <info@oneida-nation.org>; Oneida Tribe of Indians of Wisconsin <cwilliam@oneidanation.org>; Onondaga Nation <admin@onondaganation.org>; Rennetta McClure <rmcclure@moncommission.com>; Richard McCorkle <richard_mccorkle@fws.gov>; Sean P McDermott <Sean.McDermott@noaa.gov>; Shannon Holsey <shannon.holsey@mohican-nsn.gov>; Shaun Wicklein <smwickle@usgs.gov>; Steve Moyer <steve_moyer@tu.org>; Steve Moyer (smoyer@tu.org) <smoyer@tu.org>; Stuart Welsh <swelsh@wvu.edu>; Sunset Beach



Marina <info@sunsetbeach-marina.com>; Susan Bachor <sbachor@delawaretribe.org>; Susan Pierce <susan.m.pierce@wv.gov>; Tonawanda Band of Seneca <tonseneca@aol.com>; Tonya Tipton <tonya@shawnee-tribe.com>; Vincent Vicites <vvicites@fayettepa.org>; William Fisher <wfisher@sctribe.com>; William Tarrant <wtarrant@sctribe.com>
**Cc:** jsmet@cubehydro.com; Foster, Joyce <JFoster@trccompanies.com>
**Subject:** [External] REMINDER: Information Request for the Pre-Application Document for Relicensing of the Lake Lynn Hydroelectric Project (FERC No. 2459)
**Importance:** High

***ATTENTION:*** *This email message is from an external sender. Do not open links or attachments from unknown sources. To report suspicious email, forward the message as an attachment to CWOPA_SPAM@pa.gov.*

Good morning -

Attached is an Information Request for the Pre-Application Document for the FERC relicensing of the Lake Lynn Hydroelectric Project (FERC No. 2459).

As a reminder, please provide your comments within 30 days of this letter (by June 20). If you have any questions regarding this request please contact Jody Smet at jsmet@cubehydro.com or Joyce Foster at jfoster@trccompanies.com.



Thank you,
Michelle

**Michelle Blair**
Project Coordinator

14 Gabriel Drive, Augusta, ME 04330
**T** 207.620.3845 | **F** 207.621.8226 | mblair@trccompanies.com
LinkedIn | Twitter | Blog | TRCcompanies.com

**Foster, Joyce**

---

**From:** Michael Strager <mstrager@wvu.edu>
**Sent:** Thursday, June 20, 2019 2:23 PM
**To:** Blair, Michelle A.
**Cc:** Jody Smet; Foster, Joyce; Duane Nichols
**Subject:** RE: Information Request for the Pre-Application Document for Relicensing of the Lake Lynn Hydroelectric Project (FERC No. 2459)
**Attachments:** Notes from CLEAR for Cube Hydro FERC license 6-20-19.docx

Hi Michelle,



Thanks for the invitation to submit information for the PAD.

Attached is the submission from myself and Duane Nicholas who represent the Cheat Lake Environment and Area Recreation (CLEAR).

Mike Strager
102 Lake Pointe
Morgantown, WV 26508
mstrager@gmail.com
304-276-3334

**From:** Blair, Michelle A. [mailto:mblair@trccompanies.com]
**Sent:** Monday, May 20, 2019 3:06 PM
**To:** Absentee-Shawnee Tribe of Oklahoma <106NAGPRA@astribe.com>; Amanda Pitzer <amanda@cheat.org>; Anita Carter <greystone.poa@hotmail.com>; Betty Wiley <betty.w304@gmail.com>; Bob Irvin <birvin@americanrivers.org>; Bonney Hartley <bonney.hartley@mohican-nsn.gov>; Brett Barnes <bbarnes@estoo.net>; Brian Bridgewater <Brian.L.Bridgewater@wv.gov>; Brice Obermeyer <bobermeyer@delawaretribe.org>; Bryan Printup <bprintup@hetf.org>; Cassie Harper <cassie@shawnee-tribe.com>; Clint Halftown <clint.halftown@gmail.com>; Colleen McNally-Murphy <colleen@hydroreform.org>; Coopers Rock State Forest <coopersrocksf@wv.gov>; Cosmo Servidio <cosmo.servidio@epa.gov>; Curtis Schreffler <clschref@usgs.gov>; Dana Kelly <dkelly@delawarenation.com>; Danny Bennett <Danny.A.Bennett@wv.gov>; Darren Bonaparte <darren.bonaparte@srmt-nsn.gov>; David



Wellman <David.I.Wellman@wv.gov>; Delaware Nation, Oklahoma <ec@delawarenation.com>; Delaware Tribe of Indians <cbrooks@delawaretribe.org>; Duane Nichols <duane330@aol.com>; Eastern Shawnee Tribe of Oklahoma <estochief@hotmail.com>; Edgewater Marina <edgewater@cheatlakedocks.com>; Ella Belling <ella@montrails.org>; Heather Smiles <hsmiles@pa.gov>; Jacob Harrell <Jacob.D.Harrell@wv.gov>; Jay Toth <jay.toth@sni.org>; Jesse Bergevin <jbergevin@oneida-nation.org>; John Spain <john.spain@ferc.gov>; Kevin Colburn <kevin@americanwhitewater.org>; Kevin Mendik <Kevin_Mendik@nps.gov>; Laura Misita <lmisita@oneida-nation.org>; Megan Gottlieb <Megan.K.Gottlieb@usace.army.mil>; Mike Strager <mstrager@gmail.com>; Oneida Indian Nation <info@oneida-nation.org>; Oneida Tribe of Indians of Wisconsin <cwilliam@oneidanation.org>; Onondaga Nation <admin@onondaganation.org>; Rennetta McClure <rmcclure@moncommission.com>; Richard McCorkle <richard_mccorkle@fws.gov>; Sean P McDermott

<Sean.McDermott@noaa.gov>; Shannon Holsey <shannon.holsey@mohican-nsn.gov>; Shaun Wicklein <smwickle@usgs.gov>; Steve Moyer <steve_moyer@tu.org>; Steve Moyer (smoyer@tu.org) <smoyer@tu.org>; Stuart Welsh <swelsh@wvu.edu>; Sunset Beach Marina <info@sunsetbeach-marina.com>; Susan Bachor <sbachor@delawaretribe.org>; Susan Pierce <susan.m.pierce@wv.gov>; Tonawanda Band of Seneca <tonseneca@aol.com>; Tonya Tipton <tonya@shawnee-tribe.com>; Vincent Vicites <vvicites@fayettepa.org>; William Fisher <wfisher@sctribe.com>; William Tarrant <wtarrant@sctribe.com>
**Cc:** jsmet@cubehydro.com; Foster, Joyce <JFoster@trccompanies.com>
**Subject:** Information Request for the Pre-Application Document for Relicensing of the Lake Lynn Hydroelectric Project (FERC No. 2459)

Good afternoon-



Attached is an Information Request for the Pre-Application Document for the FERC relicensing of the Lake Lynn Hydroelectric Project (FERC No. 2459).

Please provide your comments within 30 days of this letter. If you have any questions regarding this request please contact Jody Smet at jsmet@cubehydro.com or Joyce Foster at jfoster@trccompanies.com.

Thank you,
Michelle

**Michelle Blair**
Project Coordinator

14 Gabriel Drive, Augusta, ME 04330
**T** 207.620.3845 | **F** 207.621.8226 | mblair@trccompanies.com
LinkedIn | Twitter | Blog | TRCcompanies.com

7

Prepared Input for the Pre-Application Document for the Lake Lynn Hydroelectric Project

June 20, 2019

Submitted by:

Mike Strager – Vice President, Cheat Lake Environment and Area Recreation, 102 Lake Pointe, Morgantown, W 26508, mstrager@gmail.com, 304-276-3334

Duane Nichols – President, Cheat Lake Environment and Area Recreation, 330 Dream Catcher Circle, Morgantown, WV 26508, duane330@aol.com, 304-599-8040

This document highlights issues noted by the Cheat Lake Environment and Area Recreation (CLEAR). CLEAR has been active since 1994 promoting recreational and environmental improvements for Monongalia County's largest open-water resource. We appreciate the opportunity to provide our input for Cube Hydro to address in the relicensing process of the Lake Lynn Hydroelectric Project (FERC No. 2459).

---

Issues of Concern and Recommendations:

ISSUE #1:
A 2017 Carrying Capacity Study for Cheat Lake, WV was completed for Cube Hydro and concluded that there were a total of 1,226 boats moored on docks at Cheat Lake. This includes the four marinas and 204 private docks. In addition, to these boats on the lake, the Sunset Beach Marina has a public boat ramp which was surveyed throughout the summer of 2017 and found an average of 69 boats brought to the lake for use on a typical summer weekend day.

The traditional approach to calculate a boating carrying capacity for lakes is from published literature in the outdoor recreation, parks and conservation, and National Park Service Literature as well as EPA Environmental Impact Statements and lake management planning. The boating carrying capacity for Cheat Lake focused on the safety carrying capacity of the lake. The carrying capacity based on safety is derived from the traditional "space standards" approach for assessing boating carrying capacity (Bureau of Outdoor Recreation 1970). This approach specifies the amount of space needed for safe boat operation (expressed in acres of surface area per boat, or acres per boat). The National Park Service has adopted a range of 9 to 18 acres per boat as a guideline for safe boating on open water (NPS 1987). Considering the steep topography which creates narrow lines of sight, two bridges, and the fact that Cheat Lake is on average less than a quarter mile wide (measured from 30 random transects), the most restrictive 18 acres per boat could be justifiably used in the study.

The total boat-able or navigable acres of water for Cheat Lake is 1,598 acres (calculated with a Geographic Information Systems and 1:4,800 scale hydrography). According to this factor, the boating capacity of Cheat Lake maxes out at 88 boats in use at one time using the 18 acres per boat ratio or 177 boats using the less restrictive 9 acres per boat use area. These numbers are simply found for boating capacity by dividing the number of water surface acres by the "acres per boat" standard.

Based on the observed total of 291 boats in use on August 13, 2017 (a typical summer boating weekend day), the lake was greatly over its carry capacity and was therefore a safety issue. In addition, the total number of boats moored at the lake plus and average of 69 trailered on a warm summer weekend day only requires 13.6 % of boats to be in use before the 177 boat carrying capacity is reached.

RECOMMENDATION:
The reason the number of boats used in operation is important is because it directly impacts safety on the lake. Too many permitted boat docks create potentially dangerous situations especially when the lake is unlimited horsepower and without speed limits. While the WV Division of Natural Resources Office of Enforcement monitors the lake for safe operation, their job becomes much more difficult with an unsafe number of boats are permitted for use on the lake by Cube Hydro. Since Cube Hydro is responsible for boat dock permits at both marinas and personal access sites around the lake it is strongly suggested Cube Hydro does not allow any more permits and keeps this policy into the future. Yearly inspections and surveys are also recommended to insure the number of boats moored at the lake are all permitted ones. Another possible suggestion is to charge out of state boaters a higher use fee to operate at the lake.

ISSUE #2:
Many of the marinas and private docks on Cheat Lake randomly place buoys at varying distances from the end of their docks. These buoys are not consistent around the lake and therefore are not taken seriously by boaters and can cause issues regarding right of ways and safe travel at the lake.

RECOMMENDATION:
Cube Hydro should contact the marinas and private dock owners to let them know all buoys should extend 100 feet from the end of the dock to be consistent with US Army Corps of Engineers national waterway policy and guidelines.

ISSUE #3:
The Cheat Lake Beach needs new sand to maintain a quality beach for the community. The last two years sand has been added that was not sufficient enough for coverage and was also the wrong type. The sand chosen was too fine and ended up washing into the lake.

RECOMMENDATION:
After research at six local lake beaches in our area, it is suggested to buy <u>concrete sand</u> for our beach. This sand is lighter in color and coarser than previously applied. This sand applied at Jennings Randolph lake has lasted the past 3 years on a slope that is much steeper than our beach. Note the picture to the right. Because this sand is coarser it does not wash away and doesn't cloud the water once in the lake. This will save Cube Hydro in the long run with less maintenance and applications.

The sand can be purchased from Fairfax Materials, Inc in Oakland Maryland. A quote and information for them is listed below. It is old so a new quote from them would be necessary.

**FAIRFAX MATERIALS, INC.**
8490 GARRETT HIGHWAY
OAKLAND, MARYLAND 21550

Central Dispatch: (301) 334-8101 (800) 325-8663
Sales - Oakland: (301) 334-8184 / Scherr: (304) 749-8889
Sales Fax - Oakland: (301) 334-9381 / Scherr: (304) 749-8988

***QUOTATION - Page 1 of 1***

**C.O.D. SALES [ CASH ]**
N/A

**Quoted: 06/01/2016**
**Firm Date: 12/31/2016**

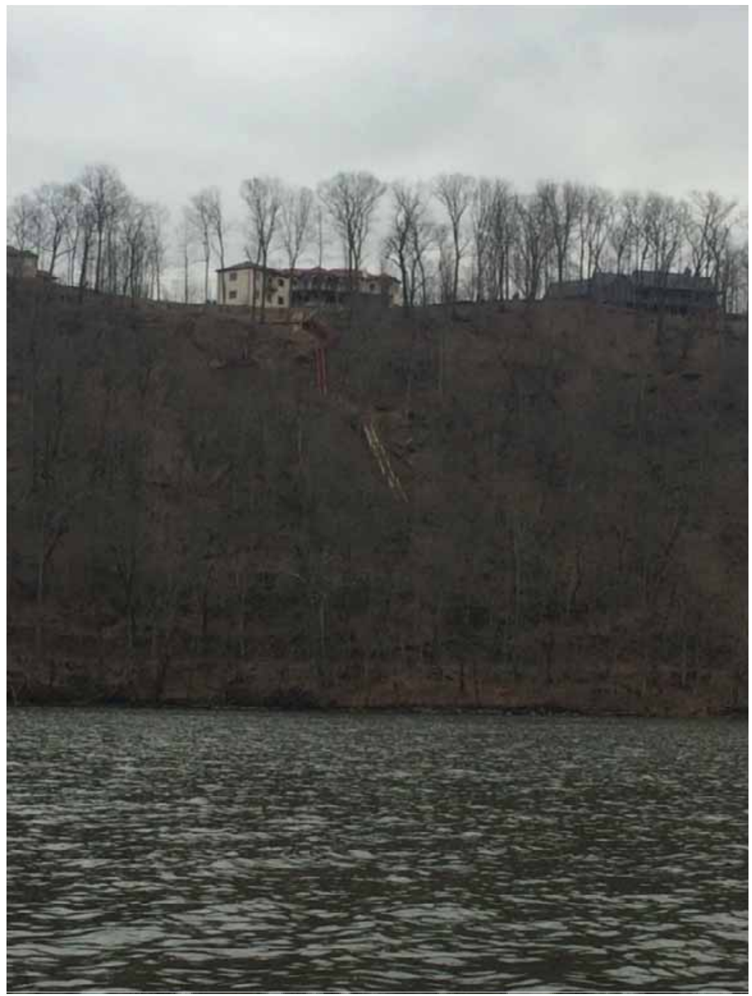
Attention: **MIKE**

Project: **CHEAT LAKE BEACH SAND [ CHELAK ]**
CUSTOMER NOT ON FILE - COD SALE ONLY.

| Plant | Product Description | Est. Qty. | Mat'l FOB Plant | Freight | Total | |
|---|---|---|---|---|---|---|
| THOMAS QUARRY | CONCRETE SAND (SS) | 100.00 | $18.90 | $12.70 | $31.60 | Per Ton |
| THOMAS QUARRY | FUEL SURCHG-DELIV | 0.00 | $0.00 | $0.00 | $0.00 | Per Ton |
| THOMAS QUARRY | TAILGATED/SPREADER BOX | 0.00 | $40.00 | $0.00 | $40.00 | Per Load |

ISSUE #4:
Large woody debris on the shoreline of the Cheat Lake Beach at the Cheat Lake Park and Trail is unsightly and potentially dangerous for swimmers and small children.

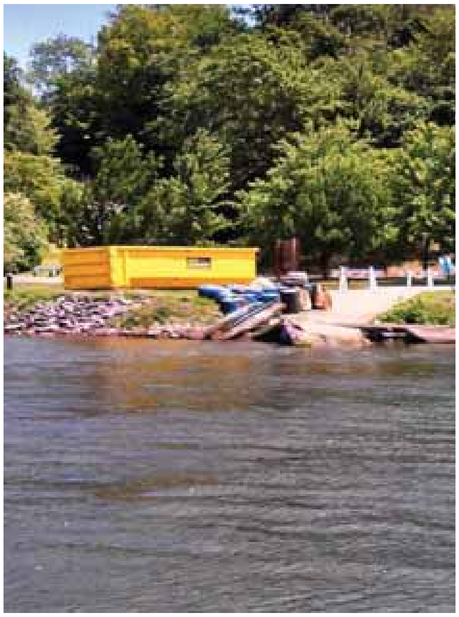
RECOMMENDATION:
The maintenance crew or contracted group needs to remove the large wood that floats to the beach at least every Friday during the summer.

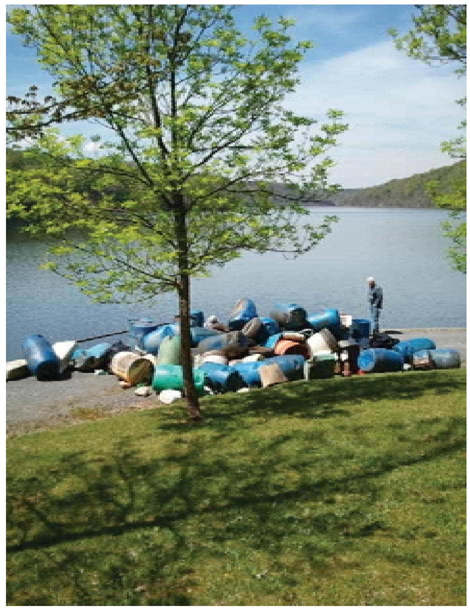


ISSUE #5:
Rail trail closings result from slides that occur along the trail in both directions from the Cheat Lake Park. This is a function of the steep terrain and impacts to the land cover. However, many land owners that believe they own the land down to the rail trail have illegally cleared the natural vegetation and increased the chance of land slides. The picture to the right is of a house building a path and steps down to the rail trail. This house is in the Falling Water development just upstream from the swimming beach location.

RECOMMENDATION:
Cube Hydro needs to inform all adjacent land owners to the Cheat Lake Park and Trail to avoid trespassing and disturbing any of the natural vegetation or elevation to the rail trail. In addition, a shoreline management plan should be implemented to reduce erosion and unsightly development along the riparian area of the lake. It could be recommended that all trees 12in in diameter or larger be preserved for stability and aesthetics of the shoreline riparian area.

ISSUE #6:
For the past 6 years the CLEAR organization has volunteered its time to clean up the lake from large debris that poses boating hazards as well as is aesthetically unpleasant. The pictures show the amount and types of debri that CLEAR has picked up using a work boat that own in an annual sweep of the lake. Some years these cleanups have occurred multiple times. This work is necessary to keep Cheat Lake cleaner and safer.

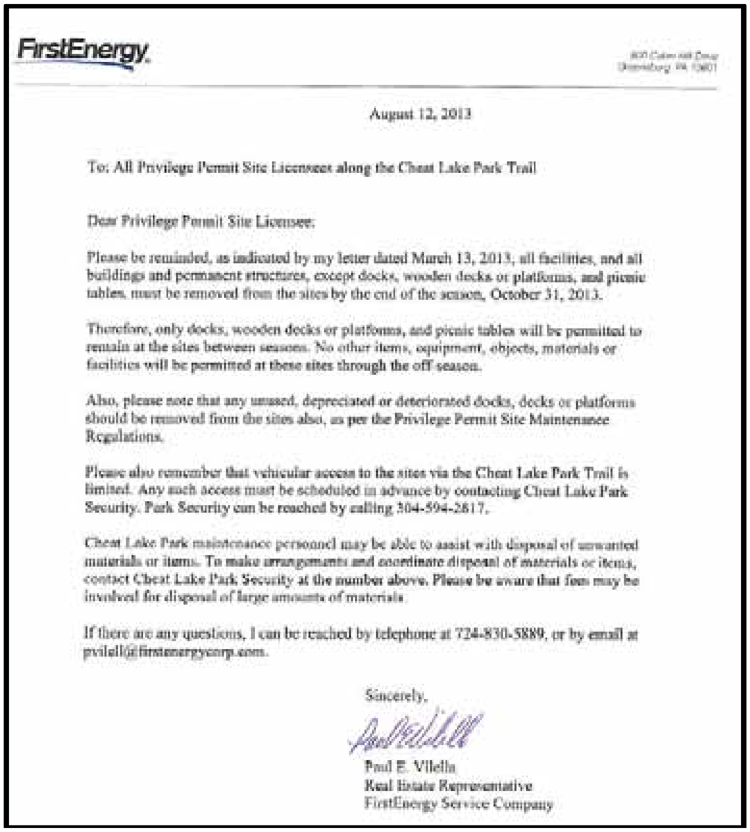




RECOMMENDATION:
CLEAR plans to continue with these annual clean ups and would like Cube Hydro to cooperate by disposing of the trash we collect from the lake. In years past we have collected the debris and deposited it at the winter boat ramp for hauling. Some years there has been a large dumpster placed at this location to help in the removal.

ISSUE #7

In August of 2013, the Operating Company at Cheat Lake sent the letter below to all permit site licensees along the Cheat Lake Park Trail. It required leases to remove all permanent structures that were not docks from the leased areas. To this date, there remains many sites that have not been cleaned up and that continue to be use for overnight camping which is not allowed. Many of the sites are as shown in the pictures below are on Cube Hydro property illegally.



FirstEnergy

August 12, 2013

To: All Privilege Permit Site Licensees along the Cheat Lake Park Trail

Dear Privilege Permit Site Licensee:

Please be reminded, as indicated by my letter dated March 13, 2013, all facilities, and all buildings and permanent structures, except docks, wooden decks or platforms, and picnic tables, must be removed from the sites by the end of the season, October 31, 2013.

Therefore, only docks, wooden decks or platforms, and picnic tables will be permitted to remain at the sites between seasons. No other items, equipment, objects, materials or facilities will be permitted at these sites through the off season.

Also, please note that any unused, depreciated or deteriorated docks, decks or platforms should be removed from the sites also, as per the Privilege Permit Site Maintenance Regulations.

Please also remember that vehicular access to the sites via the Cheat Lake Park Trail is limited. Any such access must be scheduled in advance by contacting Cheat Lake Park Security. Park Security can be reached by calling 304-594-2817.

Cheat Lake Park maintenance personnel may be able to assist with disposal of unwanted materials or items. To make arrangements and coordinate disposal of materials or items, contact Cheat Lake Park Security at the number above. Please be aware that fees may be involved for disposal of large amounts of materials.

If there are any questions, I can be reached by telephone at 724-830-5889, or by email at pvilell@firstenergycorp.com.

Sincerely,

Paul E. Vilella
Real Estate Representative
FirstEnergy Service Company

RECOMMENDATION:

The sites along the rail trail need to be cleaned up and restored to original condition and the sites being used at random locations around the lake should be cleaned up and vacated.

## Foster, Joyce

**From:** Duane Nichols <duane330@aol.com>
**Sent:** Thursday, June 20, 2019 3:39 PM
**To:** jsmet@cubehydro.com; Foster, Joyce
**Cc:** duane330@aol.com
**Subject:** CLEAR - Nichols - Lake Lynn 2459 - June 20, 2019
**Attachments:** Submission of CLEAR -Prelicense Document- 6-20-19.docx

Submission of Cheat Lake Environment & Recreation Association, 330 Dream Catcher Circle, Morgantown, WV 26508. Duane Nichols, President; Michael Strager, Vice President, Ann Chester, Secretary, Donna Weems, Treasurer. June 20, 2019

1

RE: Relicensing Process for Lake Lynn Hydroelectric Project (FERC No. 2459).

The following essential topics are requested to become part of the relicensing of the Lake Lynn Project and then incorporated into the operation and maintenance of the facility and surroundings.

1. Memorandum of Understanding (MOU) on Recreation, Safety & Security is needed with other local entities, viz. Monongahela County (Chestnut Ridge County Camp), West Virginia University (WVU Research Forest), WV Division of Natural Resources (Coopers Rock State Forest), WV Division of Natural Resources (fishing facilities, fishing regulation, fish research w/ WVU), et al.

2

2. Cheat Lake Park & Trail: Operation of Trail (security per MOU, security gate, year-round trail availability, rest-room availability), Maintenance of trail (trail surface, erosion, subsidence, tree removal), Signage (install & maintain signage on WV 857 for Park & Trail, maintain or improve current signage), Extension of Trail (integrate with Sheepskin Trail in Pennsylvania, integrate with slate dump at south end via construction of natural science destination)

3. Cheat Lake Swimming Beach (sand selection & supply, limit rip-rap, safety & security per MOU, extend swimming beach and/or picnic area to day-use boat docks, remove woody debris from beach shoreline and new picnic area), Establish separate dog swimming area and disallow dogs at children's beach)

4. Cheat Lake Boat Docks & Boating Activities (prepare & distribute guidebook on dock leasing & dock maintenance, publicize name & contact detail for information officer, establish



limitation on number of boats, boat horsepower, boat noise level, boat speed). Note: State Law can prevail.

5. Local Annual Update/Briefing on Lake Lynn Operations & Challenges w/ Q&A (public meeting at Cheat Lake Fire Hall, for example)

6. Lake Lynn Dam & Related Issues (Publicize statement on integrity of dam built ca. 1927, do not permit water withdraw activities from Lake, do not permit horizontal drilling near or under Lake, do not permit underground storage of hydrocarbons near or under Lake.

7. Lake Lynn Advisory Council on Recreation, Safety & Security (establish advisory council to include representatives of County, State and Federal agencies as well as voluntary local group(s).

Submitted by Duane Nichols, President, CLEAR, 330 Dream Catcher Circle, Morgantown, WV 26508.  304-599-8040. WV Day: June 20, 2019.

Submission of Cheat Lake Environment & Recreation Association, 330 Dream Catcher Circle, Morgantown, WV 26508. Duane Nichols, President; Michael Strager, Vice President, Ann Chester, Secretary, Donna Weems, Treasurer. June 20, 2019

RE: Relicensing Process for Lake Lynn Hydroelectric Project (FERC No. 2459).

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6. Lake Lynn Dam & Related Issues (Publicize statement on integrity of dam built ca. 1927, do not permit water withdraw activities from Lake, do not permit horizontal drilling near or under Lake, do not permit underground storage of hydrocarbons near or under Lake.

7. Lake Lynn Advisory Council on Recreation, Safety & Security (establish advisory council to include representatives of County, State and Federal agencies as well as voluntary local group(s).

Submitted by Duane Nichols, President, CLEAR, 330 Dream Catcher Circle, Morgantown, WV 26508. 304-599-8040. WV Day: June 20, 2019.

## Foster, Joyce

**From:** Stratford Douglas <stratdouglas@gmail.com>
**Sent:** Thursday, June 20, 2019 4:37 PM
**To:** Foster, Joyce; jsmet@cubehydro.com
**Cc:** Charlie Walbridge; Kevin Colburn; Garrett Thompson; Amanda Pitzer
**Subject:** Proposed Recreational Enhancement, Lake Lynn Relicensing
**Attachments:** BuzzardRunCheatLakeAccessProposal.docx

Dear Ms Foster and Ms. Smet:



Attached you'll find a proposal for a recreational enhancement that I would like to see in included in the PAD and comments in the Traditional Licensing Process for the Lake Lynn Hydroelectric Project, P-2459.
Thanks for your consideration.

Stratford Douglas
1024 Snake Hill Road
Morgantown, WV 26508
724-605-5329

PS, here is a text version that does not rely on the figures found in the MS-Word version.

The upper end of the Cheat Lake (Lake Lynn) reservoir is remote and beautiful, and difficult to access from the shore. There is an unimproved dirt road (currently gated) on state-owned public land (Snake Hill Wildlife Management Area) that could provide access to a point roughly 3 kilometers south (upstream) of any access point to the lake. The proposed access point is a level area of approximately 6 acres on the shoreline.

By improving this access road and adding a small parking lot, the Lake Lynn licensee could add significant recreational opportunity for fishermen to access quiet and remote areas. It would also make it much more feasible for boaters to access 3.8 miles of remote, wild, and easy (class II) white water in the Lower Cheat Canyon, a section that is rarely run at present because of access difficulties.

Whitewater Access Value. Class II whitewater is suitable for novice kayakers, canoeists, and



stand-up paddleboards (SUPs). The Lower Cheat consists of 3.8 miles of Class II whitewater located adjacent to the Morgantown metropolitan area, situated in a wild and remote-feeling 1200 foot deep canyon. The Lower Cheat Canyon is rarely run at present, primarily because of the 4.5 mile flat water paddle across Cheat Lake to the nearest public take-out point.
The proposed recreational enhancement at Buzzard Run Road would shorten the flat water paddle to the take-out from 4.5 miles to 1.9 miles, which will make the whitewater trip much more attractive.

Fishing Access Value. Fishermen wishing to reach the upper section of Cheat Lake currently must do so by boat. The proposed access improvement would allow fishermen to use the area near the parking lot, and it would also allow them access to an existing trail on public land that follows the course of the Cheat River from the end of Buzzard Run Road to approximately 6 miles to the next access point upstream at Jenkinsburg in Preston County.

The Proposed Project. We propose improvements to an existing one-lane road ("Buzzard Run Road"), 1.4 miles long, moderately sloped, and easily accessible by SUV, that connects the proposed take-out to Snake Hill Road. Buzzard Run Road forms the border of the Snake Hill Wildlife Management Area for much of its length. (Google Maps incorrectly shows it following Buzzard Run to the lake; in fact it reaches the lake at the mouth of an unnamed stream farther south.)

We propose improving the existing Buzzard Run Road by adding proper drainage, gravel and, where possible, one or two turnouts to allow for light two-way traffic. In addition, we propose development of a small parking lot in the six-acre flat lakeside area at the bottom of this existing road. For boating access we propose a concrete ramp near the mouth of the



unnamed tributary. It may be appropriate to add a fishing pier as well.

It may be of interest to note that this very same improvement was proposed by Allegheny Power in a public meeting concerning previous relicensing proceeding, in 1999. At that time it was proposed as an alternative to the Cheat Lake Trail that was subsequently built at the park at Morgan Run. We believe that the time for this project has come.

Stratford Douglas:
Friends of the Cheat (Board Member and Treasurer)
American Whitewater (Lifetime Member)

## Recreational Access to Upper Cheat Lake through Buzzard Run Road Improvements

The upper end of the Cheat Lake (Lake Lynn) reservoir is remote and beautiful, and difficult to access from the shore. There is an unimproved dirt road (currently gated) on state-owned public land (Snake Hill Wildlife Management Area) that could provide access to a point roughly 3 kilometers south (upstream) of any access point to the lake. The proposed access point is a level area of approximately 6 acres on the shoreline.

By improving this access road and adding a small parking lot, the Lake Lynn licensee could add significant recreational opportunity for fishermen to access quiet and remote areas. It would also make it much more feasible for boaters to access 3.8 miles of remote, wild, and easy (class II) white water in the Lower Cheat Canyon, a section that is rarely run at present because of access difficulties.

**Whitewater Access Value.** Class II whitewater is suitable for novice kayakers, canoeists, and stand-up paddleboards (SUPs). The Lower Cheat consists of 3.8 miles of Class II whitewater located adjacent to the Morgantown metropolitan area, situated in the 1200 foot deep canyon shown in the picture at right. The Lower Cheat Canyon is rarely run at present, primarily because of the 4.5 mile flat water paddle across Cheat Lake to the nearest public take-out point.

The proposed recreational enhancement at Buzzard Run Road would shorten the flat water paddle to the take-out from 4.5 miles to 1.9 miles, which will make the whitewater trip much more attractive.

**Fishing Access Value.** Fishermen wishing to reach the upper section of Cheat Lake currently must do so by boat. The proposed access improvement would allow fishermen to use the area near the parking lot, and it would also allow them access to an existing trail on public land that follows the course of the Cheat River from the end of Buzzard Run Road to approximately 6 miles to the next access point upstream at Jenkinsburg in Preston County.

**The Proposed Project.** We propose improvements to an existing one-lane road ("Buzzard Run Road"), 1.4 miles long, moderately sloped, and easily accessible by SUV, that connects the proposed take-out to Snake Hill Road. Buzzard Run Road follows approximately the route shown in black on the map. It forms the border of the Snake Hill Wildlife Management Area for much of its length. (Google Maps incorrectly shows it following Buzzard Run to the lake; in fact it reaches the lake at the mouth of an unnamed stream farther south.)

We propose improving the existing Buzzard Run Road by adding proper drainage, gravel and, where possible, one or two turnouts to allow for light two-way traffic. In addition, we propose development of a small parking lot in the six-acre flat lakeside area at the bottom of this existing road. For boating access we propose a concrete ramp near the mouth of the unnamed tributary. It may be appropriate to add a fishing pier as well.

It may be of interest to note that this very same improvement was ***proposed by Allegheny Power*** in a public meeting concerning previous relicensing proceeding, in 1999. At that time it was proposed as an alternative to the Cheat Lake Trail that was subsequently built at the park at Morgan Run. We believe that the time for this project has come.

Stratford Douglas
1024 Snake Hill Road
Morgantown, WV 26508
stratdouglas@gmail.com
724-605-5329

Friends of the Cheat (Board Member, Treasurer)
American Whitewater (Lifetime Member)

Stratford Douglas, Morgantown, WV.
The upper end of the Cheat Lake (Lake Lynn) reservoir is remote and beautiful, and difficult to access from the shore. There is an unimproved dirt road (currently gated) on state-owned public land (Snake Hill Wildlife Management Area) that could provide access to a point roughly 3 kilometers south (upstream) of any access point to the lake. The proposed access point is a level area of approximately 6 acres on the shoreline.

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We propose improving the existing Buzzard Run Road by adding proper drainage, gravel and, where possible, one or two turnouts to allow for light two-way traffic. In addition, we propose development of a small parking lot in the six-acre flat lakeside area at the bottom of this existing road. For boating access we propose a concrete ramp near the mouth of the unnamed tributary. It may be appropriate to add a fishing pier as well.

It may be of interest to note that this very same improvement was proposed by Allegheny Power in a public meeting concerning previous relicensing proceeding, in 1999. At that time it was proposed as an alternative to the Cheat Lake Trail that was subsequently built at the park at Morgan Run. We believe that the time for this project has come.

Stratford Douglas:
Friends of the Cheat (Board Member and Treasurer)
American Whitewater (Lifetime Member)
Attachments area

Document Content(s)

## Foster, Joyce

**From:** Garrett Thompson <gthompson@cheat.org>
**Sent:** Thursday, June 20, 2019 11:01 PM
**To:** jsmet@cubehydro.com; Foster, Joyce
**Cc:** Amanda Pitzer; Stratford Douglas
**Subject:** Friends of the Cheat - Comments on Lake Lynn Re-licensing
**Attachments:** FOC_Comments_P-2459-005.docx

Dear Ms. Smet and Ms. Foster,



Attached you'll find a letter I submitted via the FERC e-filing system, on behalf of Friends of the Cheat, commenting on opportunities for recreational enhancement to be considered during the re-licensing of the Lake Lynn Hydroelectric Project, docket # P-2459-005. Thank you for your consideration.

Sincerely,

Garrett Thompson
Recreation and Lands Manager, Friends of the Cheat
1343 N. Preston Hwy, Kingwood WV, 26537

Friends of the Cheat
1343 North Preston Highway | Kingwood, West Virginia 26537 | (304) 329-3621

June 20, 2019

RE: *Information Request for the Pre-Application Document for Relicensing of the Lake Lynn Hydroelectric Project (FERC No. P-2459-005)*

Dear Ms. Foster and Ms. Smet,

On behalf of Friends of the Cheat, I'd like to start by thanking you for the opportunity to submit comments to be included as part of the Pre-Application Document for Relicensing of the Lake Lynn Hydroelectric Project.

For 25 years, Friends of the Cheat (FOC) and our River of Promise (ROP) partners have worked diligently to restore water quality to the Cheat River and Cheat Lake through reclamation of mine lands and the remediation of acid mine drainage (AMD). Irresponsible mining had left the Cheat and nine of its lower tributaries severely damaged by AMD. Walleye were extirpated by the late 1940s. Historic data collected by WV Division of Natural Resources (DNR) show mean lake pH levels less than 5 between the 1950s and early 1990s. A few pollution tolerant fish species including bullhead catfish and white suckers sought refuge in the lake's sheltered embayments. Massive pollution releases from the T&T mine into Muddy Creek in 1994 and 1995 dropped the pH of the lake to 4. As a result, the Cheat River was named one of America's Most Endangered Rivers in 1995 by the national organization American Rivers. These events catalyzed the formation of Friends of the Cheat and the River of Promise task force.

The efforts of FOC and our ROP partners, most notably the US Office of Surface Mining (OSM) and WV Department of Environmental Protection (DEP), have restored water quality to the Cheat River main stem and Cheat Lake. Over 200 land reclamation and water treatment projects have been implemented with millions of dollars of funds resulting in millions of pounds of AMD pollution removed from the Cheat's tributaries. The river and lake have not seen a pH depression below 6 since 2011 and the main stem has been removed from the state's list of impaired waters for pH impairment. The removal of iron (ferrous hydroxide or "yellow boy") as well as aluminum and manganese is visibly noticeable by reduced staining of rocks near the water's edge as well as armoring of fiberglass boat bottoms, which was a prevalent problem through the '90s.

Improved water quality has fostered the rebound of Cheat Lake's fishery. DNR reports a dramatic recovery of species richness (27-34 species per year) including abundant sportfish such as largemouth and smallmouth bass, yellow perch, and walleye. Fishing tournaments now attract anglers from across the country which benefits the local economy. FOC is particularly excited about the walleye, which research shows are spawning up into the northern reaches of the Cheat Canyon.

With a drainage area of roughly 1400 square miles all flowing down to Cheat Lake, not only does the Cheat River constitute a critical piece of the region's ecosystem, it is also home to a large human population that lives, works and plays within the drainage. Friends of the Cheat recognizes that opportunities to recreate and connect with nature and the outdoors can not only improve the quality of life for a region's citizens, but it also leads to the engagement with and appreciation of our resources that can help prevent them from being squandered and abused. Cheat Lake and the surrounding area already

Friends of the Cheat

Friends of the Cheat

1343 North Preston Highway | Kingwood, West Virginia 26537 | (304) 329-3621

provides a plethora of outdoor activities; including paddling, boating, fishing, hiking, cycling, birding and more. Cube Hydro has already improved and created recreation opportunities around Cheat Lake. FOC and key partners have identified several opportunities for additional improvement of recreational opportunities that we believe should be considered as part of this next re-licensing process.

FOC is aware and supportive of the proposal to create a public access to the upper reaches of Cheat Lake by improving an existing gated road in Snake Hill Wildlife Management Area along Buzzard Run. This would provide another trailhead for hikers to enter the WMA, fishermen to access this upper section of the lake usually only reachable by boat, and would provide an egress opportunity for whitewater paddlers running the Lower Cheat Canyon. Despite being located in close proximity to the Cheat Lake and Morgantown metropolitan areas, and providing a wonderfully scenic and exciting float through class 2 rapids in a deep canyon, this section is infrequently paddled. This is mostly due to the 4.5 mile paddle across Cheat Lake to the nearest existing public access at the Ices Ferry bridge, which can be a laborious task in short maneuverable whitewater craft that are well suited for the rapids upstream, not to mention the danger of encounters with fast moving power boats. The creation of a new public access by improving Buzzard Run Road would shorten this flatwater paddle to 1.9 miles and thereby make this whitewater trip much more attractive.

**Commented [A1]:** Could also mention safety/power boats

Another opportunity for recreation enhancement in the Cheat Lake area would be to improve access and connectivity of both ends of the existing Cheat Lake Trail. Currently the trail follows the eastern shoreline of Cheat Lake for 4.4 miles and provides opportunities for walking, running, biking and fishing. The north end of the trail can be accessed via a trailhead and steep flight of stairs off of Morgan Run Road. The south end of the trail dead ends abruptly. With the future route of the Sheepskin Trail passing by just to the north, and local businesses, residential neighborhoods, and Coopers Rock State Forest to the south, there lies an opportunity to work towards increased connectivity of these trail system. By doing so, we can enhance the value of these isolated trail sections in such a way that their value becomes greater than the sum of their parts. We recommend that possibilities to extend the southern end of the Cheat Lake Trail, around the peninsula where it currently terminates, to a newly developed trailhead be thoroughly investigated, as well as the streamlining of the northern terminus to avoid the steep stairs and improve the connectivity to the future route of the Sheepskin Trail.

Thank you for this opportunity to comment on the upcoming relicensing of the Lake Lynn Hydroelectric Project.

Sincerely,

Garrett Thompson
Recreation & Lands Manager
Friends of the Cheat

## Foster, Joyce

**From:** Jody Smet <jsmet@cubehydro.com>
**Sent:** Friday, June 21, 2019 1:59 PM
**To:** Foster, Joyce
**Subject:** Fwd: Cheat Lake trails

Begin forwarded message:



**From:** Dan Miller <DMiller@potesta.com>
**Date:** June 21, 2019 at 3:44:36 PM GMT+2
**To:** "jsmet@cubehydro.com" <jsmet@cubehydro.com>
**Cc:** Garrett Thompson <gthompson@cheat.org>
**Subject: Cheat Lake trails**

CAUTION: This email originated from outside your organization. Exercise caution when opening attachments or clicking links, especially from unknown senders.

Dear Cube Hydro,

I submitted a comment on the FERC web site about your permit renewal. Last year I met with David Fox during a meeting with Friends of the Cheat to discuss how local organizations can partner with Cube Hydro to enhance the recreational aspects of the lake. As a member of the Rotary Club of Cheat Lake we have a mutual interest in expanding the pedestrian trails to connect with other existing trails. I hope you will focus on this aspect of recreation and partner with the local groups who live and recreate around this beautiful resource.

Regards,
Dan

Daniel J. Miller, Ph.D.
Senior Scientist



Potesta & Associates, Inc.
125 Lakeview Drive
Morgantown, WV 26508

Office; 304-225-2245 ext.2005
Mobile: 681-285-8159
Fax:   304-225-2246
email: dmiller@potesta.com
www.potesta.com

and seal. If you have received this information in error, please notify the sender immediately.

Daniel Miller, Morgantown, WV.
I would like to see an extension of the pedestrian trail system especially from the dam to the Monongahela River, and along other areas to connect to other trails.

Document Content(s)

## Foster, Joyce

**From:** Foster, Joyce
**Sent:** Tuesday, June 25, 2019 8:14 AM
**To:** Norman, Janet
**Cc:** Jody Smet
**Subject:** RE: [EXTERNAL] Lake Lynn Project (FERC No. 2459) - Ipac consultation
**Attachments:** Lake_Lynn_Project_Boundary_revised 6-24-2019.zip

Janet,



As follow-up to our communication last week, attached is the corrected Shapefile that we used to re-run the IPaC unofficial review for the Lake Lynn Project (FERC No. 2459. Please let us know if you have any questions or issues with the attachment.

Thanks,

**Joyce Foster**
Planner

TRC

179 Clarks Lane, Aylett, VA 23009
**T** 804.769.1667 | **C** 804.338.5110
LinkedIn | Twitter | Blog | TRCcompanies.com

**Please note that our domain name and email addresses have changed**

**From:** Norman, Janet [mailto:janet_norman@fws.gov]
**Sent:** Thursday, June 20, 2019 11:18 AM
**To:** Foster, Joyce <JFoster@trccompanies.com>
**Cc:** Jody Smet <jsmet@cubehydro.com>
**Subject:** Re: [EXTERNAL] Lake Lynn Project (FERC No. 2459) - Ipac consultation done

Terrific, thank you Joyce.

I appreciate the follow up information.



Janet

On Thu, Jun 20, 2019 at 8:48 AM Foster, Joyce <JFoster@trccompanies.com> wrote:

> Janet,
>
> As follow-up to our conversation related to the Lake Lynn Project FERC relicensing, I will send you the Shapefile for the Project that we used for the IPaC unofficial resource/species list as soon as it is available, hopefully later today. Our GIS staff is currently correcting an error in the Project area polygon and we will rerun the IPaC unofficial review using this corrected Shapefile.

As we discussed, I am also sending you the contact information for Jody Smet, the Project Licensee:

Jody J. Smet, AICP

Director, FERC Licensing and Compliance

(O) 804-739-0654



(C) 804-382-1764

jsmet@cubehydro.com

As I mentioned, I am the consultant assisting with the relicensing process. My contact information is below:

Joyce Foster

TRC

804-769-1667 (office)

804-338-5110 (cell)

jfoster@trccompanies.com

We are looking forward to working with you.

**Joyce Foster**
Planner



179 Clarks Lane, Aylett, VA 23009

**T** 804.769.1667 | **C** 804.338.5110

LinkedIn | Twitter | Blog | TRCcompanies.com

**Please note that our domain name and email addresses have changed**

Begin forwarded message:

**From:** "Norman, Janet" <janet_norman@fws.gov>
**Date:** June 19, 2019 at 6:06:25 PM GMT+2
**To:** <jsmet@cubehydro.com>
**Subject: Ipac consultation done?**

CAUTION: This email originated from outside your organization. Exercise caution when opening attachments or clicking links, especially from unknown senders.

Hi Jody,



I don't have your phone number, and was hoping to talk to you regarding the Lake Lynn re-licensing information search. Wanted to go over some of the specifics of the Ipac process, if we can?

Here is my phone, below, and I will be back in the office by 1pmish.

Thanks.

Janet

--

Janet Norman

Biologist

U.S. Fish and Wildlife Service

Chesapeake Bay Field Office

177 Admiral Cochrane Dr.

Annapolis, MD 21401



Office:  410-573-4533

Fax:  410-269-0832

Janet_Norman@fws.gov

www.fws.gov/chesapeakebay

--
Janet Norman

Biologist
U.S. Fish and Wildlife Service
Chesapeake Bay Field Office
177 Admiral Cochrane Dr.
Annapolis, MD 21401
Office:  410-573-4533
Fax:  410-269-0832
Janet_Norman@fws.gov
www.fws.gov/chesapeakebay

| | |
|---|---|
| **From:** | Braun, Olivia |
| **To:** | Foster, Joyce |
| **Subject:** | Lake Lynn Generation, LLC - Relicensing of the Lake Lynn Hydroelectric Project |
| **Date:** | Wednesday, June 26, 2019 8:44:21 AM |

Good Morning Joyce,
The PGC is in receipt of your letter dated May 20, 2019 and would like to request some additional information about the project so that we may provide information for your pre-application document. At your earliest convenience, please provide the PGC with project mapping that clearly illustrates the location and boundary of the project area as well as any proposed improvements that may be proposed as part of the relicensing efforts. Once we receive this information, we will be in a better position to reply to you letter.

Many thanks and please feel free to contact me with any questions,

**Olivia A. Braun**
Environmental Planner
Environmental Planning & Habitat Protection Division
Bureau of Wildlife Habitat Management
Pennsylvania Game Commission
2001 Elmerton Avenue
Harrisburg, PA  17110
Phone: 717-787-4250, Ext. 3128
olbraun@pa.gov

## Foster, Joyce

**From:** Foster, Joyce
**Sent:** Thursday, June 27, 2019 11:20 AM
**To:** Braun, Olivia
**Cc:** Jody Smet
**Subject:** RE: Lake Lynn Generation, LLC - Relicensing of the Lake Lynn Hydroelectric Project
**Attachments:** Lake_Lynn_Project_Boundary_revised.pdf

Good morning,



Attached is a figure that shows the Project boundary and Project area for the Lake Lynn Hydroelectric Project. Please let us know if you need anything else or have any questions. Since this request is for information or data you would like to see included in the Pre-application Document, at this time the Licensee is not proposing any changes or improvements at the Project.

Thank you,

**Joyce Foster**
Planner

179 Clarks Lane, Aylett, VA 23009
**T** 804.769.1667 | **C** 804.338.5110
LinkedIn | Twitter | Blog | TRCcompanies.com

**Please note that our domain name and email addresses have changed**

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**From:** Braun, Olivia [mailto:olbraun@pa.gov]
**Sent:** Wednesday, June 26, 2019 8:44 AM
**To:** Foster, Joyce <JFoster@trccompanies.com>
**Subject:** Lake Lynn Generation, LLC - Relicensing of the Lake Lynn Hydroelectric Project

Good Morning Joyce,

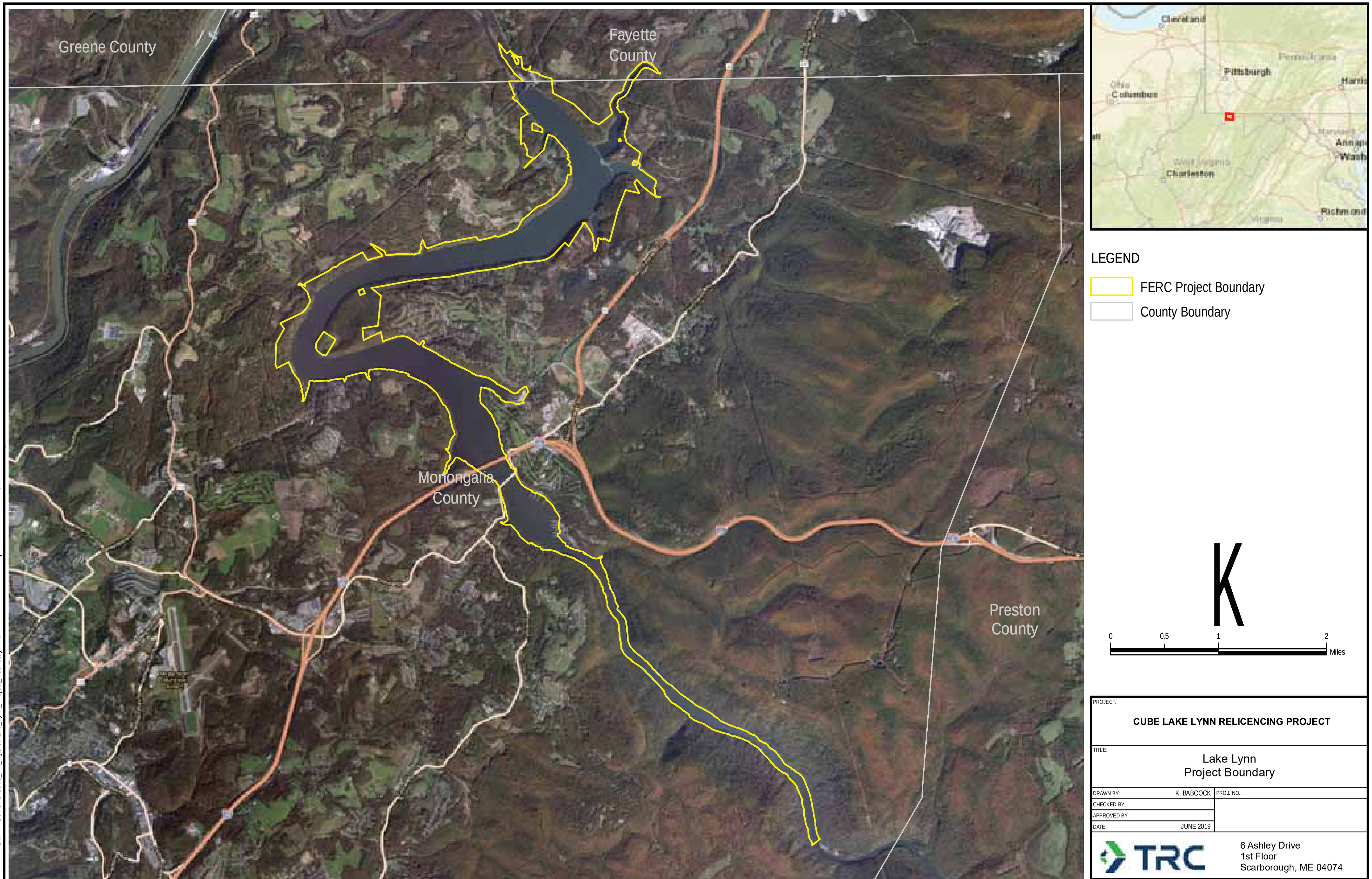


The PGC is in receipt of your letter dated May 20, 2019 and would like to request some additional information about the project so that we may provide information for your pre-application document. At your earliest convenience, please provide the PGC with project mapping that clearly illustrates the location and boundary of the project area as well as any proposed improvements that may be proposed as part of the relicensing efforts. Once we receive this information, we will be in a better position to reply to you letter.

Many thanks and please feel free to contact me with any questions,

**Olivia A. Braun**
Environmental Planner
Environmental Planning & Habitat Protection Division
Bureau of Wildlife Habitat Management
Pennsylvania Game Commission

2001 Elmerton Avenue
Harrisburg, PA  17110
Phone: 717-787-4250, Ext. 3128
olbraun@pa.gov




PROJECT: CUBE LAKE LYNN RELICENCING PROJECT

TITLE: Lake Lynn
Project Boundary

| | | |
|---|---|---|
| DRAWN BY: | K. BABCOCK | PROJ. NO.: |
| CHECKED BY: | | |
| APPROVED BY: | | |
| DATE: | JUNE 2019 | |

TRC
6 Ashley Drive
1st Floor
Scarborough, ME 04074

FILE NO.: Lake_Lynn_Project_Boundary.mxd

Plot Date: 6/27/2019, 09:44:15 AM by JFREDENBURG -- LAYOUT: ANSI B(11"x17")
Path: S:\1-PROJECTS\Cube_PE_Hydro\Lake_Lynn_Project_Boundary.mxd

Coordinate System: NAD 1983 UTM Zone 17N (Foot US)
Map Rotation: 0

TRC - GIS

FEDERAL ENERGY REGULATORY COMMISSION
WASHINGTON D.C. 20426
(June 27, 2019)

OFFICE OF ENERGY PROJECTS

Project No. 2459-000
Lake Lynn Hydroelectric Project
Lake Lynn Generation, LLC

Deborah Dotson, President
Delaware Nation
P.O. Box 825
Anadarko, OK 73005

**Reference: Consultation with Tribes for the Lake Lynn Hydroelectric Project No. 2459**

Dear President Dotson,

The Federal Energy Regulatory Commission (Commission) invites your participation in the relicensing process for the existing Lake Lynn Hydroelectric Project No. 2459 (Lake Lynn Project). The Commission's relicensing process is an opportunity for both the licensee and interested agencies, tribes, and other stakeholders to consider the project's existing operation and protection, mitigation, and enhancement measures, and evaluate the need for any changes or additional measures to be implemented over the term of any new license issued for the project. The 51.2-megawatt Lake Lynn Project is located on the Cheat River in Monongalia County, West Virginia, and Fayette County, Pennsylvania. We anticipate that Lake Lynn Generation, LLC (Lake Lynn Generation), the licensee for the project, will file a notice of intent and Pre-Application Document by November 30, 2019, to initiate the pre-filing process, and file an application for a new license by November 30, 2022.

It is very important that a tribe whose interests could be affected by the relicensing of the existing Lake Lynn Project participate early in the process so that tribal issues are addressed. For this reason, please inform us if you have an interest in participating in the relicensing process for the project.

In addition, please indicate if you would like to meet with Commission staff to discuss the Commission's licensing process, how your Tribe can participate to the fullest extent possible, your interests and concerns in the affected area, and how to establish procedures to ensure appropriate communication between Commission and tribal staffs.

The meeting can be limited to Commission and your Tribal staff, or can be open to other tribes[1] or Lake Lynn Generation.

**If at all possible, we would appreciate your response by August 02, 2019.** The Commission strongly encourages electronic filing. Please file your response using the Commission's eFiling system at http://www.ferc.gov/docs-filing/efiling.asp. Commenters can submit brief comments up to 6,000 characters, without prior registration, using the eComment system at http://www.ferc.gov/docs-filing/ecomment.asp. You must include your name and contact information at the end of your comments. For assistance, please contact FERC Online Support at FERCOnlineSupport@ferc.gov, (866) 208-3676 (toll free), or (202) 502-8659 (TTY). In lieu of electronic filing, please send a paper copy to: Secretary, Federal Energy Regulatory Commission, 888 First Street NE, Washington, DC 20426. The first page of any filing should include docket number **P-2459-000**.

If you have any questions or comments, please contact Emily Carter at (202) 502-6512 or Emily.Carter@ferc.gov. Ms. Carter will contact you shortly to follow-up on this letter.

Sincerely,

John B. Smith, Chief
Mid-Atlantic Branch
Division of Hydropower Licensing

cc:

Kim Penrod, Cultural Resources Manager
Delaware Nation
*Via email*

Harold Peterson
Bureau of Indian Affairs - Eastern Region
545 Marriott Drive, Suite 700
Nashville, TN 37214

---

[1] Commission staff is also inviting the Delaware Tribe of Indians and the Osage Nation to participate in the relicensing process.

Document Content(s)

FEDERAL ENERGY REGULATORY COMMISSION
WASHINGTON D.C. 20426
(June 27, 2019)

OFFICE OF ENERGY PROJECTS

Project No. 2459-000
Lake Lynn Hydroelectric Project
Lake Lynn Generation, LLC

Chief Chester Brooks
Delaware Tribe of Indians
170 NE Barbara
Bartlesville, OK 74006

**Reference: Consultation with Tribes for the Lake Lynn Hydroelectric Project No. 2459**

Dear Chief Brooks,

The Federal Energy Regulatory Commission (Commission) invites your participation in the relicensing process for the existing Lake Lynn Hydroelectric Project No. 2459 (Lake Lynn Project). The Commission's relicensing process is an opportunity for both the licensee and interested agencies, tribes, and other stakeholders to consider the project's existing operation and protection, mitigation, and enhancement measures, and evaluate the need for any changes or additional measures to be implemented over the term of any new license issued for the project. The 51.2-megawatt Lake Lynn Project is located on the Cheat River in Monongalia County, West Virginia, and Fayette County, Pennsylvania. We anticipate that Lake Lynn Generation, LLC (Lake Lynn Generation), the licensee for the project, will file a notice of intent and Pre-Application Document by November 30, 2019, to initiate the pre-filing process, and file an application for a new license by November 30, 2022.

It is very important that a tribe whose interests could be affected by the relicensing of the existing Lake Lynn Project participate early in the process so that tribal issues are addressed. For this reason, please inform us if you have an interest in participating in the relicensing process for the project.

In addition, please indicate if you would like to meet with Commission staff to discuss the Commission's licensing process, how your Tribe can participate to the fullest extent possible, your interests and concerns in the affected area, and how to establish procedures to ensure appropriate communication between Commission and tribal staffs.

The meeting can be limited to Commission and your Tribal staff, or can be open to other tribes[1] or Lake Lynn Generation.

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If you have any questions or comments, please contact Emily Carter at (202) 502-6512 or Emily.Carter@ferc.gov. Ms. Carter will contact you shortly to follow-up on this letter.

Sincerely,

John B. Smith, Chief
Mid-Atlantic Branch
Division of Hydropower Licensing

cc:

Dr. Brice Obermeyer, Historic Preservation
Delaware Tribe of Indians
*Via email*

Harold Peterson
Bureau of Indian Affairs - Eastern Region
545 Marriott Drive, Suite 700
Nashville, TN 37214

---

[1] Commission staff is also inviting the Delaware Nation and the Osage Nation to participate in the relicensing process.

Document Content(s)

FEDERAL ENERGY REGULATORY COMMISSION
WASHINGTON D.C. 20426
(June 27, 2019)

OFFICE OF ENERGY PROJECTS

Project No. 2459-000
Lake Lynn Hydroelectric Project
Lake Lynn Generation, LLC

Chief Geoffrey Standing Bear
Osage Nation
627 Grandview Ave.
Pawhuska, OK 74056

**Reference: Consultation with Tribes for the Lake Lynn Hydroelectric Project No. 2459**

Dear Chief Standing Bear,

The Federal Energy Regulatory Commission (Commission) invites your participation in the relicensing process for the existing Lake Lynn Hydroelectric Project No. 2459 (Lake Lynn Project). The Commission's relicensing process is an opportunity for both the licensee and interested agencies, tribes, and other stakeholders to consider the project's existing operation and protection, mitigation, and enhancement measures, and evaluate the need for any changes or additional measures to be implemented over the term of any new license issued for the project. The 51.2-megawatt Lake Lynn Project is located on the Cheat River in Monongalia County, West Virginia, and Fayette County, Pennsylvania. We anticipate that Lake Lynn Generation, LLC (Lake Lynn Generation), the licensee for the project, will file a notice of intent and Pre-Application Document by November 30, 2019, to initiate the pre-filing process, and file an application for a new license by November 30, 2022.

It is very important that a tribe whose interests could be affected by the relicensing of the existing Lake Lynn Project participate early in the process so that tribal issues are addressed. For this reason, please inform us if you have an interest in participating in the relicensing process for the project.

In addition, please indicate if you would like to meet with Commission staff to discuss the Commission's licensing process, how your Tribe can participate to the fullest extent possible, your interests and concerns in the affected area, and how to establish procedures to ensure appropriate communication between Commission and tribal staffs.

The meeting can be limited to Commission and your Tribal staff, or can be open to other tribes[1] or Lake Lynn Generation.

**If at all possible, we would appreciate your response by August 02, 2019.** The Commission strongly encourages electronic filing. Please file your response using the Commission's eFiling system at http://www.ferc.gov/docs-filing/efiling.asp. Commenters can submit brief comments up to 6,000 characters, without prior registration, using the eComment system at http://www.ferc.gov/docs-filing/ecomment.asp. You must include your name and contact information at the end of your comments. For assistance, please contact FERC Online Support at FERCOnlineSupport@ferc.gov, (866) 208-3676 (toll free), or (202) 502-8659 (TTY). In lieu of electronic filing, please send a paper copy to: Secretary, Federal Energy Regulatory Commission, 888 First Street NE, Washington, DC 20426. The first page of any filing should include docket number **P-2459-000**.

If you have any questions or comments, please contact Emily Carter at (202) 502-6512 or Emily.Carter@ferc.gov. Ms. Carter will contact you shortly to follow-up on this letter.

Sincerely,

John B. Smith, Chief
Mid-Atlantic Branch
Division of Hydropower Licensing

cc:

Dr. Andrea Hunter, THPO
Osage Nation Historic Preservation Office
*Via email*

Harold Peterson
Bureau of Indian Affairs - Eastern Region
545 Marriott Drive, Suite 700
Nashville, TN 37214

[1] Commission staff is also inviting the Delaware Nation and the Delaware Tribe of Indians to participate in the relicensing process.

Document Content(s)

| | |
|---|---|
| **From:** | Braun, Olivia |
| **To:** | Foster, Joyce |
| **Cc:** | Jody Smet |
| **Subject:** | RE: [External] RE: Lake Lynn Generation, LLC - Relicensing of the Lake Lynn Hydroelectric Project |
| **Date:** | Tuesday, July 02, 2019 7:59:47 AM |
| **Attachments:** | image001.png |

Hi Joyce,

Thanks so much for this information – it was very helpful. At this time, given that no activities are proposed the PGC does not have any information to provide for inclusion in the Pre-Application Document. However, the PGC would suggest that if/when projects are identified for completion within the Pennsylvania portions of the project area that a Pennsylvania Natural Heritage Inventory (PNDI) search be completed to ensure that coordination with the PGC (or other jurisdictional agencies as necessary) could be identified and initiated as early as possible.

To initiate a PNDI review, please visit www.naturalheritage.state.pa.us and click on the "Conservation Explorer" link on the bottom left hand side of the page. Upon completion, a receipt will be generated which will summarize search result each of the four jurisdictional agencies. If the Search Results section states that "Further Review is Required" for the PGC, then please refer to the "What to Send to Jurisdictional Agency" section of the receipt for a "Check-list of Minimum Materials" that should be submitted to the PGC.

The PGC appreciates the opportunity to provide comments at this early stage of the relicensing process. If you have any questions, please feel free to contact me.

Best,

**Olivia A. Braun**
Environmental Planner
Environmental Planning & Habitat Protection Division
Bureau of Wildlife Habitat Management
Pennsylvania Game Commission
2001 Elmerton Avenue
Harrisburg, PA 17110
Phone: 717-787-4250, Ext. 3128
olbraun@pa.gov

---

**From:** Foster, Joyce <JFoster@trccompanies.com>
**Sent:** Thursday, June 27, 2019 11:20 AM
**To:** Braun, Olivia <olbraun@pa.gov>
**Cc:** Jody Smet <jsmet@cubehydro.com>
**Subject:** [External] RE: Lake Lynn Generation, LLC - Relicensing of the Lake Lynn Hydroelectric Project

Good morning,

Attached is a figure that shows the Project boundary and Project area for the Lake Lynn Hydroelectric Project. Please let us know if you need anything else or have any questions. Since this request is for information or data you would like to see included in the Pre-application Document, at this time the Licensee is not proposing any changes or improvements at the Project.

Thank you,

**Joyce Foster**
Planner

TRC
179 Clarks Lane, Aylett, VA 23009
**T** 804.769.1667 | **C** 804.338.5110
LinkedIn | Twitter | Blog | TRCcompanies.com

**Please note that our domain name and email addresses have changed**

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**From:** Braun, Olivia [mailto:olbraun@pa.gov]
**Sent:** Wednesday, June 26, 2019 8:44 AM
**To:** Foster, Joyce <JFoster@trccompanies.com>
**Subject:** Lake Lynn Generation, LLC - Relicensing of the Lake Lynn Hydroelectric Project

Good Morning Joyce,
The PGC is in receipt of your letter dated May 20, 2019 and would like to request some additional information about the project so that we may provide information for your pre-application document. At your earliest convenience, please provide the PGC with project mapping that clearly illustrates the location and boundary of the project area as well as any proposed improvements that may be proposed as part of the relicensing efforts. Once we receive this information, we will be in a better position to reply to you letter.

Many thanks and please feel free to contact me with any questions,

**Olivia A. Braun**
Environmental Planner
Environmental Planning & Habitat Protection Division
Bureau of Wildlife Habitat Management
Pennsylvania Game Commission
2001 Elmerton Avenue
Harrisburg, PA 17110
Phone: 717-787-4250, Ext. 3128
olbraun@pa.gov

# Foster, Joyce

**From:** Jody Smet <jsmet@cubehydro.com>
**Sent:** Monday, July 08, 2019 3:25 PM
**To:** Foster, Joyce
**Subject:** FW: Information request: Lake Lynn

Jody J. Smet, AICP
Director, FERC Licensing and Compliance
(O) 804-739-0654



(C) 804-382-1764
jsmet@cubehydro.com (Please note new email address)

CUBE HYDRO CAROLINAS

**From:** Harrell, Jacob D <Jacob.D.Harrell@wv.gov>
**Sent:** Monday, July 8, 2019 2:55 PM
**To:** Jody Smet <jsmet@cubehydro.com>
**Subject:** RE: Information request: Lake Lynn



Jody,

We have a lot of experience with the ILP. No experience with the ALP, but in reviewing projects in other states that have employed this process, we do like the emphasis the ALP



has on developing solutions and building those open-channel relationships between licensees and stakeholders. That collaborative nature seems to resolve conflicts much more amicably than other processes. At least, that is how it appears. For the ILP, we really like the defined structural components which does make it fairly easy for us to know what to expect and what to plan for. FERC's involvement through the ILP can be nice, as well. We find that the TLP works just as well as the ILP, but I feel that disputes and disagreements tend to take a little longer than they should to resolve and so sometimes things get drawn out, at least that is our experience with a few of the projects that had elected to go this route. This is not to say that this project would have a lot of disputes or disagreements that would slow down the relicensing process, but it may be something to think about. Ultimately, I don't know what the best route would be in this situation, but the WVDNR wouldn't be opposed to either one. The end result is always the same, the only difference is the path used to get there. I feel that Cube Hydro does a fairly well job at working with the resource agencies and hopefully this relationship can be maintained throughout the relicensing process.

---

**From:** Jody Smet <jsmet@cubehydro.com>
**Sent:** Monday, July 08, 2019 2:07 PM
**To:** Harrell, Jacob D <Jacob.D.Harrell@wv.gov>
**Subject:** RE: Information request: Lake Lynn

Okay, I'm curious about your preference for the ILP or ALP? Just more experience with it, or do you feel it offers benefits over the ILP?

I appreciate your support either way.



Jody J. Smet, AICP
Director, FERC Licensing and Compliance
(O) 804-739-0654
(C) 804-382-1764
jsmet@cubehydro.com (Please note new email address)

CUBE HYDRO
CAROLINAS

**From:** Harrell, Jacob D <Jacob.D.Harrell@wv.gov>
**Sent:** Monday, July 8, 2019 2:04 PM
**To:** Jody Smet <jsmet@cubehydro.com>
**Subject:** RE: Information request: Lake Lynn

CAUTION: This email originated from outside your organization. Exercise caution when opening attachments or clicking links, especially from unknown senders.

Jody,



The WVDNR would prefer that the ILP or ALP be used, but is perfectly comfortable with the TLP. If you guys want to go the TLP route, then we wouldn't object.

Thanks,

Jacob Harrell

---

**From:** Jody Smet <jsmet@cubehydro.com>
**Sent:** Wednesday, July 03, 2019 4:30 PM
**To:** Harrell, Jacob D <Jacob.D.Harrell@wv.gov>
**Subject:** RE: Information request: Lake Lynn

Jacob,

A question for you – does WVDNR have any concerns about the relicensing process proposal – Traditional Licensing Process?

Jody J. Smet, AICP
Director, FERC Licensing and Compliance
(O) 804-739-0654
(C) 804-382-1764
jsmet@cubehydro.com (Please note new email address)

CUBE HYDRO
CAROLINAS





---

**From:** Harrell, Jacob D <Jacob.D.Harrell@wv.gov>
**Sent:** Wednesday, June 19, 2019 2:57 PM
**To:** Jody Smet <jsmet@cubehydro.com>
**Subject:** Information request: Lake Lynn

Jody,

Just for clarification purposes on our end, regarding the information request for the Lake Lynn Hydroelectric Project, this request is for information from WVDNR to use in informing the NOI/PAD, correct? There may be some confusion here that the request is for studies that we might request for the relicensing, though I think that would come after the PAD has been submitted and following the first scoping meeting. I want to make sure I have this correct.

Thanks,

Jacob Harrell

Coordination Unit



WVDNR – Wildlife Resources Section
1110 Railroad Street
Farmington, WV 26571
(304)704-9328
Jacob.D.Harrell@wv.gov

## Foster, Joyce

**From:** Foster, Joyce
**Sent:** Tuesday, July 09, 2019 12:17 PM
**To:** Norman, Janet
**Cc:** Jody Smet
**Subject:** FW: [EXTERNAL] Lake Lynn Project (FERC No. 2459) - Ipac consultation
**Attachments:** Lake_Lynn_Project_Boundary_revised 6-24-2019.zip

Janet,



I am following up to make sure you were able to open the attached Shapefile and that it was what you needed. Please let us know if you need anything else.

Thanks,

**Joyce Foster**
Planner

179 Clarks Lane, Aylett, VA 23009
**T** 804.769.1667 | **C** 804.338.5110
LinkedIn | Twitter | Blog | TRCcompanies.com

**Please note that our domain name and email addresses have changed**

**From:** Foster, Joyce
**Sent:** Tuesday, June 25, 2019 8:14 AM
**To:** Norman, Janet <janet_norman@fws.gov>
**Cc:** Jody Smet <jsmet@cubehydro.com>
**Subject:** RE: [EXTERNAL] Lake Lynn Project (FERC No. 2459) - Ipac consultation

Janet,

As follow-up to our communication last week, attached is the corrected Shapefile that we used to re-run the IPaC unofficial review for the Lake Lynn Project (FERC No. 2459. Please let us know if you have any questions or issues with the attachment.



Thanks,

**Joyce Foster**
Planner

179 Clarks Lane, Aylett, VA 23009
**T** 804.769.1667 | **C** 804.338.5110
LinkedIn | Twitter | Blog | TRCcompanies.com

**Please note that our domain name and email addresses have changed**

**From:** Norman, Janet [mailto:janet_norman@fws.gov]
**Sent:** Thursday, June 20, 2019 11:18 AM
**To:** Foster, Joyce <JFoster@trccompanies.com>
**Cc:** Jody Smet <jsmet@cubehydro.com>
**Subject:** Re: [EXTERNAL] Lake Lynn Project (FERC No. 2459) - Ipac consultation done

Terrific, thank you Joyce.

I appreciate the follow up information.

Janet

On Thu, Jun 20, 2019 at 8:48 AM Foster, Joyce <JFoster@trccompanies.com> wrote:



> Janet,
>
> As follow-up to our conversation related to the Lake Lynn Project FERC relicensing, I will send you the Shapefile for the Project that we used for the IPaC unofficial resource/species list as soon as it is available, hopefully later today. Our GIS staff is currently correcting an error in the Project area polygon and we will rerun the IPaC unofficial review using this corrected Shapefile.
>
> As we discussed, I am also sending you the contact information for Jody Smet, the Project Licensee:

Jody J. Smet, AICP

Director, FERC Licensing and Compliance

(O) 804-739-0654

(C) 804-382-1764

jsmet@cubehydro.com

7

As I mentioned, I am the consultant assisting with the relicensing process.  My contact information is below:

Joyce Foster

TRC

804-769-1667 (office)

804-338-5110 (cell)

jfoster@trccompanies.com

8

We are looking forward to working with you.

**Joyce Foster**
Planner

179 Clarks Lane, Aylett, VA 23009

**T** 804.769.1667 | **C** 804.338.5110

LinkedIn | Twitter | Blog | TRCcompanies.com



**Please note that our domain name and email addresses have changed**

Begin forwarded message:

**From:** "Norman, Janet" <janet_norman@fws.gov>
**Date:** June 19, 2019 at 6:06:25 PM GMT+2
**To:** <jsmet@cubehydro.com>
**Subject: Ipac consultation done?**

CAUTION: This email originated from outside your organization. Exercise caution when opening attachments or clicking links, especially from unknown senders.

Hi Jody,

I don't have your phone number, and was hoping to talk to you regarding the Lake Lynn re-licensing information search. Wanted to go over some of the specifics of the Ipac process, if we can?

Here is my phone, below, and I will be back in the office by 1pmish.

Thanks.



Janet

--

Janet Norman

Biologist

U.S. Fish and Wildlife Service

Chesapeake Bay Field Office

177 Admiral Cochrane Dr.

Annapolis, MD 21401

Office:  410-573-4533

Fax:  410-269-0832

Janet_Norman@fws.gov

www.fws.gov/chesapeakebay



--
Janet Norman
Biologist
U.S. Fish and Wildlife Service
Chesapeake Bay Field Office
177 Admiral Cochrane Dr.
Annapolis, MD 21401
Office:  410-573-4533
Fax:  410-269-0832
Janet_Norman@fws.gov

www.fws.gov/chesapeakebay

**Foster, Joyce**

**From:** Blair, Michelle A.
**Sent:** Wednesday, July 10, 2019 11:29 AM
**To:** Foster, Joyce
**Subject:** Fwd: Information Request for the Pre-Application Document for Relicensing of the Lake Lynn Hydroelectric Project (FERC No. 2459)
**Attachments:** MISC-PA and WV-0619-002.pdf

Get Outlook for iOS



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**From:** Erin Thompson <ethompson@delawarenation-nsn.gov>
**Sent:** Wednesday, July 10, 2019 11:26:53 AM
**To:** Blair, Michelle A.
**Subject:** RE: Information Request for the Pre-Application Document for Relicensing of the Lake Lynn Hydroelectric Project (FERC No. 2459)

Please see attached consultation letter.

Thank you,
Erin

Erin Thompson

Delaware Nation Historic Preservation Director
31064 SH 281
P.O. Box 825
Anadarko, OK 73005
405-247-2448 ex. 1403
ethompson@delawarenation-nsn.gov

---

**From:** Dana Kelly <dkelly@delawarenation-nsn.gov>
**Sent:** Wednesday, June 19, 2019 2:46 PM
**To:** Erin Thompson <ethompson@delawarenation-nsn.gov>
**Subject:** FW: Information Request for the Pre-Application Document for Relicensing of the Lake Lynn Hydroelectric Project (FERC No. 2459)



Dana Kelly
Historic Preservation
106/ Archive Assistant
Delaware Nation
31064 S HWY 281
P.O. Box 825
Anadarko, OK 73005
Phone: 405-247-2448 ext. 1407
Email: dkelly@delawarenation-nsn.gov

**From:** Blair, Michelle A. <mblair@trccompanies.com>
**Sent:** Monday, May 20, 2019 2:06 PM
**To:** Absentee-Shawnee Tribe of Oklahoma <106NAGPRA@astribe.com>; Amanda Pitzer <amanda@cheat.org>; Anita Carter <greystone.poa@hotmail.com>; Betty Wiley <betty.w304@gmail.com>; Bob Irvin <birvin@americanrivers.org>; Bonney Hartley <bonney.hartley@mohican-nsn.gov>; Brett Barnes <bbarnes@estoo.net>; Brian Bridgewater <Brian.L.Bridgewater@wv.gov>; Brice Obermeyer <bobermeyer@delawaretribe.org>; Bryan Printup <bprintup@hetf.org>; Cassie Harper <cassie@shawnee-tribe.com>; Clint Halftown <clint.halftown@gmail.com>; Colleen McNally-Murphy <colleen@hydroreform.org>; Coopers Rock State Forest <coopersrocksf@wv.gov>; Cosmo Servidio <cosmo.servidio@epa.gov>; Curtis Schreffler <clschref@usgs.gov>; Dana Kelly <dkelly@delawarenation.com>; Danny Bennett <Danny.A.Bennett@wv.gov>; Darren Bonaparte <darren.bonaparte@srmt-nsn.gov>; David



Wellman <David.I.Wellman@wv.gov>; e c <ec@delawarenation.com>; Delaware Tribe of Indians <cbrooks@delawaretribe.org>; Duane Nichols <duane330@aol.com>; Eastern Shawnee Tribe of Oklahoma <estochief@hotmail.com>; Edgewater Marina <edgewater@cheatlakedocks.com>; Ella Belling <ella@montrails.org>; Heather Smiles <hsmiles@pa.gov>; Jacob Harrell <Jacob.D.Harrell@wv.gov>; Jay Toth <jay.toth@sni.org>; Jesse Bergevin <jbergevin@oneida-nation.org>; John Spain <john.spain@ferc.gov>; Kevin Colburn <kevin@americanwhitewater.org>; Kevin Mendik <Kevin_Mendik@nps.gov>; Laura Misita <lmisita@oneida-nation.org>; Megan Gottlieb <Megan.K.Gottlieb@usace.army.mil>; Mike Strager <mstrager@gmail.com>; Oneida Indian Nation <info@oneida-nation.org>; Oneida Tribe of Indians of Wisconsin <cwilliam@oneidanation.org>; Onondaga Nation <admin@onondaganation.org>; Rennetta McClure <rmcclure@moncommission.com>; Richard McCorkle <richard_mccorkle@fws.gov>; Sean P McDermott <Sean.McDermott@noaa.gov>; Shannon Holsey <shannon.holsey@mohican-nsn.gov>;

Shaun Wicklein <smwickle@usgs.gov>; Steve Moyer <steve_moyer@tu.org>; Steve Moyer (smoyer@tu.org) <smoyer@tu.org>; Stuart Welsh <swelsh@wvu.edu>; Sunset Beach Marina <info@sunsetbeach-marina.com>; Susan Bachor <sbachor@delawaretribe.org>; Susan Pierce <susan.m.pierce@wv.gov>; Tonawanda Band of Seneca <tonseneca@aol.com>; Tonya Tipton <tonya@shawnee-tribe.com>; Vincent Vicites <vvicites@fayettepa.org>; William Fisher <wfisher@sctribe.com>; William Tarrant <wtarrant@sctribe.com>
**Cc:** jsmet@cubehydro.com; Foster, Joyce <JFoster@trccompanies.com>
**Subject:** Information Request for the Pre-Application Document for Relicensing of the Lake Lynn Hydroelectric Project (FERC No. 2459)

Good afternoon-



Attached is an Information Request for the Pre-Application Document for the FERC relicensing of the Lake Lynn Hydroelectric Project (FERC No. 2459).

Please provide your comments within 30 days of this letter. If you have any questions regarding this request please contact Jody Smet at jsmet@cubehydro.com or Joyce Foster at jfoster@trccompanies.com.

Thank you,
Michelle

**Michelle Blair**
Project Coordinator

14 Gabriel Drive, Augusta, ME 04330
**T** 207.620.3845 | **F** 207.621.8226 | mblair@trccompanies.com
LinkedIn | Twitter | Blog | TRCcompanies.com







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*The Delaware Nation*
**Historic Preservation Department**
31064 State Highway 281
Anadarko, OK 73005
Phone (405)247-2448

July 10, 2019

To Whom It May Concern:

The Delaware Nation Historic Preservation Department received correspondence regarding the following referenced project(s).

**Project:** Relicensing of the Lake Lynn Hydroelectric Project (FERC No. 2459)

Our office is committed to protecting tribal heritage, culture and religion with particular concern for archaeological sites potentially containing burials and associated funerary objects.

The Lenape people occupied the area indicated in your letter during prior to European contact until their eventual removal to our present locations. According to our files, the location of the proposed project does not endanger cultural, or religious sites of interest to the Delaware Nation. **Please continue with the project as planned** keeping in mind during construction should an archaeological site or artifacts inadvertently be uncovered, all construction and ground disturbing activities should immediately be halted until the appropriate state agencies, as well as this office, are notified (within 24 hours), and a proper archaeological assessment can be made.

Please note the Delaware Nation, the Delaware Tribe of Indians, and the Stockbridge Munsee Band of Mohican Indians are the only Federally Recognized Delaware/Lenape entities in the United States and consultation must be made only with designated staff of these three tribes. We appreciate your cooperation in contacting the Delaware Nation Cultural Preservation Office to conduct proper Section 106 consultation. Should you have any questions, feel free to contact our offices at 405-247-2448 ext. 1403.

Erin N. Thompson

Erin Thompson
Director of Historic Preservation
Delaware Nation
31064 State Highway 281
Anadarko, OK 73005
Ph. 405-247-2448 ext. 1403
ethompson@delawarenation-nsn.gov

## Joyce Foster

**From:** Jody Smet <jsmet@cubehydro.com>
**Sent:** Thursday, October 24, 2019 4:09 PM
**To:** Foster, Joyce
**Subject:** [EXTERNAL] Fwd: Lake Lynn Hydro Project (FERC No. 2459) – FERC Relicensing Update and Doodle poll for Joint Meeting/Site Visit

**Follow Up Flag:** Follow up
**Flag Status:** Completed



Begin forwarded message:

**From:** Bonney Hartley <bonney.hartley@mohican-nsn.gov>
**Date:** October 24, 2019 at 10:16:48 AM EDT
**To:** Jody Smet <jsmet@cubehydro.com>
**Subject: RE: Lake Lynn Hydro Project (FERC No. 2459) – FERC Relicensing Update and Doodle poll for Joint Meeting/Site Visit**



Hello,
Stockbridge Munsee Community does not wish to participate as this project is not located in our area of cultural interest.
Best,
Bonney

*Bonney Hartley*
Tribal Historic Preservation Manager
Stockbridge-Munsee Mohican Tribal Historic Preservation
Extension office
65 1st Street
Troy, NY 12180
(518) 244-3164
Bonney.Hartley@mohican-nsn.gov
www.mohican-nsn.gov

**From:** Jody Smet <jsmet@cubehydro.com>
**Sent:** Wednesday, October 23, 2019 8:02 PM
**To:** Absentee-Shawnee Tribe of Oklahoma <106NAGPRA@astribe.com>; Amanda Pitzer <amanda@cheat.org>; Andy Bernick <andrew.bernick@ferc.gov>; Anita Carter <greystone.poa@hotmail.com>; Betty Wiley <betty.w304@gmail.com>; Bob Irvin <birvin@americanrivers.org>; Bonney Hartley <Bonney.Hartley@mohican-nsn.gov>; Brett Barnes <bbarnes@estoo.net>; Brian Bridgewater <Brian.L.Bridgewater@wv.gov>; Brice Obermeyer <bobermeyer@delawaretribe.org>; Bryan Printup <bprintup@hetf.org>; Cassie Harper <cassie@shawnee-tribe.com>; Cheryl Nagle <chnagle@pa.gov>; Clint Halftown <clint.halftown@gmail.com>; Colleen McNally-Murphy <colleen@hydroreform.org>; Coopers Rock State Forest <coopersrocksf@wv.gov>; Curtis Schreffler <clschref@usgs.gov>; Dana Kelly <dkelly@delawarenation.com>; Daniel Miller <DMiller@potesta.com>; Danny Bennett <Danny.A.Bennett@wv.gov>; Darren Bonaparte <darren.bonaparte@srmt-nsn.gov>; David Wellman <David.I.Wellman@wv.gov>; Delaware Nation, Oklahoma <ec@delawarenation.com>; Delaware Tribe of Indians <cbrooks@delawaretribe.org>; Duane Nichols <duane330@aol.com>; Edgewater Marina <edgewater@cheatlakedocks.com>; Ella Belling <ella@montrails.org>; Erin Thompson <ethompson@delawarenation-nsn.gov>; Garrett Thompson <gthompson@cheat.org>; Heather Smiles <hsmiles@pa.gov>; Jacob Harrell <Jacob.D.Harrell@wv.gov>; Janet Norman <Janet_Norman@fws.gov>; Jay Toth <jay.toth@sni.org>; Jesse Bergevin <jbergevin@oneida-nation.org>; John Spain <john.spain@ferc.gov>; Kevin Colburn <kevin@americanwhitewater.org>; Kevin Mendik <Kevin_Mendik@nps.gov>; Laura Misita <lmisita@oneida-nation.org>; Megan Gottlieb <Megan.K.Gottlieb@usace.army.mil>; Mike Strager <mstrager@gmail.com>; Olivia Braun <olbraun@pa.gov>; Oneida Indian Nation <info@oneida-nation.org>; Onondaga Nation <admin@onondaganation.org>; Rennetta McClure <rmcclure@moncommission.com>; Scott Williamson <scwilliams@pa.gov>; Sean P McDermott <Sean.McDermott@noaa.gov>; Shannon Holsey <Shannon.Holsey@mohican-nsn.gov>; Shaun Wicklein <smwickle@usgs.gov>; Steve Moyer <smoyer@tu.org>; Stratford Douglas <stratdouglas@gmail.com>; Stuart Welsh <swelsh@wvu.edu>; Susan Bachor <sbachor@delawaretribe.org>; Susan Pierce <susan.m.pierce@wv.gov>; Tonawanda Band of Seneca <tonseneca@aol.com>; Tonya Tipton <tonya@shawnee-tribe.com>; Vincent Vicites <vvicites@fayettepa.org>; William Fisher <wfisher@sctribe.com>; William Tarrant <wtarrant@sctribe.com>; Sunsetoutdoorsupply@gmail.com; Daniel Miller <DMiller@potesta.com>
**Subject:** RE: Lake Lynn Hydro Project (FERC No. 2459) – FERC Relicensing Update and Doodle poll for Joint Meeting/Site Visit

All, just a reminder to participate in the Doodle poll by Friday.

Thanks,

Jody J. Smet, AICP
Director, FERC Licensing and Compliance
(O) 804-739-0654
(C) 804-382-1764
jsmet@cubehydro.com (Please note new email address)

CUBE HYDRO
CAROLINAS

**From:** Jody Smet
**Sent:** Friday, October 18, 2019 2:27 PM
**To:** Absentee-Shawnee Tribe of Oklahoma <106NAGPRA@astribe.com>; Amanda Pitzer <amanda@cheat.org>; Andy Bernick <andrew.bernick@ferc.gov>; Anita Carter <greystone.poa@hotmail.com>; Betty Wiley <betty.w304@gmail.com>; Bob Irvin <birvin@americanrivers.org>; Bonney Hartley <bonney.hartley@mohican-nsn.gov>; Brett Barnes <bbarnes@estoo.net>; Brian Bridgewater <Brian.L.Bridgewater@wv.gov>; Brice Obermeyer <bobermeyer@delawaretribe.org>; Bryan Printup <bprintup@hetf.org>; Cassie Harper <cassie@shawnee-tribe.com>; Cheryl Nagle <chnagle@pa.gov>; Clint Halftown <clint.halftown@gmail.com>; Colleen McNally-Murphy <colleen@hydroreform.org>; Coopers Rock State Forest <coopersrocksf@wv.gov>; Curtis Schreffler <clschref@usgs.gov>; Dana Kelly <dkelly@delawarenation.com>; Daniel Miller <DMiller@potesta.com>; Danny Bennett <Danny.A.Bennett@wv.gov>; Darren Bonaparte <darren.bonaparte@srmt-nsn.gov>; David Wellman <David.I.Wellman@wv.gov>; Delaware Nation, Oklahoma <ec@delawarenation.com>; Delaware Tribe of Indians <cbrooks@delawaretribe.org>; Duane Nichols <duane330@aol.com>; Edgewater Marina <edgewater@cheatlakedocks.com>; Ella Belling <ella@montrails.org>; Erin Thompson <ethompson@delawarenation-nsn.gov>; Garrett Thompson <gthompson@cheat.org>; Heather Smiles <hsmiles@pa.gov>; Jacob Harrell <Jacob.D.Harrell@wv.gov>; Janet Norman <Janet_Norman@fws.gov>; Jay Toth <jay.toth@sni.org>; Jesse Bergevin <jbergevin@oneida-nation.org>; John Spain <john.spain@ferc.gov>; Kevin Colburn <kevin@americanwhitewater.org>; Kevin Mendik <Kevin_Mendik@nps.gov>; Laura Misita <lmisita@oneida-nation.org>; Megan Gottlieb <Megan.K.Gottlieb@usace.army.mil>; Mike Strager <mstrager@gmail.com>; Olivia Braun <olbraun@pa.gov>; Oneida Indian Nation <info@oneida-nation.org>; Onondaga Nation <admin@onondaganation.org>; Rennetta McClure <rmcclure@moncommission.com>; Scott Williamson <scwilliams@pa.gov>; Sean P McDermott <Sean.McDermott@noaa.gov>; Shannon Holsey <shannon.holsey@mohican-nsn.gov>; Shaun Wicklein <smwickle@usgs.gov>; Steve Moyer <smoyer@tu.org>; Stratford Douglas <stratdouglas@gmail.com>; Stuart Welsh <swelsh@wvu.edu>; Susan Bachor <sbachor@delawaretribe.org>; Susan Pierce <susan.m.pierce@wv.gov>; Tonawanda Band of Seneca <tonseneca@aol.com>; Tonya Tipton <tonya@shawnee-tribe.com>; Vincent Vicites <vvicites@fayettepa.org>; William Fisher <wfisher@sctribe.com>; William Tarrant <wtarrant@sctribe.com>; Sunsetoutdoorsupply@gmail.com; Daniel Miller <DMiller@potesta.com>
**Subject:** Lake Lynn Hydro Project (FERC No. 2459) – FERC Relicensing Update and Doodle poll for Joint Meeting/Site Visit
**Importance:** High

Lake Lynn Hydro Project Stakeholders,

On August 29, 2019, Lake Lynn Generation, LLC (Lake Lynn) filed with the Federal Energy Regulatory Commission (FERC) a Notification of Intent (NOI) and Pre-Application Document (PAD) for the relicensing of the Lake Lynn Hydroelectric Project (FERC No. 2459) (Project), located near the City of Morgantown, West Virginia, in Monongalia County, West Virginia and Fayette County, Pennsylvania. Lake Lynn also requested approval from FERC to use the Traditional Licensing Process (TLP) for the Project relicensing. On October 17, 2019, FERC provided notice of Lake Lynn's filing and approved the use of the TLP (see attached documents). In accordance with FERC's regulations, Lake Lynn must hold a Joint Agency/Public Meeting and Site Visit for the Project no sooner than 30 days, but no later than 60 days, from FERC's letter dated October 17, 2019 (i.e., between November 16, 2019 and December 16, 2019). The purpose of the Joint Agency/Public Meeting is to provide an overview of the Project, discuss the licensing process and schedule, and receive input from stakeholders and interested parties.

To assist us in scheduling the Joint Agency/Public Meeting and Site Visit at the Project, we have developed a Doodle poll. **Please respond with your availability by noon on Friday, October 25, 2019, to the Doodle poll at the following link: https://doodle.com/poll/zccu84iaf8mgsq6k**. We will schedule the Joint Agency/Public Meeting and Site Visit based on the date that works for the majority and the availability of the meeting space.

Thank you,


Jody J. Smet, AICP
Director, FERC Licensing and Compliance
(O) 804-739-0654
(C) 804-382-1764
jsmet@cubehydro.com (Please note new email address)


CUBE HYDRO
CAROLINAS

Lake Lynn Generation, LLC
Two Bethesda Metro Center, Suite 1330
Bethesda, MD 20814

**Via eFiling**

November 21, 2019

Kimberly D. Bose, Secretary
Federal Energy Regulatory Commission
888 First Street, N.E.
Washington, D.C. 20426

Re: Lake Lynn Hydroelectric Project (FERC No. 2459)
Notice of Joint Meeting and Site Visit

Dear Secretary Bose,

On August 29, 2018, Lake Lynn Generation, LLC (Lake Lynn) filed with the Federal Energy Regulatory Commission (FERC or Commission) a Notice of Intent to File a License Application (NOI), Pre-Application Document (PAD), and Request to Use the Traditional Licensing Process (TLP) for the relicensing of the Lake Lynn Hydroelectric Project (FERC No. 2459) (Project). By letter order dated October 17, 2019, FERC granted Lake Lynn's request to use the TLP.

Lake Lynn hereby provides written notice to FERC and the Distribution List for the Project of its upcoming Joint Meeting and Site Visit to be conducted in accordance with the requirements of 18 CFR § 16.8 (b)(3)(ii) for the relicensing of the Project. The Joint Meeting and Site Visit are open to the interested public, agencies, and Native American Tribes. The Joint Meeting will be held at 10:00 a.m. on Thursday, December 12, 2019, at the Cheat Lake Volunteer Fire Department located at 409 Fairchance Road, Morgantown, West Virginia 26508. The Site Visit will commence at 1:30 p.m. at Sunset Beach Marina located at 177 Sunset Beach Road, Morgantown, West Virginia 26508. An agenda for the Joint Meeting and Site Visit is attached.

The purpose of the Joint Meeting is to provide an overview of the Project and the information provided in the PAD filed with the Commission on August 29, 2019; discuss the licensing process and schedule; discuss any necessary studies to be conducted by Lake Lynn to support its license application; and receive input and feedback regarding the information presented. All interested parties are invited to attend the Joint Meeting to assist in identifying and clarifying the scope of issues to be addressed during this phase of the relicensing process.

In accordance with the requirements of 18 C.F.R. § 16.8(i), at least 14 days in advance of the Joint Meeting, Lake Lynn will publish notice of the Joint Meeting and Site Visit in *The Herald-Standard* (a daily newspaper of general circulation in Fayette County, Pennsylvania) and *The Dominion Post* (a daily newspaper of general circulation in Monongalia County, West Virginia).

Please do not hesitate to contact me at (804) 739-0654 or by email at jsmet@cubehydro.com if you have any questions concerning this filing, the Joint Meeting, or Site Visit. **Please note that attendees MUST RSVP participation at jsmet@cubehydro.com or 804-739-0654 no later than November 29, 2019.**

Sincerely,
**Lake Lynn Generation, LLC**

Jody Smet
Director, FERC Licensing and Compliance

cc: Joyce Foster, TRC
Distribution List

**Agenda for Joint Meeting and Site Visit**
**Lake Lynn Generation, LLC**
**Lake Lynn Hydroelectric Project (FERC No. 2459)**

**December 12, 2019**

**10:00 a.m. – 12:30 p.m.**

**Joint Meeting:** Morgantown, West Virginia
**Location:** Cheat Lake Volunteer Fire Department located at 409 Fairchance Road, Morgantown, West Virginia 26508

**12:30 p.m. – 1:30 p.m.**

**Lunch Break**

**1:30 p.m. – 4:30 p.m.**

**Site Visit:** Lake Lynn Project
**Location:** Meet at 1:30 p.m. at Sunset Beach Marina located at 177 Sunset Beach Road, Morgantown, West Virginia 26508

**Lake Lynn Generation, LLC**
**Lake Lynn Project (P-2459)**
**Distribution List (updated November 21, 2019)**

**ELECTED OFFICIALS**

Governor Jim Justice
West Virginia Office of the Governor
State Capitol
1900 Kanawha Blvd. E
Charleston, WV 25305

Patrick Morrisey
West Virginia Office of the Attorney General
State Capitol Complex, Bldg. 1, Room E-26
Charleston, WV 25305

The Honorable Joe Manchin III
United States Senate
306 Hart Senate Office Building
Washington D.C. 20510

The Honorable Shelley Capito
United States Senate
172 Russell Senate Office Building
Washington, DC 20510

The Honorable David McKinley
United States House of Representatives
2239 Rayburn HOB
Washington, DC 20515

Governor Tom Wolf
Commonwealth of Pennsylvania
Office of the Governor
508 Main Capitol Building
Harrisburg, PA 17120

Josh Shapiro
Pennsylvania Office of the Attorney General
16th Floor, Strawberry Square
Harrisburg, PA 17120

The Honorable Pat Toomey
United States Senate
248 Russell Senate Office Building
Washington, DC 20510

The Honorable Bob Casey
United States Senate
393 Russell Senate Office Building
Washington, DC 20510

The Honorable Guy Reschenthaler
United States House of Representatives
531 Cannon House Office Building
Washington, DC 20515

**FEDERAL AGENCIES**

Janet Norman, Biologist
U.S. Fish and Wildlife Service
Chesapeake Bay Field Office
177 Admiral Cochrane Drive
Annapolis, MD 21401
Janet_Norman@fws.gov

Megan Gottlieb, P.E.
Water Management Unit
U.S. Army Corps of Engineers
Pittsburgh District
2200 William S. Moorhead Federal Building
1000 Liberty Avenue
Pittsburgh, PA 15222-4186
Megan.K.Gottlieb@usace.army.mil

Sean McDermott
Regional Hydropower Coordinator
National Marine Fisheries Service
Northeast Regional Office
1 Blackburn Dr.
Gloucester, MA 01930-2298
sean.mcdermott@noaa.gov

Kevin Mendik
Hydropower Program Coordinator
National Park Service
15 State St, Floor 10
Boston, MA 02109-3502
Kevin_Mendik@nps.gov

Cosmo Servidio
Region 3 Administrator
US Environmental Protection Agency
1650 Arch Street
Philadelphia, PA 19103-2029

Curtis Schreffler
Associate Director, Northeast Region
US Geological Survey
Pennsylvania Water Science Center
215 Limekiln Road
New Cumberland, PA 17070
clschref@usgs.gov

Shaun Wicklein
Virginia and West Virginia Water Science Center
US Geological Survey
1730 East Parham Road
Richmond, VA 23228
smwickle@usgs.gov

Director
Federal Emergency Management Agency
500 C Street, SW
Washington, DC 20472

**STATE**

Jacob Harrell
Wildlife Resources Section Coordination Unit
West Virginia Division of Natural Resources
Elkins Operations Center
PO Box 67
Elkins, WV 26241
Jacob.D.Harrell@wv.gov

Danny Bennett
West Virginia Division of Natural Resources
Elkins Operations Center
PO Box 67
Elkins, WV 26241
Danny.A.Bennett@wv.gov

David Wellman
Fisheries Management
West Virginia Division of Natural Resources
James Plaza 1110 Railroad St.
Farmington, WV 26571-0099
David.I.Wellman@wv.gov

Coopers Rock State Forest
61 County Line Dr.
Bruceton Mills, WV, 26525
coopersrocksf@wv.gov

Brian Bridgewater
West Virginia Department of Environmental Protection
Division of Water and Waste Management
601 57th Street, SE
Charleston, WV 25304
Brian.L.Bridgewater@wv.gov

Susan Pierce
Director and Deputy State Historic Preservation Officer
West Virginia Division of Culture and History
1900 Kanawha Boulevard East
Charleston, WV 25305
susan.m.pierce@wv.gov

Ronald Schwartz
Regional Director, Southwest Regional Office
Pennsylvania Department of Environmental Protection
400 Waterfront Drive
Pittsburgh, PA 15222-4745

Scott R. Williamson
Program Manager, Waterways and Wetlands Program
PA Dept. of Environmental Protection South-central Regional Office
909 Elmerton Ave
Harrisburg, PA 17110
scwilliams@pa.gov

Secretary Cindy Adams Dunn
Pennsylvania Department of Conservation and Natural Resources
Rachel Carson State Office Building
400 Market Street
Harrisburg, PA 17105

Heather Smiles
Chief, Division of Environmental Services
Pennsylvania Fish and Boat Commission
595 East Rolling Ridge Drive,
Bellefonte, PA 16823
hsmiles@pa.gov

Olivia Braun
Pennsylvania Game Commission
2001 Elmerton Avenue
Harrisburg, PA 17110
olbraun@pa.gov

Cheryl Nagle
PA Historical and Museum Commission
State Historic Preservation Office
Commonwealth Keystone Building, Second Floor
400 North Street
Harrisburg, PA 17120-0093
chnagle@pa.gov

**MUNICIPAL**

Rennetta McClure
County Administrator
Monongalia County Commission
243 High Street, Room 202
Morgantown, WV 26505
rmcclure@moncommission.com

Vincent Vicites
Chairman, County Commissioner
Fayette County, PA
61 East Main Street
Uniontown, PA 15401
vvicites@fayettepa.org

Albert Gallatin Municipal Authority
PO Box 211
Point Marion, PA 15474-0211

Borough of Point Marion, PA
426 Morgantown Street
Point Marion, PA 15474

Springhill Township
198 Lake Lynn Rd.
Lake Lynn PA 15451

**TRIBAL**

US Bureau of Indian Affairs
Eastern Regional Office
545 Marriott Drive, Suite 700
Nashville, TN 37214

Absentee-Shawnee Tribe of Oklahoma
Edwina Butler-Wolfe, Governor
2025 S. Gordon Cooper Drive
Shawnee, OK 74801

Cayuga Nation
Clint Halftown
P.O. Box 803
Seneca Falls, NY 13148
clint.halftown@gmail.com

Delaware Nation, Oklahoma
Deborah Dotson, President
PO Box 825
Anadarko, OK 73005
ec@delawarenation.com

Delaware Tribe of Indians
Chester "Chet" Brooks, Chief
5100 Tuxedo Blvd.
Bartletsville, OK 74006
cbrooks@delawaretribe.org

Eastern Shawnee Tribe of Oklahoma
Glenna Wallace, Chief
PO Box 350
Seneca, MO 64865

Oneida Indian Nation
Raymond Halbritter, Nation Representative
2037 Dream Catcher Plaza
Oneida, NY 13421
info@oneida-nation.org

Oneida Indian Nation of Wisconsin
Tehassi Hill, Chair
P. O. Box 365
N7210 Seminary Rd
Oneida, WI 54155-0365

Onondaga Nation
Sidney Hill, Chief
4040 Route 11
Nedrow, NY 13120
admin@onondaganation.org

Osage Nation
Geoffrey Standing Bear, Principal Chief
627 Grandview Avenue
PO Box 779
Pawhuska, OK 74056

Seneca Nation of Indians
Rickey Amstrong, Sr., President
90 O:hi'yoh Way
Salamanca, NY 14779

Seneca-Cayuga Tribe of Oklahoma
William L. Fisher, Chief
P.O. Box 453220
23701 S. 655 Rd.
Grove, OK 74344
wfisher@sctribe.com

Shawnee Tribe
Cassie Harper, Tribal Administrator
P.O. Box 189
29 South Highway 69a
Miami OK 74355
cassie@shawnee-tribe.com

St. Regis Mohawk Tribe
Chief Beverly Kiohawiton Cook
71 Margaret Terrance Memorial Way
Akwesasne, NY 13655

Stockbridge-Munsee Band of the Mohican Nation of Wisconsin
Shannon Holsey, Tribal President
N8476 MohHeConNuck Road
Bowler, WI 54416
shannon.holsey@mohican-nsn.gov

Tonawanda Band of Seneca
Roger Hill, Chief
P.O. Box 795
7027 Meadville Road
Basom, NY 14013
tonseneca@aol.com

Tuscarora Nation
Leo Henry, Chief
2006 Mt. Hope Road
Lewiston, NY 14092

Eastern Band of Cherokee Indians
Richard Sneed, Principal Chief
P.O. Box 1927
Cherokee, NC 28719

Cherokee Nation
Principal Chief Bill John Baker
P.O. Box 948
Tahlequah, OK 74465

United Keetoowah Band of Cherokee Indians in Oklahoma
Chief Joe Bunch
P.O Box 746
Tahlequah, OK 74465

Absentee-Shawnee Tribe of Oklahoma
Devon Frazier, THPO
2025 S. Gordon Cooper Drive
Shawnee, OK 74801
106NAGPRA@astribe.com

Delaware Nation, Oklahoma
Erin Thompson, Director
Cultural Resources/106 Department
31064 State Highway 281
Anadarko, OK 73005
ethompson@delawarenation-nsn.gov
cc: dkelly@delawarenation.com

Susan Bachor
Delaware Tribe of Indians
P.O. Box 64
Pocono Lake, PA 18347
sbachor@delawaretribe.org

Brett Barnes, THPO
Eastern Shawnee Tribe of Oklahoma
PO Box 350
Seneca, MO 64865
bbarnes@estoo.net

Roxanne Weldon
Eastern Shawnee Tribe of Oklahoma
PO Box 350
Seneca, MO 64865

Oneida Indian Nation
Jesse Bergevin, Historic Preservation Specialist
2037 Dream Catcher Plaza
Oneida, NY 13421
jbergevin@oneida-nation.org

Oneida Indian Nation
Laura Misita, Land Administrator
Oneida Indian Nation Legal Dept.
5218 Patrick Road
Verona, New York 13478
lmisita@oneida-nation.org

Oneida Indian Nation of Wisconsin
Corina Williams, THPO
P. O. Box 365
N7210 Seminary Rd
Oneida, WI 54155-0365

Onondaga Nation
Tony Gonyea, Faithkeeper 4040
Route 11
Administrative Building
Nedrow, NY 13120

Osage Nation
Dr. Andrea Hunter, THPO
627 Grandview Avenue
Pawhuska, OK 74056

Seneca Nation of Indians
Jay Toth, THPO 90 O:hi'yoh Way
Salamanca, NY 14779
jay.toth@sni.org

Seneca-Cayuga Tribe of Oklahoma
William Tarrant, Cultural Director
P.O. Box 453220
23701 S. 655 Rd.
Grove, OK 74344
wtarrant@sctribe.com

Shawnee Tribe
Tonya Tipton, THPO
P.O. Box 189
29 South Highway 69a
Miami OK 74355
tonya@shawnee-tribe.com

St. Regis Mohawk Tribe
Darren Bonaparte, THPO
71 Margaret Terrance Memorial Way
Community Building
Akwesansne, NY 13655
darren.bonaparte@srmt-nsn.gov

Stockbridge-Munsee Band of the Mohican Nation of Wisconsin
Bonney Hartley, THPO New York Office
65 1st St
Troy, NY 12180
bonney.hartley@mohican-nsn.gov

Tuscarora Nation
Bryan Printup
5226 Walmore Road
Lewiston, NY 14092
bprintup@hetf.org

**NGOs**

Duane Nichols, President
Cheat Lake Environment & Recreation Association
330 Dream Catcher Circle
Morgantown, WV 26508
duane330@aol.com

Mike Strager, Ph.D., Vice President
Cheat Lake Environment & Recreation Association
102 Lakepointe
Morgantown, WV 26508
mstrager@gmail.com

Ella Belling
Executive Director
Mon River Trails Conservancy
P.O. Box 282
Morgantown, WV 26507
ella@montrails.org

Amanda J. Pitzer
Friends of the Cheat
1343 North Preston Highway
Kingwood, WV 26537
amanda@cheat.org

Owen Mulkeen
Associate Director
Friends of the Cheat
1343 North Preston Highway
Kingwood, WV 26537
owen@cheat.org

Betty L. Wiley
Upper Monongahela River Association
373 Dunkard Avenue
Westover, WV 26501
betty.w304@gmail.com

Anita Carter, Property Manager
Greystone-On-The-Cheat Property Owners Association, Inc.
706 Sunset Beach Road
Morgantown, WV 26508
greystone.poa@hotmail.com

Adam Polinski
The Coopers Rock Foundation
P.O. Box 505
Morgantown, WV 26507

Kevin R Colburn
American Whitewater
20 Battery Park Ave Suite 302
Asheville, NC 28801-2879
kevin@americanwhitewater.org

Bob Irvin
President
American Rivers
1101 14th Street NW, Suite 1400
Washington, DC 20005
birvin@americanrivers.org

Steve Moyer
Trout Unlimited
1777 N. Kent Street, Suite 100
Arlington, VA 22209
smoyer@tu.org

Colleen McNally-Murphy
National Coordinator
Hydropower Reform Coalition
1101 14th St. NW, Suite 1400
Washington, DC 20005
colleen@hydroreform.org

Angie Rosser
Executive Director
West Virginia Rivers Coalition
3501 MacCorkle Ave. SE #129
Charleston WV 25304

Garrett Thompson
Friends of the Cheat
1343 North Preston Highway
Kingwood, WV 26537
gthompson@cheat.org

Daniel Miller, Ph.D.
Rotary Club of Cheat Lake
125 Lakeview Drive
Morgantown, WV 26508
DMiller@potesta.com

**OTHER INTERESTED PARTIES**

Sunset Beach Marina
177 Sunset Beach Road
Morgantown, WV 26508

Stuart Welsh
West Virginia Cooperative Fish and Wildlife Research Unit
West Virginia University
322 Percival Hall
Morgantown, WV 26506
swelsh@wvu.edu

The Lakehouse Restaurant and Marina
165 Sunset Beach Road
Cheat Lake, WV 26508

Edgewater Marina
239 Fairchance Road
Morgantown, WV 26508
edgewater@cheatlakedocks.com

Stratford Douglas
1024 Snake Hill Road
Morgantown, WV 26508
stratdouglas@gmail.com

Sean Goodwin
seangoodwin@yahoo.com

Jim Kotcon
jkotcon@gmail.com

**FERC**

John Spain, P.E.
Regional Engineer
Federal Energy Regulatory Commission
Division of Dam Safety and Inspections – New York Regional Office
19 West 34th Street, Suite 400
New York, NY 10001
john.spain@ferc.gov

Andy Bernick, Ph.D.
Federal Energy Regulatory Commission
888 First St. NE
Washington, DC 20426
andrew.bernick@ferc.gov

Lake Lynn Generation, LLC
Two Bethesda Metro Center, Suite 1330
Bethesda, MD 20814

**Via eFiling**

January 23, 2020

Kimberly D. Bose, Secretary
Federal Energy Regulatory Commission
888 First Street, N.E.
Washington, D.C. 20426

Re: Lake Lynn Hydroelectric Project (FERC No. P-2459)
Joint Meeting and Site Visit Summary and Proof of Publication of Newspaper Notice

Dear Secretary Bose,

On August 29, 2019, Lake Lynn Generation, LLC (Lake Lynn) filed with the Federal Energy Regulatory Commission (FERC) a Notice of Intent to File a License Application (NOI), Pre-Application Document (PAD), and Request to Use the Traditional Licensing Process (TLP) for the relicensing of the Lake Lynn Hydroelectric Project (FERC No. P-2459) (Project). By letter order dated October 17, 2019, FERC granted Lake Lynn's request to use the TLP.

On November 21, 2019, pursuant to 18 CFR § 16.8(b)(3), Lake Lynn provided written notice to FERC and the Project Distribution List of its Joint Meeting and Site Visit for the relicensing of the Project. In accordance with the requirements of 18 CFR.§ 16.8(i), at least 14 days in advance of the Joint Meeting, Lake Lynn published notice of the Joint Meeting and Site Visit in the *Herald-Standard* (a daily newspaper of general circulation in Fayette County, Pennsylvania) and *The Dominion Post* (a daily newspaper of general circulation in Monongalia County, West Virginia). Proof of publication of the notices in each newspaper is provided in Attachment 3.

The Joint Meeting and Site Visit were held on Thursday, December 12, 2019. The Joint Meeting was held at 10:00 a.m. at the Cheat Lake Volunteer Fire Department located at 409 Fairchance Road, Morgantown, West Virginia 26508. The Site Visit commenced at approximately 1:30 p.m. at Sunset Beach Marina located at 177 Sunset Beach Road, Morgantown, West Virginia 26508.

Enclosed for filing, in accordance with 18 CFR § 16.8 (b)(4), are summaries for both the Joint Meeting (Attachment 1) and Site Visit (Attachment 2). The audio recording of the Joint Meeting will be filed separately.

Please do not hesitate to contact me at (804) 739-0654 or by email at jsmet@cubehydro.com if you have any questions concerning this filing.

Sincerely,
**Lake Lynn Generation, LLC**

Jody J Smet

Jody Smet
Director, FERC Licensing and Compliance

Attachments

cc: Distribution List

# Attachment 1
# Joint Meeting Summary, Sign-In Sheets, and Presentation

**LAKE LYNN GENERATION, LLC**
**LAKE LYNN HYDROELECTRIC PROJECT (FERC NO. P-2459)**
**JOINT MEETING SUMMARY**
**DECEMBER 12, 2019**

Cheat Lake Volunteer Fire Department
409 Fairchance Road, Morgantown, West Virginia 26508
Time: 10:00 AM

Joint Meeting Participants

| Name | Affiliation | Email Address |
|---|---|---|
| Amy Wagner | Citizen | awagner1595@gmail.com |
| Andrew Gast-Bray | Monongalia County Planning Commission | agastbray@moncommission.com |
| Ann Chester | Community/Cheat Lake Environment & Recreation Association (CLEAR) | chestermcgraw@gmail.com |
| Bob Flickner | Lake Lynn Generation, LLC (Lake Lynn) | rflickner@cubehydro.com |
| Brian Bridgewater | West Virginia Department of Environmental Protection (WVDEP) | Brian.L.Bridgewater@wv.gov |
| Dale Short | Lake Lynn | dshort@cubehydro.com |
| Dan Griffin | Greystone Property Owners Association | dgriff66@aol.com |
| Dan Miller | Potesta | dmiller@potesta.com |
| Dave Hough | | davecyndy@frontier.com |
| Donna Weems | CLEAR | donnaweems@rocketmail.com |
| Danny Bennett | West Virginia Division of Natural Resources (WVDNR) | Danny.A.Bennett@wv.gov |
| Duane Nichols | CLEAR | duane330@aol.com |
| Edward Allen Hawkins | Monongalia County Commission | dr.hawk@comcast.net |
| Ella Belling | Mon River Trails Conservancy | ella@montrails.org |
| Frank Jernejcic | Upper Monongahela River Association | fjernejcic@comcast.net |
| Jacob Harrell | WVDNR | Jacob.D.Harrell@wv.gov |
| Janet Norman | U.S. Fish and Wildlife Service (USFWS) | Janet_Norman@fws.gov |
| Jody Smet | Lake Lynn | jsmet@cubehydro.com |
| Joyce Foster | TRC | jfoster@trccompanies.com |
| Karen Baldwin | Lake Lynn | kbaldwin@cubehydro.com |
| Lewis and Suzy Barnes | The Lakehouse Restaurant | szybarnes@yahoo.com |
| Mike Lutman | Resident | mlutman@comcast.net |
| Mike Strager | CLEAR/Friends of the Cheat/West Virginia University | mstrager@gmail.com |
| Nathaniel James | WVU Student | Reecejames98@gmail.com |
| Owen Mulkeen | Friends of the Cheat | owen@cheat.org |
| Parke Johnson | Greystone Estates | graceandparke@yahoo.com |
| Richard Scott | Resident | qtrking86@yahoo.com |
| Roger Phillips | Resident | rogerdalephillips@gmail.com |
| Sean Goodwin | Greystone President | seangoodwin@yahoo.com |
| Steve Calvert | Resident | scalvert@greenrivergroupsllc.com |
| Will McNeil | WVU Student/Resident | whm0005@mix.wvu.edu |

Joint Meeting Summary

The Joint Meeting commenced at 10:10 AM. Jody Smet (Director of FERC Licensing and Compliance for Cube Hydro [Cube] and Lake Lynn Generation, LLC [Lake Lynn]) opened the Joint Meeting for the relicensing of the Lake Lynn Hydroelectric Project (FERC No. P-2459) (Project). She introduced herself and stated that Lake Lynn is the licensee for the Project. She reviewed the overall schedule for the Joint Meeting and Site Visit, the agenda for the meeting, and logistics for the day. She stated that copies of the Pre-Application Document (PAD) were available in the room.

Ms. Smet asked everyone to introduce themselves. Following introductions, she stated that notification of the Joint Meeting and Site Visit was provided to stakeholders on the Project Distribution List, published in the local newspapers, and filed with the Federal Energy Regulatory Commission (FERC). Ms. Smet noted that the meeting is being recorded and that the recording would be filed with FERC.

Ms. Smet stated that Cube purchased the Project in 2014 and provided a brief overview of Cube. She explained that the Project is an asset of Cube and that Cube and its assets were recently acquired by Ontario Power Generation (OPG) Eagle Creek Renewable Energy (Eagle Creek) (a subsidiary of OPG) in October 2019. She stated that the two companies now collectively own and operate a total of 85 hydropower projects in the United States. Ms. Smet explained that the stakeholders and residents would see very little change and that the change in ownership does not change the requirements of the Project's FERC license or how the Project is operated.

Duane Nichols (Cheat Lake Environment & Recreation Association [CLEAR]) asked about contacts and who is the highest person in charge for the Project. Ms. Smet explained that Bob Flickner is the local manager/operator for the Project plant and that Dale Short is Bob's supervisor. She stated that she is in Virginia and that she is the FERC relicensing manager for the Project. She noted that the new CEO and President of the combined Eagle Creek and Cube is Eli Smith and the corporate office for Lake Lynn is in Bethesda, Maryland while the corporate office for Eagle Creek is in Morristown, New Jersey. She added that David Fox with Lake Lynn oversees FERC compliance and dam safety at the Project.

Richard Scott (resident) asked about the original charter for Cheat Lake/the Project. Ms. Smet explained the FERC license for the Project enumerates the requirements for operating the Project. Mr. Scott asked if the lake level or other requirements could change every time the Project license is applied for. Mr. Scott noted that during the last relicensing security was added at Cheat Lake Park. Ms. Smet explained that FERC issues licenses for a term of 30 to 50 years, with 40 years as the default. She added that the Project license expires in 2024 and that all stakeholders have a voice in the relicensing process.
Ms. Smet explained that relicensing must balance all the resources at the Project with the generation of power. When asked about the purpose of lowering lake, Dale Short (Lake Lynn) explained that the lake stores water for power and that it is seasonally lowered from November 1 through spring to accommodate incoming flows from snow melt. He added that Lake Lynn can drop the lake level and that sometimes they need to.

When asked how Lake Lynn notifies residents when the lake level will drop quickly, Ms. Smet stated that Lake Lynn could do better. She added that, this past fall, Lake Lynn posted notification of the low lake levels on the Project website (cheatlake.today), notified marinas, and worked with the Friends of the Cheat and CLEAR so that they could notify members using social media. She advised residents to check the Project website and added that Lake Lynn was open to other suggestions.

Ann Chester (CLEAR member and member of the community) stated that how the FERC license has been implemented by the various owners of the Project has changed over the years. Ms. Smet acknowledged that it appears there has been a consistency issue historically with how the previous owners of the Project have implemented the license requirements.

A meeting participant stated that there has been significant development in the area since the previous relicensing and that connection to other trails would provide better access to Cheat Lake from communities. When asked if the Cheat Lake Trail is the only trail in the county with maintenance issues, several meeting participants noted that there were others with maintenance and security issues. One meeting participant stated that the Greystone Estates residents have concerns about security and concerns regarding anyone being able to access the Cheat Lake Trail from other trails in the area and walk by their homes.

Ms. Smet acknowledged the desire by some for trails and more connectivity while the homeowners along Cheat Lake have concerns. Ms. Smet added that she met with Friends of the Cheat, Potesta, and others interested in trails in August 2019.

Ms. Smet stated that Lake Lynn recently collaborated on a grant proposal to the Natural Resources Conservation Service (NRCS) to repair the washout of the Cheat Lake Trail and to expand the trail around the Cheat Haven peninsula. She stated that the application was submitted by West Virginia Division of Natural Resources (WVDNR) and that they expected to receive a response in February 2020. Ms. Smet added that Lake Lynn is working on other plans to address the washout on the southern portion of the Cheat Lake Trail.

Ms. Smet stated that the washout on the southern portion of the Cheat Lake Trail is not a quick fix and that Lake Lynn is looking at how to redesign the trail and size the culverts under the trail appropriately. She stated that this would involve engineering design that would take some time. Ms. Smet stated that while this is underway, Lake Lynn is exploring options to reopen the Cheat Lake Trail sooner, but those options need to be safe and sustainable. She added that she is interested in hearing ideas from others.

One participant noted that everyone needs to be cognizant of intense weather patterns and investigate ways to prevent the shoreline from washing into Cheat Lake. Ms. Smet acknowledged that the steep topography plays into this and that stormwater runoff issues are beyond Lake Lynn's control. Ms. Smet stated that Lake Lynn and FERC do not have authority of upland areas outside the Project boundary, but this is under the authority of the county.

Andrew Gast-Bray (Monongalia County Planning Commission) stated that the County regulations do not include regulations related to water retention/stormwater runoff. Ms. Smet stated that Lake Lynn has investigated upland development and National Pollutant Discharge Elimination System (NPDES) permits. Brian Bridgewater (West Virginia Department of Environmental Protection [WVDEP]) clarified that the state's NPDES construction stormwater general permit addresses run-off during construction activities only but the permit does not address run-off after construction is complete.

Janet Norman (U.S. Fish and Wildlife Service [USFWS]) requested the name of the FERC Coordinator for this Project relicensing. Ms. Smet responded that Andy Bernick was assigned at least through the PAD development.

Ms. Smet continued the presentation by explaining that FERC has three licensing processes and that Lake Lynn is using the Traditional Licensing Processes (TLP). She explained that the Joint Meeting and Site Visit today are in the first stage of relicensing and that Lake Lynn filed a Notice of Intent (NOI) and PAD in August 2019. She said that everyone on the Project Distribution List should have received an email with a link to the PAD. She added that the meeting participants from the sign-in sheets will be added to the Project Distribution List for future information related to the relicensing.

When asked for contact information for questions about the Project, Ms. Smet suggested starting with her.

When asked about technical issues with the link at the Project website for signing up for alerts, Bob Flickner (Lake Lynn) responded that he is working on the link. Ms. Smet added that Lake Lynn can manually enter everyone from the meeting sign-in sheets to that list for Project alerts.

Ms. Smet informed the participants that the next step in the relicensing process is for them to provide written comments and study requests to FERC by February 10, 2020, which is 60 days from the Joint Meeting. She added that this is a regulatory deadline and that study requests should be reasonable and follow the study criteria established by FERC (which will be reviewed at the end of the presentation). Ms. Smet stated that Lake Lynn will review comments in February and will develop a study plan for studies in the early spring. Ms. Smet stated that 2020 will largely focus on conducting studies. She added that in the second stage of the relicensing process, Lake Lynn will develop the draft license application and stakeholders will have the opportunity to review and provide comments on that document.

Ms. Smet stated that comments should be filed with FERC and asked that folks also email her a copy. She noted that comments can be mailed to FERC, but electronic filing is preferred by FERC. She explained that, through the FERC website (ferc.gov), comments can be e-filed using the FERC project number P-2459 and that any comments filed should have this project number on it. Ms. Smet advised meeting participants to e-subscribe on FERC's website (ferc.gov) to receive an email every time something is filed with FERC for the Project. Ms. Smet stated that she or Joyce Foster with TRC (consultant supporting Lake Lynn with the relicensing of the Project) would be happy to help anyone who has trouble using FERC's e-filing or e-subscription system. Janet Norman (USFWS) added that the e-subscription feature is helpful to the agencies so that they can see everyone's comments.

Duane Nichols (CLEAR) asked if a full justification for study requests was necessary. Ms. Smet stated that study requests should try and follow FERC's study criteria. Janet Norman (USFWS) added that it is best to be more specific and more justified.

Ms. Foster (TRC) continued the presentation by providing a brief overview of the Project. Jacob Harrell (WVDNR) asked what the trash rack spacing is. Mr. Flickner responded that it is 4 inches.

Ms. Foster continued the presentation with a figure of the Project boundary and stated that this is the limit of both Lake Lynn's authority and FERC's authority. When asked how far the Project boundary extends into the riparian zone, Ms. Foster and Ms. Smet clarified that it generally follows the normal full pool elevation of the impoundment (870 feet) and includes a small parcel of land at the powerhouse, recreation sites, nature viewing areas, and Project facilities. In response to a question regarding how far the Project boundary extends below the dam, Mr. Flickner responded that it was about 400 yards. Ms. Smet noted that the Project boundary extends into Pennsylvania.

Ms. Foster continued the presentation by reviewing the information provided in the PAD. She reviewed the Project facilities and operation requirements under the existing FERC license.

Ms. Foster continued the presentation with a summary of the information provided in the PAD regarding the natural resources associated with the Project. Ms. Foster stated that the intent of the PAD is to summarize readily available information regarding the existing environment and effects of the Project on resources.

Regarding geology and soils, Ms. Foster noted that shoreline erosion surveys of the entire Cheat Lake shoreline have been conducted every 3 years since 1995 and that the most recent survey conducted in 2017 did not identify any new areas of erosion. She stated that annual shoreline erosion surveys of the Cheat Lake Park shoreline have been conducted since 1995 and that the most recent annual survey in 2018 did not identify any new areas of active erosion. Ms. Foster added that no new issues are anticipated related to geology and soils.

Ms. Foster noted that there are six USGS gauges in the Project vicinity. Janet Norman (USFWS) expressed concern over the short period of record used for the flow duration curves in the PAD due to the recalibration of the tailrace gage several years ago. Ms. Foster stated that water surface elevation data has been measured at the tailrace gage since 2010 but the previous Project licensee conducted an instream flow study in 2014 that determined there was a need to recalibrate the gage to accurately determine flow in the tailrace. Ms. Norman asked if there were a way to adjust the data prior to 2016. Ms. Smet and Ms. Foster responded that there were limitations on the information available prior to Cube owning the Project but that is something to look at moving forward.

Ms. Foster continued the presentation by summarizing the water quality information presented in the PAD. She stated that hourly dissolved oxygen (DO), pH, water temperature, and conductivity have been monitored continuously from April 1 through October 31 annually since 1997 at three locations and data is reported to FERC annually. In response to a question regarding how to obtain that data, Ms. Foster responded that it can be obtained from the FERC website using the Project number or that Lake Lynn could provide the data. Ms. Smet added that a benefit to e-subscribing to the Project docket through FERC's website is receiving an email with a link when these reports are filed with FERC.

In response to a question from a resident regarding monitoring for E. coli, Ms. Foster responded that Lake Lynn does not monitor for this parameter. A participant added that the County Health Department monitors at the beach for E. coli. Owen Mulkeen (Friends of the Cheat [FOC]) stated that FOC monitors the beach for E. coli and that the data is available at the website: theswimguide.org. In response to a question as to whether the E. coli levels are ever too high to swim, Mr. Mulkeen noted that there were times where the E. coli levels were elevated when sewage treatment systems were overrun from flooding. He added that the FOC E. coli sampling is done twice a month and the results are available within 24 hours and posted immediately on the website. Mr. Mulkeen stated that FOC does not have long-term funding to support long term E-coli monitoring.

Ms. Foster continued the presentation to state that recent data collected by Lake Lynn and the state suggests that water quality conditions upstream and downstream of the Project dam generally meet state standards and have generally improved over time, except for periods of low DO generally in late summer/early fall for most years, particularly at Cheat Lake monitor.

In response to a question regarding what the water chemistry parameters should be, Ms. Foster reviewed state water quality standards.

A participant stated that conductivity in the Cheat River and Cheat Lake almost never goes above 200 on the conductivity scale but the Monongahela River almost never goes below 200. He noted that conductivity can be closely related to parts per million of total dissolved solids.

Jody added that the state DEP issues a 401 Water Quality Certificate (WQC) before FERC can issue a license. She explained that the state can include conditions in the WQC requiring Lake Lynn to continue monitoring or perform some sort of enhancement to meet the water quality standards so that operation of the Project does not impact water quality.

In response to a question regarding whether Lake Lynn was responsible for water quality at the discharge from the dam, Ms. Smet replied that it was responsible.

Brian Bridgewater (WVDEP) complimented Lake Lynn on how it handled periods of low DO this past year by working with WVDEP to meet standards and to improve DO to protect fish and aquatic life. He added that Lake Lynn performs continuous monitoring and is required to comply with state standards.

One participant noted that the watershed of Cheat Lake is large and that many factors influence the water coming into Cheat Lake that are beyond the control of Lake Lynn. Ms. Smet responded that this is true, and E. coli and sedimentation are much bigger than Lake Lynn.

In response to a question about aeration, Dale Short (Lake Lynn) stated that Lake Lynn can open the tainter gates and allow water to go over the spillway to aerate the water (which will improve DO).

In response to a question regarding pH and conductivity, Ms. Smet confirmed that Lake Lynn cannot control pH or conductivity but is still required to monitor those parameters. She added that Lake Lynn would be interested in some relief from monitoring for these parameters.

Frank Jernejcic (Upper Monongahela River Association) stated that there has been general improvement in the water quality chemistry data over the past 15 years, and that there no real red flags in the data.

Ms. Foster continued the presentation by summarizing the comprehensive biomonitoring that has been conducted over the past 22 years at the Project under the Project Biomonitoring Plan. She noted that the PAD provides a detailed table and summary of the various biomonitoring activities including: conducting surveys that include water quality, physical habitat, and biota; walleye population monitoring and stock assessment; monitoring adult walleye movement; aquatic vegetation mapping; aquatic habitat enhancement and monitoring; American eel eDNA sampling; and benthic macroinvertebrate surveys. She added that an angler creel survey will be conducted in 2020.

Janet Norman (USFWS) asked if there had been any problems with invasive exotic aquatic plants or concerns about them in the future in Cheat Lake. Jacob Harrell (WVDNR) stated that there are no problems or concerns at present. Ms. Smet stated that she has seen issues at other hydro projects and that it is better to be proactive through education to prevent this from becoming an issue.

In response to a question about the results of the benthic monitoring, Ms. Foster stated that they generally looked good. Ms. Smet added that there was improvement over time.

Janet Norman (USFWS) asked Ms. Smet to provide her with the lab costs for the eel eDNA analysis. Ms. Smet agreed to share that cost information.

A question was raised about geese management and whether there were any studies that existed regarding geese impacts to water quality. Jacob Harrell (WVDNR) did not have any thoughts on geese management. No one was aware of anything and the group acknowledged that geese knew where to go during waterfowl hunting season.

Ms. Foster continued the presentation by summarizing wildlife and botanical resource and wetland information presented in the PAD. She noted that no studies were conducted for the PAD and the PAD summarized information that was available for the Project area.

Ms. Foster stated that for the PAD, a list of federal/state listed rare, threatened, or endangered (RTE) species was developed from a desktop review of state and federal resources. She noted that the PAD lists the RTE species potentially occurring in the Project vicinity of Project.

Ms. Foster continued the presentation by summarizing recreation at the Project. She stated that Lake Lynn collected recreation data from 2000 through 2017, more than at most hydro projects and filed Recreation Plan Updates every three years from 2003 through 2018. She added that recreation use remained about the same over the 17-year monitoring period. She stated that the Cheat Lake boating carrying capacity study conducted in 2017 found that it may be approaching carrying capacity and that Lake Lynn is not issuing any new permits for private piers or boat docks until after relicensing. She added that Lake Lynn contracted with Mike Strager at Strager Consulting to conduct a shoreline inventory in 2019 which was completed after the PAD was filed.

Ms. Smet added that Lake Lynn is not issuing permits for new piers right now based on the 2017 boating capacity study and that Lake Lynn is working to improve shoreline management at Cheat Lake. She introduced Karen Baldwin (Lake Lynn) and explained her role. She stated that Ms. Baldwin is overseeing permitting for any activities on Cheat Lake. She noted that anyone with questions about any activities in Cheat Lake or along the shoreline should contact Ms. Baldwin.

Mike Lutman (Greystone on the Cheat) asked about debris and trash collections. Ms. Smet stated that Lake Lynn supports CLEAR and Friends of the Cheat with dumpsters and monetary contributions. Mike Strager (WVU) added that many WVU student organizations volunteer their time to assist CLEAR and Friends of the Cheat with clean-up activities. Mr. Lutman asked about larger trees. Duane Nichols (CLEAR) stated that large trees are natural and provide natural habitat and that what doesn't flush down to the trash rack at the powerhouse is flagged. Mr. Nichols expressed concern about the beach area and noted that there were opportunities to improve clean up of the beach area.

Janet Norman (USFWS) stated that she needs additional information on the mussel surveys conducted in the Cheat River/Project area, including specifics on where and when. Ms. Smet stated that no recent mussel data was found during the PAD due diligence and that the agencies were contacted but no one informed Lake Lynn about any available mussel data. Ms. Norman asked about the reference in the PAD to the Pennsylvania Fish and Boat Commission (PFBC) source in the PAD. Ms. Foster clarified that this PFBC source referred to historical data.

Ms. Smet added that the Pennsylvania agencies were invited to the Joint Meeting and Site Visit but the Pennsylvania Department of Environmental Protection (PADEP) responded that the invitation was sent to them in error. In response to Ms. Smet's question as to whether WVDEP or PADEP would issue the 401 WQC, Brian Bridgewater (WVDEP) agreed to reach out to his counterpart at PADEP for clarification.

Jacob Harrell (WVDNR) added that Janet Clayton has mussel data in the Cheat River. Duane Nichols (CLEAR) added that mussels are an important topic since residents see less mussel shell material along the shoreline than in the past. Mr. Harrell stated that mussels are not a high priority for WVDNR in biomonitoring efforts.

Several residents on Cheat Lake expressed concerns about the moratorium on new pier permits while the public boat launches allow large numbers of boats onto the reservoir. Ms. Smet explained that Lake Lynn must balance various interests with its authority under the FERC license. She clarified that Lake Lynn does not have the authority to limit public use or establish and enforce boating regulations such as horsepower or noise.

In response to a question about how the boat carrying capacity was determined, Mike Strager (Strager Consulting) explained that the boating carrying capacity study used National Park Service criteria. Ms. Smet added that the moratorium is temporary. She explained that Lake Lynn oversees the marinas at the Project reservoir under its land use article in the FERC license. She added that Lake Lynn is working to improve its oversight of marinas through the lease agreements with marina operators.

Ms. Foster continued the presentation by providing an overview of the information provided by the shoreline inventory and offering to make the site available during the lunch break so that people can see the information included in the inventory. Ms. Smet added that this inventory will provide good baseline data for development of a shoreline management plan.

Ms. Foster continued the presentation with an overview of aesthetic resources. She stated that no issues have been identified relative to aesthetic resources.

Regarding cultural resources, Ms. Foster stated that there are two potentially significant cultural resources previously identified within the Project boundary – the railroad bed along the Cheat Lake Trail (a linear historic archaeological site) and the Lake Lynn powerhouse and dam (potentially eligible for the National Register of Historic Places). She noted that no other historic properties have been identified within the Project boundary. She said that no new issues have been identified and no changes to the Projects or Project operations are proposed.

Ms. Foster stated that nineteen Native American tribes have been identified as potentially interested in Project relicensing. She stated that no tribal interests or issues have been identified to date.

Ms. Foster stated that no issues related to socioeconomic resources have been identified.

Ms. Smet explained to the group that statements in the PAD about no issues being identified does not mean that those resources will not be looked at again. She stated that these resources will need to be discussed in the license application and reminded the group that this is an ongoing process with opportunities for feedback and input.

Ms. Foster stated that there is a lot of data that has been collected under the existing FERC license and will continue to be collected during this relicensing process to maintain compliance with the existing FERC license. She briefly reviewed the studies proposed by Lake Lynn in the PAD and noted efforts that will be continued under the existing FERC license: 1) no new studies for geology and soils but shoreline erosion surveys will continue in accordance with the existing FERC license; 2) no new studies for water resources but water quality data will continue to be collected and reported in accordance with the existing FERC license; 3) no new studies for aquatic resources but biomonitoring activities will be conducted in accordance with the Biomonitoring Plan that was updated in 2018 (including the angler creel survey in 2020, the ongoing aquatic habitat monitoring, and completing the American eel eDNA sampling; 4) presence/absence surveys for RTE species likely to occur within FERC Project boundary; 5) a recreation inventory of the existing Project recreation sites; 6) collect recreation use data in 2020 and (consistent with FERC's Order approving the 2018 Recreation Plan Update); and 8) consult with the state historic preservation offices (SHPO) in West Virginia and Pennsylvania and submit the Project to the SHPOs for formal review.

Janet Norman (USFWS) raised a question about the PAD's statement that no new facilities are proposed so no ground disturbance or tree cutting is proposed. She said that over the course of a new 40-year license it seemed likely that something would be proposed. Ms. Smet noted that the PAD was mainly written before the Cheat Lake Trail washout and stated that if any new facilities or expansion of facilities are proposed, Lake Lynn would consult with the agencies and seek FERC approval, if necessary. Duane Nichols (CLEAR) noted that CLEAR is asking for an expansion of the swimming beach which would involve the removal of one or two large trees.

Ms. Norman asked about the RTE species survey and the area that it would cover. Ms. Foster responded that the RTE survey would encompass the area within the Project boundary. Ms. Smet added that she had done something similar in Virginia at Cube Hydro's projects on the Shenandoah River (Warren, Luray-Newport, and Shenandoah) and that the study was developed in consultation with the agencies and David Sutherland, USFWS. Ms. Smet committed to providing Ms. Norman with the Shenandoah Projects RTE Survey study plan as a point of reference.

In response to a question as to whether evaluations of dam integrity are performed, Ms. Foster responded that there is a FERC Office of Dam Safety with a rigorous program. Dale Short (Lake Lynn) explained the Part 12 evaluations and noted that these evaluations result in a list of items that Lake Lynn must monitor including cracks in the dam. Ms. Smet added the most recent surveillance monitoring report found no serious issues.

Ella Belling (Mon River Trails Conservancy) stated that the closure of the Cheat Lake Trail will affect the numbers for the recreation use monitoring and asked how Lake Lynn would address this. Ms. Smet responded that Lake Lynn hoped to have the Cheat Lake Trail open for the 2020 recreation season, but if not, historical data could be used to estimate use. She added that Lake Lynn is proposing a 2020 study season, but there is an opportunity to possibly extend data collection into the second year (2021) prior to the submittal of the license application.

In response to a question regarding the recreation season, Ms. Foster stated that for this Project it has been considered as Memorial Day weekend through Labor Day weekend, but this varies by Project. Duane Nichols (CLEAR) added that the trail is open year-round, but the southern portion of the trail is gated and open dusk to dawn. He added that people utilize the Cheat Lake Trail during the winter in the snow.

A concern was raised about the gate at south end of Cheat Lake Trail being open for months this past year. Duane Nichols (CLEAR) stated that the recreational specialist at the recreation facilities could serve safety and security functions. He noted that there is a need for some sort of security (a Lake Lynn presence) but, since this is not a high-risk area, this would be mainly to make sure the gate functions properly and to deter issues.

Ms. Smet reminded participants that these are Lake Lynn's proposed studies and explained that additional study requests and comments on the proposed studies are due to FERC by February 10, 2020. She briefly reviewed the FERC study criteria and said that touching on these criteria will help ensure that the study request is reasonable and has a nexus to the Project. As an example, Ms. Smet noted that acid mine drainage has no nexus to the Project since Lake Lynn has no control over this and it is not connected to Project operations, but low DO does have a Project nexus. She clarified that FERC does not issue a formal Study Plan Determination for studies in the TLP.

The meeting was adjourned at approximately 12:50 p.m. Ms. Smet stated that anyone planning to join in on the Site Visit should meet at Sunset Beach Marina at approximately 1:30 p.m. Ms. Foster handed out an itinerary with addresses/coordinates for the Site Visit stops.

Lake Lynn Hydroelectric Project (FERC No. 2459)
December 12, 2019 Relicensing Meeting Attendance List

* Denotes Site Visit Participants

| | Name | Affiliation | Email | Mailing Address | Phone |
|---|---|---|---|---|---|
| * | Dan Miller | Potesta | dmiller@potesta.com | | 681-285-8159 |
| | Ann Chester | Community CLEAR | chestermcgraw@gmail.com | | 304 319-2992 |
| * | Roger Phillips | Live in Cheat Lake! | RogerDalePhillips@gmail.com | | 304-292-4012 |
| * | Richard Scott | Lake Rat | QTRKING86@YAHOO.COM | | 724-998-6172 |
| | Will McNeil | living on the lake | whm0005@mix.wvu.edu | | 304-777-9896 |
| * | Ella Belling | Mon River Trails Conservancy | ella@montrails.org | MRTC PO Box 282 Morgantown WV 26507 | 304 692-6782 |
| * | Dave Hough | | davecymry@frontier.com | | 304-288-7981 |

**Lake Lynn Hydroelectric Project (FERC No. 2459)**
**December 12, 2019 Relicensing Meeting Attendance List**

| Name | Affiliation | Email | Mailing Address | Phone |
|---|---|---|---|---|
| Donna Weems | CLEAR | donnaweems@rocketmail.com | ~~384~~. 320 Dream Catcher Circle Morgantown WV 26508 | 304-599-2867 |
| Danny Bennett | WVDNR | danny.a.bennett@wv.gov | P.O. 67 WARD Rd Elkins, WV | 304-637-0245 |
| Parke Johnson | Greystone Estates | Graceand Parke@Yahoo.com | 3956 Eastlake Dr Morgantown WV 26508 | 304-276-8542 |
| Dan Griffin | Greystone POA | dgriff66@aol.com | 3203 DEERFIELD Ct Morgantown, 26508 | 304-435-3055 |
| Mike Strager | CLEAR FCC | mstrager@gmail.com | 102 Lake Pointe Morgantown [illegible] | 304-276-3339 |
| Janet Norman. | USFWS. | Janet_Norman@fws.gov. | 177 Admiral Cochrane Dr. Annapolis MD 21401 | 410-573-4533. |
| OWEN MULKEEN | Friends of The Cheat | owen@cheat.org | 1343 North Preston Hwy Kingwood, WV 26537 | 304 329 3621 |

**Lake Lynn Hydroelectric Project (FERC No. 2459)**
**December 12, 2019 Relicensing Meeting Attendance List**

| Name | Affiliation | Email | Mailing Address | Phone |
|---|---|---|---|---|
| * Jacob Harrell | WVDNR | jacob.d.harrell@wv.gov | 1110 Railroad St Farmington, WV 26571 | (304) 704-9328 |
| * Duane Nichols | CLEAR | | | |
| Andrew GAST-BRAY | Mon County | agastbray@moncommission.com | 243 High St. Mtown, WV 26505 | (304) 291-9572 |
| Edward Alan Hawkin | Monongalia County Commission | dr.hawk@comcast.net | | |
| Brian Bridgewater | WVDEP | Brian.L.Bridgewater@wv.gov | | 304-926-0499 |
| * Amy Wagner | citizen | awagner1595@gmail.com | 628 Mariner Village Morgantown, WV 26508 | 304.376.4420 |
| Frank Jernejcic | UMRA | fjernejcic@comcast.net | 501 Lakeview Estates Townhomes Morgantown 26508 | 304-612-7725 |

**Lake Lynn Hydroelectric Project (FERC No. 2459)**
**December 12, 2019 Relicensing Meeting Attendance List**

| Name | Affiliation | Email | Mailing Address | Phone |
|---|---|---|---|---|
| * Lewis Barnes | Lakehouse Rest. | szybarnes@yahoo.com | 55 Mont Chateau Rd. Morgantown, WV. | 304 685-6565 |
| Steve Calvert | Resident | SCalvert@greenrivergroupllc.com | 4314 Brettwood Ln. Mgt. WV 26508 | |
| MIKE LUTMAN | RESIDENT | MLUTMAN@COMCAST.NET | 4131 Cove Pt. Dr Mgnt. WV 26508 | 304.290.8727 |
| Sean Goodwin | Greystone President | seangoodwin@yahoo.com | 4685 Shadyside Ln Morgantown, WV 26508 | 304 594 3880 |
| Nathaniel James | WVU student | Reecejames48@gmail.com | 277A Spruce St. Morgantown, WV 26505 | 304-951-3794 |
| | | | | |
| | | | | |

LAKE LYNN HYDROELECTRIC PROJECT
FERC No. 2459

RELICENSING MEETING AND SITE VISIT
DECEMBER 12, 2019

**LAKE LYNN GENERATION, LLC**

1

## SITE VISIT AND MEETING

**Overall Schedule**

- Joint Meeting - 10:00 AM-12:30 PM
- Lunch Break - 12:30 PM-1:30 PM
- Site visit - 1:30 PM (meet at Sunset Beach Marina)
  - Sunset Beach Marina
  - Cheat Lake Park
  - Cheat Lake Trail (north end)
  - Tailwater Fishing Platform
  - Powerhouse

**Meeting Agenda**

- Welcome and Introductions
- Overview of FERC Traditional Licensing Process and Relicensing Schedule
- Project Description
- Overview of Information Provided in the Pre-Application Document (PAD)
- Proposed Resource Studies
- Next Steps - Solicitation of Comments

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2

## INTRODUCTIONS

- Meeting Participants
- TRC
- Lake Lynn Generation, LLC

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3

## OPG / Eagle Creek / Cube

- Cube Hydro Partners has been a leading private hydropower company focused on developing, acquiring, optimizing and operating environmentally friendly run-of-river hydropower projects
- Cube managed 385 MW of installed capacity at 19 hydropower projects on 10 rivers in 5 states, generating approximately 1.5 million MWh annually
- Cube was recently acquired by OPG Eagle Creek US (October 2019)
- The two companies now collectively own and operate a total of 85 hydropower projects in the US (620 MW of capacity and 2.5M MWhs of clean energy annually)
- Our combined teams have experienced staff with extensive collective hydropower and energy experience, spanning engineering, power markets, legal and regulatory, and commercial expertise

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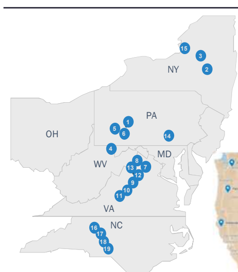
4

## COMBINED HYDRO PORTFOLIO




**Cube Hydro Partners + Eagle Creek Renewable Energy**

5

## FERC LICENSING AUTHORITY

- Under the authority of the Federal Power Act, as amended by the Electric Consumers Protection Act, FERC is responsible for issuing licenses for non-federal hydroelectric power plants.
- FERC issues licenses and relicenses for up to 50 years for constructing, operating and maintaining non-federal hydropower projects.
- Licenses issued by FERC must take into consideration the environmental as well as economic aspects of continued operation of the project.
- License conditions assure the best comprehensive use of the waterway where the project is located.

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6

# TRADITIONAL LICENSING PROCESS (TLP) OVERVIEW

- **First Stage**
  - Applicant files NOI, PAD, request to use TLP, and newspaper notice (8/29/2019)
  - FERC approves use of TLP (10/17/2019)
  - Applicant conducts joint agency/public meeting and site visit (12/12/2019)
  - Resource agencies, tribes, and stakeholders provide written comments and recommend resource studies (2/10/2020)
- **Second Stage**
  - Applicant completes reasonable and necessary studies
  - Applicant provides draft license application and study results to resource agencies and tribes
  - Resource agencies and tribes comment on draft license application
  - Applicant conducts meeting if substantive disagreements exist
- **Third Stage**
  - Applicant files final license application and sends copies to agencies and tribes

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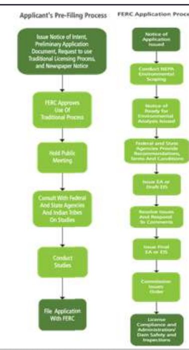
7

# FERC TLP




LAKE LYNN GENERATION

8

# RELICENSING SCHEDULE

| Activity | Responsibility | Timeframe and Regulations | Dates |
|---|---|---|---|
| File NOI, PAD, and Request to use TLP and publish Public Notice in newspapers | Lake Lynn | 5 to 5 ½ years prior to license expiration | August 29, 2019 |
| Comments on TLP Request | FERC, Relicensing Participants | Within 30 days of NOI/PAD/TLP request filing and newspaper notice | September 28, 2019 |
| FERC issues Notice of Commencement | FERC | Within 60 days of NOI/PAD/TLP request filing | October 17, 2019 |
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| Notify FERC of Joint Meeting and publish Notice in newspapers | Lake Lynn | At least 15 days in advance of meeting | November 21, 2019 |
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| Comments and Study Requests | Relicensing Participants | Due 60 days after Joint Meeting | February 10, 2020 |
| Study Plan Development | Lake Lynn | Ongoing following Joint Meeting | December 12-March 1, 2020 |
| Conduct Field Studies | Lake Lynn | One season of field studies | April 1-November 1, 2020 |
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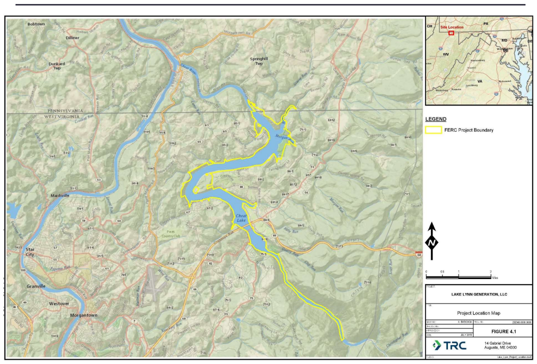
| Comments on DLA | Relicensing Participants | 90-day comment period | February 28, 2022 |
| FLA filed with FERC | Lake Lynn | 2 years prior to license expiration | November 30, 2022 |
| FERC issues Public Notice of Application | FERC | Within 14 days of FLA submittal | December 14, 2022 |
| FERC Issues New License on or before License Expiration Date | FERC | | November 30, 2024 |

9


10

# PROJECT AREA

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11

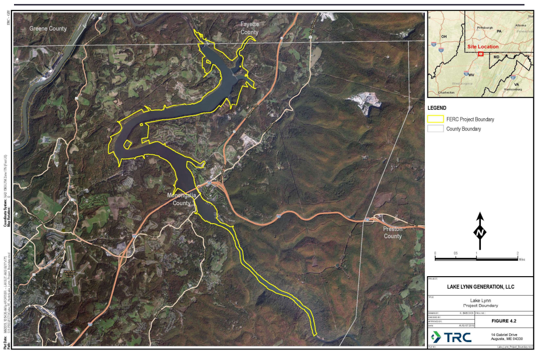
# LAKE LYNN PROJECT (FERC NO. 2459)

- 51.2 MW
- Project produces a long-term average generation of 140,352 MWh of clean electricity annually
- Constructed in 1926
- New FERC license issued in 1994
- 30-year license term expires on November 30, 2024
- Located near Morgantown, WV
- On Cheat River approximately about 3.7 miles upstream of the confluence with the Monongahela River
- Drainage area at dam – 1,411 square miles
- USGS Gage for water surface elevations in the tailrace below the Project dam (Lake Lynn gage)
- USGS Gage on Cheat River (Albright gage) approximately 14 mi upstream of the Project

LAKE LYNN GENERATION

12

## PROJECT BOUNDARY

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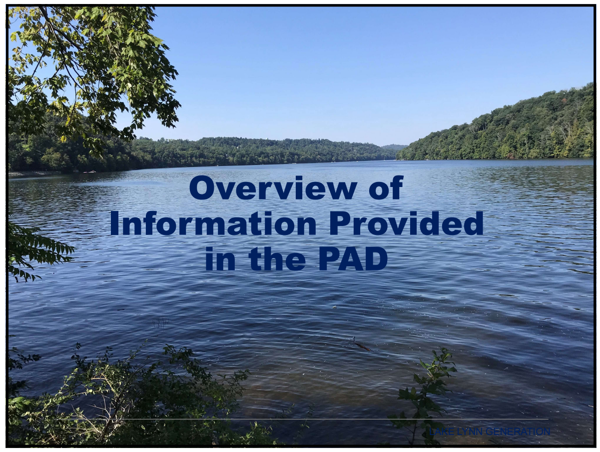
13



## Overview of Information Provided in the PAD

14

## PROJECT FACILITIES

- Concrete gravity-type dam with a spillway controlled by Tainter gates
- Reservoir with a surface area of 1,729 acres
- Log boom and trash racks at the intake facility
- Eight gated reinforced concrete penstocks
- Powerhouse containing four identical Francis generating units
- Dual 800-foot-long, 138-kV transmission lines
- Other appurtenant facilities

LAKE LYNN GENERATION

15

## PROJECT OPERATIONS

- Operated as a dispatchable peaking hydroelectric facility with storage capability
- Ponding capability varies by season and allows for peaking to satisfy minimum flow requirement
  - Minimum flow requirement of 212 cfs from the dam, or inflow, whichever is less, with an absolute minimum flow of 100 cfs regardless of inflow
  - Cheat Lake operations:

| Time of Year | Lake Elevation (ft) |
|---|---|
| May 1 – October 31 | 868 – 870 ft |
| November 1 – March 31 | 857 – 870 ft |
| April 1 – April 30 | 863 – 870 ft |

LAKE LYNN GENERATION

16

## EXISTING ENVIRONMENT AND PROJECT EFFECTS

### Geology and Soils

- Shoreline erosion surveys of the entire Cheat Lake shoreline conducted every 3 years since 1995 to identify new areas of erosion
  - Most recent survey (2017) of the entire Cheat Lake shoreline did not identify any new areas of erosion
- Annual shoreline erosion surveys of the Cheat Lake Park shoreline (Project dam to Cheat Haven peninsula) conducted since 1995
  - 2018 annual survey – no new areas of active erosion identified; previously identified areas exhibited minimal annual change in erosion levels
- Shoreline construction and reinforcement conducted in 2018 at two monitoring stations

No new issues anticipated related to geology and soils

LAKE LYNN GENERATION

17

## EXISTING ENVIRONMENT AND PROJECT EFFECTS

### Water Resources

**Hydrology and Streamflow**

- Six USGS gages in Project vicinity; closest measuring streamflow is Albright gage
- Annual flow statistics for Project (23 years of USGS gage records)

| | Annual (cfs) |
|---|---|
| Lake Lynn Project at the Albright Gage | |
| Min | 2,058 |
| Mean | 2,677 |
| Max | 3,568 |

**Water Quality**

- Hourly DO, pH, water temperature, and conductivity monitored continuously from April 1 through October 31 annually since 1997 at three locations; reported annually
- Recent data suggests water quality conditions upstream and downstream of Project dam generally meet state standards and have generally improved over time, except for periods of low DO generally in late summer/early fall for most years (September and early October), particularly at Cheat Lake monitor

Continued Project operations not anticipated to create any new adverse effects on water quality

LAKE LYNN GENERATION

18

## EXISTING ENVIRONMENT AND PROJECT EFFECTS

USGS Gage/Licensee Water Quality Data, 2008-2018

| Monitor/Gage | Water Temperature (°C) | pH | Dissolved Oxygen (mg/l) | Specific Conductance (µS/m at 25°C) |
|---|---|---|---|---|
| USGS Gage No. 03071590 Stewartstown Gage (Cheat Lake Site 07) | 3.2 - 26.7 | 6.4 - 7.3 | 1.0 - 12.8 | 48 - 205 |
| USGS Gage No. 03071605 Davidson Gage (Tailrace Site 08) | 3.5 - 27.4 | 6.3 - 7.4 | 3.4 - 14.0 | 52 - 178 |
| USGS Gage No. 03071690 Nilan Gage (Downstream Site 09 - from 2013 – Oct/Nov 2017) | 6.0 – 27.2 | 5.3 – 7.4 | 3.1 – 13.0 | 54 - 217 |
| USGS Gage 03071700 Point Marion Gage (Downstream Site 09 – site discontinued by USGS in September 2015[1]) | 0.2 – 27.5 | 4.0 – 8.3 | 5.5 – 15.2 | 61 – 681 |

[1] Data available through September 2015.

LAKE LYNN GENERATION

19

## EXISTING ENVIRONMENT AND PROJECT EFFECTS

Summary of WVDEP Ambient Water Quality Monitoring Data for Stations Closest to the Project, 2009-2019

| Parameter | MC-0001-3.5 (near the Project dam) | MC-0001-30 (upstream of Project) |
|---|---|---|
| Dissolved Oxygen (mg/L) | 5.31 – 15.41 | 6.15 – 14.98 |
| Temperature (ºC) | 0.22 – 27.0 | -0.07 – 29.03 |
| pH | 5.48 – 8.12 | 5.02 – 8.15 |
| Conductivity (µS/m) | 58.0 – 166.0 | 50.0 – 168.0 |
| Fecal Coliform (colonies) | 0 – 2,400[1] | 2 – 9,000[2] |
| Total ammonia nitrogen (mg/l) | 0.02 – 0.05 | 0.02 – 0.05 |

[1] Average number of colonies is 81.8 units.
[2] Average number of colonies is 290.9 units.

LAKE LYNN GENERATION

20

## EXISTING ENVIRONMENT AND PROJECT EFFECTS

### Fish and Aquatic Resources

- Cheat River supports warm water and cool water fish species
- Popular game species include largemouth bass, smallmouth bass, trout, crappie, walleye, and channel catfish.
- Fish and aquatic resources monitored through Project Biomonitoring Plan (and Plan updates) developed in consultation with DOI (USFWS), WVDNR, and PFBC
- Table 5.9 in the PAD summarizes comprehensive biomonitoring conducted over the past 22 years (1997-2019) and activities planned for 2020

LAKE LYNN GENERATION

21

## EXISTING ENVIRONMENT AND PROJECT EFFECTS

### Fish and Aquatic Resources

- Worked with WVDNR to conduct surveys 2005-2009 and WVU to conduct surveys March 2001-December 2015
  - Consisted of sampling water quality, physical habitat, and biota (fish and benthic macroinvertebrates)
  - Improvements in aquatic resources found
- Walleye Population Monitoring and Stock Assessment - Walleye stocking assessments and walleye surveys conducted 2005-2009 in Cheat Lake and Cheat Lake embayments

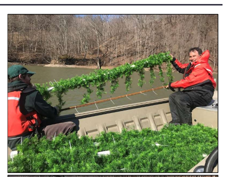
LAKE LYNN GENERATION

22

## EXISTING ENVIRONMENT AND PROJECT EFFECTS

### Fish and Aquatic Resources

- Monitoring Adult Walleye Movement - Seasonal movements and distribution of Cheat Lake walleyes were monitored using acoustic telemetry from 2012-2015
- Aquatic Vegetation Mapping - Worked with WVDNR and WVU to document the distribution and relative abundance of aquatic vegetation in Cheat Lake
- Aquatic Habitat Enhancement and Monitoring - Aquatic habitat enhancement structures installed March 2019; working with WVDNR and WVU to conduct pre-spawn, spawn, and post-spawn monitoring; consultation with resource agencies to be conducted to determine if additional enhancement/monitoring is warranted in 2020



LAKE LYNN GENERATION

23

## EXISTING ENVIRONMENT AND PROJECT EFFECTS

### Fish and Aquatic Resources

- Angler Creel Survey - A creel survey (survey targeting recreational anglers) will be conducted in 2020
- American eel eDNA - Working with USFWS in 2018 and 2019 to conduct sampling in Project tailwater for American eel DNA
- Benthic macroinvertebrate surveys - Conducted in Cheat Lake tailwater in 1997, 1998, 2001, 2005, 2008, 2011, 2014, and 2015

No issues anticipated related to fish species inhabiting Project waters

LAKE LYNN GENERATION

24

## EXISTING ENVIRONMENT AND PROJECT EFFECTS

### Wildlife and Botanical Resources

- Over 200 resident/transient bird species, 50 mammal species, and 37 amphibian species potentially occur in Cheat River habitats
- Botanical resources typical of Cheat River basin

### Riparian, Wetland and Littoral Habitats

- Most wetlands are open water lake areas followed by riverine habitat

### RTE Species

- List of federal/state listed RTE species potentially occurring, in vicinity of Project included in PAD – 2 bat species (Indiana bat and Northern Long-eared bat), 1 snail (Flat-spired Three-toothed Snail), and 1 plant (Running Buffalo Clover)

No known/expected issues related to wildlife, terrestrial botanical resources, or wetland/riparian habitat

LAKE LYNN GENERATION

25

## EXISTING ENVIRONMENT AND PROJECT EFFECTS

### Recreation

- Cheat Lake Park
- Cheat Lake Trail
- Tailrace Recreation Area
- Sunset Beach Marina Public Boat Launch
- Cheat Haven Peninsula Nature Viewing Area
- Morgan and Manning Run embayments Nature Viewing Area
- Nature Viewing Area Across from Cheat Haven
- Towers Run Nature Viewing Area

LAKE LYNN GENERATION

26

## EXISTING ENVIRONMENT AND PROJECT EFFECTS

### Recreation

- Recreation data collected 2000 through 2017
- Recreation Plan Updates filed every three years from 2003 through 2018
- Recreation use remained about the same over the 17-year monitoring period
- Cheat Lake boating carrying capacity study conducted in 2017
- No new permits for private piers or boat docks will be issued until after relicensing

No adverse effects to recreational opportunities anticipated

LAKE LYNN GENERATION

27

## EXISTING ENVIRONMENT AND PROJECT EFFECTS

### Land Use

- Project boundary generally follows the normal full pool elevation of the impoundment, except for several nature viewing areas, and includes certain lands immediately surrounding the Project facilities including the dam, powerhouse, access roads, and appurtenant facilities
- Leases and permits ("privilege permits") for private recreation access were historically granted
- Shoreline inventory conducted in 2013 to inventory boat docks along the Cheat Lake shoreline; inventory completed again in 2019 (after filing of the PAD)
- No new permits for private piers or boat docks will be issued until after relicensing

LAKE LYNN GENERATION

28

## EXISTING ENVIRONMENT AND PROJECT EFFECTS

### Aesthetic Resources

- No scenic highways or byways or National Wild and Scenic Rivers within the Project boundary or adjacent to the Project boundary

No issues identified relative to aesthetic resources

### Cultural Resources

- Two potentially significant cultural resources within the Project boundary – the railroad bed along the Cheat Lake Trail (a linear historic archaeological site) and the Lake Lynn powerhouse and dam (potentially eligible for the NRHP); no other historic properties identified within Project boundary

No new issues identified; no changes to the Project or Project operations

LAKE LYNN GENERATION

29

## EXISTING ENVIRONMENT AND PROJECT EFFECTS

### Tribal Resources

- 19 tribes identified as potentially interested in Project relicensing
- No tribal interests or issues identified to date

### Socioeconomic Resources

- No issues identified

LAKE LYNN GENERATION

30

## PROPOSED RESOURCE STUDIES

**Geology and Soils**
- Continue to conduct shoreline erosion surveys in accordance with the existing FERC License - no new studies

**Water Resources**
- Continue to collect and report water quality data in accordance with the existing FERC License - no new studies

**Fish and Aquatic Resources**
- Continue to conduct biomonitoring activities in accordance with the existing FERC License and the Biomonitoring Plan - no new studies

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31

## PROPOSED RESOURCE STUDIES

**RTE Species**
- Presence/absence surveys for RTE species likely to occur within FERC Project boundary

**Recreation**
- Conduct inventory of existing Project recreation sites
- Collect recreation use data in 2020 and file the next Recreation Plan update by March 31, 2021 (consistent with FERC's Order modifying and approving the 2018 Recreation Plan Update)
- Conduct a creel survey (survey that targets recreational anglers) in 2020 (consistent with 2018 Biomonitoring Plan)

LAKE LYNN GENERATION

32

## PROPOSED RESOURCE STUDIES

**Cultural Resources**
- Consult with the WVSHPO and PHMC and submit the Project to the SHPO for formal review

LAKE LYNN GENERATION

33

## NEXT STEPS RELICENSING SCHEDULE

| Activity | Responsibility | Timeframe and Regulations | Dates |
|---|---|---|---|
| File NOI, PAD, and Request to use TLP and publish Public Notice in newspapers | Lake Lynn | 5 to 5 ½ years prior to license expiration | August 29, 2019 |
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LAKE LYNN GENERATION

34

## FERC STUDY CRITERIA

1. Describe goals and objectives of study proposal
2. Explain relevant resource management goals
3. Describe any existing information
4. Explain relevant public interest if requester is not a resource agency
5. Nexus to project operations and effects and how study results would inform development of license requirements
6. Methodology consistent with accepted practice
7. Consideration of level of effort and cost and why alternative studies would not suffice

LAKE LYNN GENERATION

35


36

## CONTACT

LAKE LYNN GENERATION, LLC

Jody Smet
Director, FERC Licensing and Compliance
2 Bethesda Metro Center, Suite 1330
Bethesda, MD 20814
jsmet@cubehydro.com
Tel: 804-739-0654

LAKE LYNN GENERATION

37

**Attachment 2**
**Site Visit Summary**

**LAKE LYNN GENERATION, LLC**
**LAKE LYNN HYDROELECTRIC PROJECT (FERC NO. P-2459) RELICENSING**

**SITE VISIT SUMMARY**
**DECEMBER 12, 2019**

Site Visit Participants[1]

| Name | Affiliation | Email Address |
|---|---|---|
| Amy Wagner | Citizen | awagner1595@gmail.com |
| Bob Flickner | Lake Lynn Generation, LLC (Lake Lynn) | rflickner@cubehydro.com |
| Dale Short | Lake Lynn | dshort@cubehydro.com |
| Dan Miller | Potesta | dmiller@potesta.com |
| Dave Hough | | davecyndy@frontier.com |
| Duane Nichols | Cheat Lake Environment & Recreation Association (CLEAR) | duane330@aol.com |
| Ella Belling | Mon River Trails Conservancy | ella@montrails.org |
| Jacob Harrell | West Virginia Division of Natural Resources (WVDNR) | Jacob.D.Harrell@wv.gov |
| Janet Norman | U.S. Fish and Wildlife Service (USFWS) | Janet_Norman@fws.gov |
| Jody Smet | Lake Lynn | jsmet@cubehydro.com |
| Joyce Foster | TRC | jfoster@trcsolutions.com |
| Karen Baldwin | Lake Lynn | kbaldwin@cubehydro.com |
| Lewis Barnes | The Lakehouse Restaurant | szybarnes@yahoo.com |
| Mike Strager | CLEAR/Friends of the Cheat/West Virginia University | mstrager@gmail.com |
| Owen Mulkeen | Friends of the Cheat | owen@cheat.org |
| Parke Johnson | Greystone Estates | graceandparke@yahoo.com |
| Richard Scott | Resident | qtrking86@yahoo.com |
| Roger Phillips | Resident | rogerdalephillips@gmail.com |

Site Visit Summary

The group gathered at approximately 1:30 p.m. at Sunset Beach Marina. Participants were noted on the Joint Meeting sign-in sheets. The group viewed the public launch ramp at Sunset Beach Marina.

Some participants departed from the Site Visit at Sunset Beach Marina. The remaining participants caravanned to the upper parking area at Cheat Lake Park. The group walked to the lower area of the park near the playground area and continued along the south end of the Cheat Lake Trail. The group viewed the beach area along the trail. The group was given the option of continuing to walk along the trail to the wash-out area or returning to the park. The group decided to return to the park. The group viewed the winter boat ramp at Cheat Lake Park and then returned to their vehicles.

[1] This list includes the participants at the first stop on the Site Visit. Some participants left the Site Visit after this first stop and did not continue on the Site Visit.

Due to the small size of the group planning to continue to the powerhouse, the group decided to caravan in two vehicles along the north end of the Cheat Lake Trail to the powerhouse. Before entering the powerhouse facilities, Lake Lynn provided safety gear. Dale Short and Bob Flickner (Lake Lynn) provided a safety briefing. Mr. Flickner led the tour of the powerhouse facilities and provided an overview of the project facilities.

After the tour of the powerhouse facilities, the group viewed the reopened Tailwater Fishing Pier from the powerhouse parking area. The group caravanned along the north end of the Cheat Lake Trail and returned to the vehicles at the Cheat Lake Park upper parking lot.

The site visit concluded at approximately 4:30 p.m.

*Site Visit Discussion Topics*

Topics discussed during the Site Visit included:

- Concerns about parking overflow from Sunset Beach Marina blocking the road so that residents cannot access their property;
- Excavation at Sunset Beach Marina;
- Unauthorized trail across Lake Lynn's property to join the Cheat Lake Trail;
- Possible shoreline vegetation enhancement at Cheat Lake Park;
- Concern over a portion of the dock at the winter boat ramp that was damaged;
- Maintenance at recreation sites; and
- Questions and clarifications regarding operations, fish, American eel eDNA sample locations, and dissolved oxygen.

**Attachment 3**
**Proof of Publication of Newspaper Notices**

010152287 November 20

**NOTICE OF JOINT MEETING AND SITE VISIT**
**LAKE LYNN HYDROELECTRIC PROJECT (FERC NO. 2459)**

On August 29, 2019, Lake Lynn Generation, LLC (Lake Lynn) filed with the Federal Energy Regulatory Commission (FERC) a Notice of Intent to File a License Application (NOI), Pre-Application Document (PAD), and Request to Use the Traditional Licensing Process (TLP) for the relicensing of the Lake Lynn Hydroelectric Project (Project) (FERC No. 2459) located on the Cheat River in Monongalia County, West Virginia and Fayette County, Pennsylvania. By letter dated October 17, 2019, FERC approved Lake Lynn's request to use the TLP.

Lake Lynn is holding a joint meeting and site visit in accordance with FERC requirements (18 CFR § 16.8 (b)(3)(ii)). The joint meeting and site visit are open to the public. The joint meeting will be held at 10:00 a.m. on Thursday, December 12, 2019, at the Cheat Lake Volunteer Fire Department located at 409 Fairchance Road, Morgantown, West Virginia 26508. The site visit for the Lake Lynn Project will be held immediately following the meeting.

The purpose of the joint meeting is to outline Lake Lynn's plan to relicense the Project and provide a forum for comments and questions about the Project and the relicensing process. The agenda for the meeting includes an overview of the relicensing process and schedule, an overview of the Project, an overview of the information provided in the PAD filed with FERC, a summary of the proposed resource studies, and a description of the next steps in the relicensing process.

If you have any questions regarding the joint meeting or site visit or would like to request a detailed meeting agenda, please contact Ms. Jody Smet at jsmet@cubehydro.com or 804-739-0654. **Please note that you MUST RSVP your participation to Jody Smet at jsmet@cubehydro.com or 804-739-0654 no later than November 29, 2019.**

**DominionPost**

1251 Earl L Core Road
Morgantown, WV 26505
(304) 291-9420

*PUBLISHER'S CERTIFICATE OF PUBLICATION*

I, **Brad Pennington,** Advertising Director of THE DOMINION POST, a newspaper of general circulation published in the City of Morgantown, County and State aforesaid, do hereby certify that the annexed

Legal Notice

was published in the said THE DOMINION POST once a week for **1** successive weeks commencing on the **20th** day of **November**, **2019** and ending on the **20th** day of **November** ,**2019**

The publisher's fee for said publication is **$59.06**

Given under my hand this **20th** day of **November** , **2019**

Brad Pennington (SEAL)

Advertising Director of THE DOMINION POST

Subscribed and sworn to before me this **20th** day of **November** , **2019**

Karen E. Gonzalez

Notary Public of Monongalia County, W. Va.

My commission expires on the 12 day of September 2023.

OFFICIAL SEAL
NOTARY PUBLIC
STATE OF WEST VIRGINIA
Karen E. Gonzalez
WV Newspaper Publishing Co.
1251 Earl L. Core Rd.
Morgantown, WV 26505
My Commission Expires Sept. 12, 2023

# HERALD-Standard

8 East Church Street
Uniontown, PA 15401-0848
Phones: 724-439-7510 (Classified) 724-439-7509 (Billing)

**PUBLIC NOTICE ADVERTISING NOTICE**

**Account Number:**

**Proof Date:** 11-19-19

**Ad Number:** 3768

**TRC**
**ATTN: JOYCE FOSTER**
**179 CLARKS LANE**
**AYLETT, VA 23009**

PROOF CHARGE IS $5.00 FOR AFFIDAVIT, $2.50 FOR CLERICAL FEE

FOR YOUR RECORDS ONLY

| ACCOUNT # | DESCRIPTION | LINES | TIMES | PROOF | TOTAL CHARGES |
|---|---|---|---|---|---|
| | NOTICE OF JOINT MEETING AND SITE VISIT I | 36 | 1 | 7.50 | .00 |
| 11-19-19 | | | | | |
| DATES APPEARED | | | | | |

## PROOF OF PUBLICATION

The HERALD-Standard
a daily newspaper of general circulation, published by Central Pennsylvania Newspapers, LLC., a Pennsylvania corporation, 8 East Church Street, Uniontown, Fayette County, Pennsylvania, was established in 1907, and has been issued regularly, except legal holidays since said date.

The attached advertisement, which is exactly as printed and published, appeared in the regular issue

**Central Pennsylvania Newspapers, LLC./Herald Standard**

By Sharon K Wallach

**STATE OF PENNSYLVANIA,**
**COUNTY OF FAYETTE,** } **SS:**

Before me, a Notary Public in and for such county and state, personally appeared SHARON K. WALLACH , who being duly sworn according to law says that she is ADVERTISING DIRECTOR of Central Pennsylvania Newspapers, LLC./Herald-Standard that neither affiant nor said corporation is interested in the subject matter of the attached advertisement; and that all of the allegations of the foregoing statement including those as to the time, place and character of publication are true.

Sworn to and subscribed before me this 19th day of November 2019

Commonwealth of Pennsylvania - Notary Seal
Beverly L. Paull, Notary Public
Fayette County
My commission expires August 8, 2023
Commission number 1355326
Member, Pennsylvania Association of Notaries

By Beverly L Paull

**Central Pennsylvania Newspapers, LLC.** **8 East Church Street** **UNIONTOWN, PA. 15401-0848**

ADNo: 3768 Customer Number:
Customer Name: Company: TRC
Address: ATTN: JOYCE FOSTER 179 CLARKS LANE
City/St/Zip: AYLETT ,VA 23009
Phone: (804) 769-1667 Solicitor: SM
Category: 10 Class: 10 Rate: LE-0 Start: 11-19-2019 Stop: 11-19-2019
Lines: 36 Inches: 3.50 Words: 307

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Credit Card: Am. Express ##############1002 Expire: 04-20
Order Number:
Cost: 210.86 Adjustments: .00
Payments: 210.86 Discount: .00
Balance: .00

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**NOTICE OF JOINT MEETING AND SITE VISIT**
**LAKE LYNN HYDROELECTRIC PROJECT (FERC NO. 2459)**

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**DIVISION OF NATURAL RESOURCES**
**Wildlife Resources Section**
**District 1**
**P.O. Box 99**
**1110 Railroad Street**
**Farmington, West Virginia 26571-0099**
**Telephone (304) 825-6787**
**Fax (304) 825-6270**

**Jim Justice**
***Governor***

**Stephen S. McDaniel**
***Director***

February 12, 2020

Electronic file

Kimberly D. Bose, Secretary
Federal Energy Regulatory Commission
888 First Street, N.E.
Washington, DC 20426

**RE: Lake Lynn Hydroelectric Project (FERC no. P-2459); Notice of Intent, Pre-Application Document, and Study Requests**

Dear Secretary Bose:

Thank you for allowing the West Virginia Division of Natural Resources, Wildlife Resources Section (WRS) the opportunity to provide comments with regards to the referenced Pre-Application Document (PAD) for the relicensing of the Lake Lynn Hydroelectric Project (Project), FERC No. 2459. Lake Lynn Generation, LLC (Licensee or Applicant) has elected to utilize the Traditional Licensing Process in preparing for a new license. The current Project license was issued on December 27, 1994 and is set to expire on November 30, 2024. The applicant submitted the referenced NOI/PAD in accordance with FERC regulation and consistent with the requirements of 18 CFR § 5.5.

The Project is an established hydroelectric project located on the Cheat River adjacent to the border between Pennsylvania and West Virginia with Project areas located occupying lands in

both states. The Project has an installed project capacity at 51.2 MW using four Francis generating units. The comments below are being provided pursuant to 18 C.F.R §4.38(b)(5).

**Section 4.2 Project Facilities**

The description of the Project facilities described within this section makes mention of trash racks installed at the intake facility. Beyond that, there is no further information regarding the specifications of the trash racks. Based on a preliminary site visit, it would appear as if the trash racks were of a steel construction and installed with spacing of approximately 5-inches. Such large trash rack spacing allows for the entrainment of larger fish that would be more susceptible to blade strikes and turbine-induced mortality as these fish enter the intake structures and pass through the turbines. In an effort to reduce fish mortality, the WRS would request that the trash rack spacing not exceed 3 inches and have an approach velocity of no more than 2.0 fps. The WRS further recommends angled trash racks be employed as a means to further reduce entrainment.

**Section 4.4 Current and Proposed Project Operations**

The current FERC license requires an operation schedule whereby the lake elevation is maintained between 868 and 870 feet from May 1 to October 31, between 857 and 870 feet from November 1 through March 31, and between 863 feet and 870 feet from April 1 through April 30. The April 1 to April 30 schedule was initially designed as a provision to reduce the Project's impacts on spawning fish populations within the lake, particularly yellow perch and walleye. The thinking at that time was that these fish species predominantly spawned during the early Spring month of April. Recent data has become available through the triennial biomonitoring studies, in particular a recent analysis of yellow perch habitat, which may indicate that in some years, based on temperature and weather conditions, the spawn may begin in mid-March and extend into Mid-April or later. Similar results were observed in a study on the walleye populations within the lake by a member of the WRS staff whereby the walleye spawn was documented as early as mid-March. Considering, there is concern that the lake elevation schedule during the month of March (between 857 and 870 feet) would not be sufficient in protecting the spawn and would have the potential to dewater a great many eggs thus impacting recruitment. It may be necessary, then, to revisit the current project operations and examine possible avenues to protect these species throughout the spawning season. A new schedule could be based on temperature such that in normal years the schedule can remain as is, but in warm years where the WRS, based on water temperature variables (45ºF for a sustained period in March), anticipates that an early spawning period would occur, the April elevation schedule could be moved back to mid-March.

**Section 5.2**

The continuous monitoring of water quality as required by License Article 405 of the existing Project License is an invaluable tool in the management of the resources. As such, the WRS would request that water quality monitoring within the reservoir and tailwaters be continued throughout the term of the upcoming license.

**Section 5.3.2.2 Catadromous and Diadromous Species**

This passage asserts that "there is no known occurrence of the American eel in the Cheat River basin, however...eels have been collected in the Ohio River basin from the Kanawha, New, and Greenbrier Rivers." In fact, the American eel has also been collected in the Monongahela River within the past 10 years as far upstream as the Morgantown Lock and Dam. This point is upstream of the confluence of Cheat River with the Monongahela River. It could therefore be assumed that there is a strong likelihood that the American eel may also be located within the Cheat drainage. However, it should be noted that, at least with regards to recent data collection, the American eel has not been observed within the tailwaters of the project. A recent eDNA study of the Project tailwaters resulted in no positive recordings of the American eel. The reasons for the negative results may be because of study design or perhaps because there were no eels in the Cheat River watershed. Nonetheless, it is the WRS' understanding that the US Fish and Wildlife Service (USFWS) will be requesting additional analysis of the Project waters to determine presence or absence of the American eel. The WRS would not be opposed to any USFWS request regarding this particular subject matter.

**Section 5.3.2 Fish Resources and Habitats**

As per state rule §47-5A-6, reimbursement for the incidental loss of fish due to project operation will be required. Therefore, the WRS would request that a comprehensive desktop entrainment study be utilized to determine the likely number of fish, fish species, and size classes to become entrained and experience mortality as a result of the Project's operation.

**Section 5.3.2.3 Fish Passage**

The major components of a hydropower facility (i.e. the turbines) pose a particular risk to fish passage and an additional impediment to fish passage. Project operations may attract fish moving downstream to pass through the turbines creating an unnecessary risk for mortality. It is the flowing water through the Project that initially attracts the migrating fish. Additionally, passage over the spillway could also be hazardous for fish. To minimize the potential hazards for the downstream movement of fish, the WRS would request that a feasibility study be conducted to explore potential options for a bypass system or diversionary tactics.

**Section 5.8.3.4 Public Boat Launching Facility at Sunset Beach Marina**

Sedimentation at the Sunset Beach Marina has become a significant issue over the years and has only worsened to the point by which anglers and boaters are affected. Launching a boat from this area has become more challenging and at some levels, is next to impossible. The Licensee has made great strides in correcting the sedimentation via dredging the embayment. Still, there is concern that this is a temporary fix and without a plan in place to address future sedimentation of the embayment, this is a problem that will likely occur again. Therefore, the WRS would request the licensee draft a sedimentation plan in an effort to minimize future sedimentation and reduce costly dredging activities.

**Section 5.8.5 Boating Carrying Capacity Study**

The results of the boating carrying capacity study would suggest that the number of boaters using Lake Lynn at any given time has exceeded that of a safe operating amount for the lake. Law enforcement records have yet to show any significant increase of incidents. Nevertheless, the WRS is not opposed to the Licensee's moratorium on new private piers/boat docks within the Project reservoir. According to the scoping meeting, the moratorium was enacted by the Licensee as a temporary measure to reduce the number of boats on the lake with the intention to lift the moratorium, or at least re-examine its effectiveness, following the relicensing process. The WRS views the moratorium as being beneficial in reducing the level of impact to shoreline habitat caused by the continued construction of the lake shoreline. Shoreline habitat is critical for a healthy, sustainable fishery and therefore, the WRS would be not be opposed to continuing the moratorium beyond the FERC relicensing of the Project.

**Section 6.2.7.1 Potential Issues and Project Effects**

This section lists a proposal to "create public access to the upper reaches of Cheat Lake by improving an existing gated road in Snake Hill Wildlife Management Area along Buzzard Run." The WRS would be unequivocally opposed to this proposal. The WRS is not interested in opening up the gated road that passes through the WMA property. Continued maintenance of the access road would be problematic and an undue burden for the state and the Licensee with very little benefit to the WRS' prime constituents.

**State 401 Water Quality Certification**

Section 401(a)(1) of the federal Clean Water Act, 33 U.S.C. § 1341(a)(1) provides that any applicant of a federal license or permit must obtain a state certification from the appropriate state certifying agency. This certification is to ensure that any activity conducted under the license are to be in compliance with all applicable provisions of the Clean Water Act. The state of WV will have one year to act on a received 401 application from the date the US Army Corps of Engineers deems the federal 404 application to be complete.

**Study Requests**

The WRS is in support of the studies proposed by the Licensee for the Lake Lynn Hydroelectric Project as identified within the PAD. Additional studies not previously included within the PAD are being provided by the WRS. The WRS makes these requests in support of currently proposed studies, to correct deficiencies in data and to offer a greater level of detail where needed. The WRS further requests the opportunity to review any study plans associated with this project. The request format is in accordance with that described in 18 CFR § 5.9 (b).

**Study Request 1: Entrainment Study**

**Goals and Objectives:**

The goal of the proposed study is to determine the number of fish that are either entrained or impinged and to estimate the injury and mortality of fish that pass through the turbines during

Project operation. The WRS is requesting a desktop entrainment study be conducted on the Lake Lynn Project. The goal of the desktop study will be to estimate mortality for compliance with state code.

As the resource agency, it is the goal of the WRS to manage and protect the resources. To the furtherment of this goal, WV code §47-5A-6 requires that mitigation be completed for any impacts to the resources. In this case, entrainment of fish through the turbines causes undue stress to the fish and can potentially be fatal. Therefore, the WRS would request that any mortality in fish be compensated. In order to properly ascertain the number of fish that succumb to mortality, an entrainment study will need to be performed.

The WRS recommends a desktop entrainment analysis utilizing the EPRI database. Data used for the analysis should be presented by species and by two-inch size classes. The WRS would further recommend that a field component be incorporated to verify results.

**Resource Management Goals:**

The WRS is charged with the protection and management of all wildlife within West Virginia, including within Cheat river and Lake Lynn. As per state rule §47-5A-6, the State would require the applicant to compensate the state for any loss of fish.

**Existing Information:**

To the best of its knowledge, the WRS is not aware of any entrainment studies that have been conducted at the Project. The years of biomonitoring data conducted in accordance with the existing license, will help to inform this entrainment analysis.

**Nexus Between Project Operation:**

During Project operation, fish of a certain size are able to pass through the trash racks and become entrained through the turbines. As the turbines operate, it is likely that some fish will be struck by the turbine blades while others will succumb to changes in barometric pressures as they pass through the intake. The likelihood of a blade strike and turbine-induced mortality increases as the size of the fish increases. Therefore, compensatory mitigation will be required as replacement for the loss of fish.

**Study Methodology:**

The methodology employed should include a combination of desktop entrainment analysis and field verification. The standard practice has been to utilize the Electric Power Research Institute (EPRI) turbine entrainment and survival database as a model in evaluated the potential of entrainment at a facility. The WRS has had concerns that this particular practice lacks the scientific creditability necessary to make informed decisions about the management of the fishery. Therefore, the WRS requests the opportunity to review any entrainment data considered

for use in the desktop entrainment analysis. Further, the WRS may request that a verification procedure be incorporated as a means to test the veracity and accuracy of the desktop entrainment results. Deploying hydroacoustics sampling techniques may be one way to achieve this goal as a more cost-effective method than deploying nets downstream. Data for any type of analysis should be presented by species and by 2-inch class sizes to remain consistent with general state practices. The WRS is willing to further discuss methodologies with the applicant.

**Level of Effort and Cost:**

The level of effort required to conduct a desktop entrainment analysis is relatively minor and most consulting firms/universities are well equipped to perform such an analysis. Additionally, the cost of a desktop entrainment analysis is much more attainable when compared to the alternative of an in-field entrainment analysis. Incorporating an in-field verification procedure with the analysis will increase the level of effort and cost and would require certain levels of training, expertise, and equipment. Nonetheless, an in-field verification procedure is still attainable and within reasonable limits of effort and cost.

**Study Request 2: Upstream/Downstream Fish Passage and Feasibility Study**

**Goals and Objectives:**

The goals of this study are to assess movement of fish through the project area; identify likely routes fish would take under a variety of conditions; and assess the feasibility of incorporating alternative routes or additional fish protection measures.

**Existing Information:**

To the best of its knowledge, the WRS is unaware of any study on upstream/downstream passage at the Project. Any study that may have been completed is likely dated material and incompatible in reflecting current conditions and population dynamics.

**Nexus Between Project Operation:**

Dam features, because of their general nature, impede the upstream and downstream movement of fish. By design, the dam at the Project affords no migration upstream. Downstream migration is offered by one of two routes: through the dam gates; and through the Project's powerhouse. Neither of these two routes provides for a safe migration downstream. The route through the powerhouse would mean risking turbine strikes or dangerous changes in barometric pressure. The route through the dam gates may provide for an equally perilous journey with fish tumbling down rough concrete faces. It is evident, then, that the Project has a direct relationship to fish passage.

**Study Methodology:**

Methodology would include a literature review of all available options for bypass routes and fish protection measures and an analysis on how such measures could be incorporated into the current project designs. Architectural design and structural engineers would need to be consulted for their expertise in determining feasibility of any new structural component at the project.

**Level of Effort and Cost:**

A study such as this would most likely take less than a year to complete with minimal effort. Discussions with engineers and reviews of designed structures would be necessary to properly assess the feasibility of any bypass channels or fish protection structures. Additionally, this study could be completed in concert with study request #1 (entrainment study) to reduce costs and effort. The WRS is not aware of the cost associated with this study but would assume it to be at a nominal rate.

**Study Request 3: Reservoir Sedimentation Study**

The WRS is requesting that a sedimentation study of the Project's reservoir be conducted at the problem areas and a plan to monitor and address any sedimentation issues be developed.

**Goals and Objectives:**

The goal of this survey is to asses sedimentation within certain problem areas within the Project reservoir and to develop a plan to address any deficiencies as they arise.

**Existing Information:**

Reports of sedimentation affecting boaters and anglers have risen in recent years, but as of yet no study that the WRS is aware of has been conducted on the sedimentation and no plan has been developed to address it. Steps to remedy sedimentation are typically taken when the issue rises to unsuitable levels. A more preventive strategy here may reduce future costs of sediment removal and keep recreation areas open without issue.

**Nexus Between Project Operation:**

By their very nature, dams cause sedimentation within the reservoir as the moving water slows down and particles are allowed to settle out. Therefore, the Project operations have a direct influence on the level of sedimentation.

**Study Methodology:**

The methodology should begin by examining possible sources of sedimentation within the reservoir and then by identifying potential preventive measures that could be taken to reduce the level of sedimentation in those areas that have demonstrated an affinity for a build-up of sediment (i.e. Sunset Beach).

**Level of Effort and Cost:**

Most consulting firms and universities would be fully capable of conducting a sedimentation study, including interpreting and analyzing the data. The costs of such a study is variable dependent on contractor used to conduct the study and the level of attention to detail.

The WRS appreciates the opportunity to provide comments and to make study requests. If you have any questions regarding this letter, comments made, or these study requests, please contact me by telephone at (304)825-6787, or by email at Jacob.D.Harrell@wv.gov.

Sincerely Yours,

Jacob Harrell
Hydropower Coordination Biologist

Cc: Jody Smet, Lake Lynn Generation, LLC
David Fox, Lake Lynn Generation, LLC
Janet Norman, USFWS
Paul Johanson, WVDNR
Mark Scott, WVDNR
Zack Brown, WVDNR
David Wellman, WVDNR
Danny Bennett, WVDNR

LAKE LYNN HYDRO PROJECT: ISSUES AND COMMENTS FOR RELICENSING

SUBMITTED BY: Duane Nichols, President, Cheat Lake Environment & Recreation Association, 330 Dream Catcher Circle, Morgantown, WV 26508

RE: Project P-2459, Relicense for Lake Lynn Hydroelectric Project. Date: February 10, 2020

1. Clear and complete procedures are needed for Trail maintenance and repair, for both routine and non-routine circumstances.

2. Clear and complete goals, guidelines and procedures are needed for the Sunset Beach marina and other marinas, to cover the operation, maintenance and planning for the future.

3. Boating is a primary recreational activity on the Lake, so there is a need for boating guidelines and limits consistent with the rules and regulations of the WV DNR. Boat guidelines and regulations, public dock maintenance, channel depth (dredging), parking lot criteria, etc., are all in need of explicit definition and guidance.

4. Periodic lake cleanup activities need to be continued by CLEAR and others with the support of Lake Lynn Hydro to remove plastic and structural debris floating in the lake and backwaters. The CLEAR pontoon boat should be useful for these activities.

5. Given that the Lake is limited in boating capacity during busy weekends, the limit has been reached for the number of marinas, boat slips and personal access area sites.

6. Swimming beach season should match the boating season of May 1$^{st}$ to October 31$^{st}$

7. Regular maintenance of the swimming beach is needed to remove large debris (mainly tree segments) and to keep quality sand fresh and deep, as mostly children use it.

8. The swimming beach area needs to be extended toward the day-use boat docks to permit the designation of a dog beach, given that dogs interfere with the swimming experience of small children; this will also add space for additional picnic tables, that are already needed.

9. Monitoring and remediation of the on-going shoreline erosion are needed with components of these activities taking place on an annual basis.

10. Hillside slips, ground subsidence and washouts along the Trails must be prepared for, as they are not uncommon, so that monitoring, temporary work-arounds and repairs can take place in a timely manner.

11. Signage on WV 857 for the Cheat Lake Park & Trail needs to be maintained year round and the signage on the Trail maintained for public use year round.

12. Telephone(s) & email address(es) are needed on signs and on web page(s) for information and for emergencies.

13. Formal plans and procedures are needed that assigns responsibilities for the various types of emergency at the Dam, on the Trails, on the Lake, downstream in Pennsylvania, etc.

14. Brochures are needed for public distribution to include the history, overview of facilities, rules/regulations, contacts, etc.

15. The Internet Web-Site is needed with multiple pages to include the brochure information, lake level, operational updates, warnings, etc.

16. News Releases (quarterly & timely) are needed providing general information, trail closings, warnings and other items for current news.

17. For the Fishing Pier, there is a need to identify the opportunities, guidelines, operation and maintenance schedules.

18. A continued commitment to regional trail development should include interfacing with the proposed Sheepskin Trail in Pennsylvania, for a connection to other regional trails, to involve the opening of the trail level gate at the Lake Lynn Dam for daylight walking, hiking, jogging and bicycling.

19. For the Lake level protocol, there is a need to reiterate the water level ranges vs. months of the year on the Web-site and in the Brochure(s).

20. For the Recreation Season protocol, there is a need to reiterate the schedule of May 1 thru October 31, with the Trail being open and accessible year round. The “boat launch” in the Park is essential for summer use by kayak & canoe users and for winter use by fishing boat users.

21. There is a need for a description of the functions of (existing & new) recreation personnel, security personnel, park maintenance personnel; and guidelines are needed for the interaction of these people with public.

22. An Advisory Committee is needed with Quarterly meetings and quarterly reports, consisting of members from Monongalia County, WV-DNR, WVU, WV trail group, PA trail group, PA-DNR/DEP, plus 2 or 3 local environmental/conservation groups.

23. A study of the details of the history of Cheat Lake and the Lake Lynn Dam is needed to examine the role of the project there on the Mason-Dixon Line affecting both West Virginia and Pennsylvania, whether it is a private “for-profit” entity with public obligations or whether it is “for the public interest” to provide recreation and a public service (electricity). These considerations take on a greater significance when foreign ownership is under way.

The Cheat Lake Environment & Recreation Association (CLEAR) has been active to promote the public use of Cheat Lake for over 30 years. The officers are Duane Nichols, President, Mike Strager, Vice President, Ann Chester, Secretary, and Donna Weems, Treasurer.

CONTACT INFORMATION: Duane G. Nichols, 330 Dream Catcher Circle, Morgantown, WV 26508. Phone: 304-216-5535, Email Address: Duane330@aol.com

Submitted by Duane Nichols of CLEAR this 10th day of February 2020.

Document Content(s)

United States Department of the Interior

FISH AND WILDLIFE SERVICE

Chesapeake Bay Field Office
177 Admiral Cochrane Drive
Annapolis, Maryland 21401
http://www.fws.gov/chesapeakebay

February 13, 2020

Jody Smet
Director, FERC Licensing and Compliance
Lake Lynn Generation, LLC
2 Bethesda Metro Center, Suite 1330
Bethesda, MD 20814

Dear Ms. Smet:

The U.S. Fish and Wildlife Service (Service) has reviewed the October 17, 2019 Notice of Intent (NOI) to File for a License and attached Pre-Application Document (PAD) for the Lake Lynn Hydroelectric Project (FERC #2459), filed by Lake Lynn Generation, LLC (Applicant). The Applicant has elected to use the Traditional Licensing Process (TLP) for this re-licensing application of the Lake Lynn Hydroelectric Project on the Cheat River near Morgantown, West Virginia and in Fayette County, Pennsylvania. The current project license was issued on December, 1994 and will expire on November 30, 2024.

The Service attended the Joint Agency meeting and site visit on December 12, 2020 in Morgantown, WV, with the Applicant, state and local agencies, and interested residents. We offer the following recommendations on the PAD and our Study Requests.

The following comments are provided pursuant to the Endangered Species Act (ESA) of 1973 (87 Stat. 884, as amended: 16 U.S.C. 1531 *et seq.*), the Migratory Bird Treaty Act (16 U.S.C. 703-712; Ch. 128; July 13, 1918; 40 Stat.755), and the Fish and Wildlife Coordination Act (48 Stat. 401, as amended; 16 U.S.C. 661 *et seq.*).

The project is a 51.2 megawatt (MW) single development project operated since 1926. It consists of: 1) a 125-foot high by 1,000-foot long concrete gravity-type dam with a 624-foot long spillway controlled by 26 Tainter gates, each 17 feet high by 21 feet long; 2) a reservoir with a surface area of 1,729 acres and containing about 72,00 acre-feet of water at full pool elevation of 870 feet National Geodetic Vertical Datum; 3) a log boom and track racks at the intake facility; 4) eight 12-foot by 18-foot gated penstocks of reinforced concrete; 5) a 72-foot by 165-foot by 68-foot high brick powerhouse containing four identical Francis generating units with a total rated capacity of 51.2 MW; 6) dual 800-foot long 138-kilovolt transmission lines; and 7) appurtenant facilities. In 2018, the licensee completed a turbine replacement and upgrade of Unit 2.

**Pre-Application Document**

Section 4.4 Current and Proposed Project Operations.

The Service supports the concerns of the West Virginia Division of Natural Resources (WV DNR) regarding the quality and timing of available yellow perch (*Perca flavenscens*) and walleye (*Sander vitreus*) habitat within the reservoir lake, with proposed drawdown operations. Their assessment is that the lake elevation schedule during the month of March (between 863 and 870 feet) is likely insufficient to protect the spawning period and could dewater many fish eggs which would hamper recruitment to the populations. We would like to better understand how lake levels, downstream flow releases, and draw down schedules impact fish and wildlife resource needs so we can determine whether there are ways to minimize these impacts.

Section 5.2 Water Resources

The current License Article 405 (continuous monitoring of water quality) has proved very beneficial to the Licensee and resource agencies as this monitoring resulted in effective management of a low flow event during the summer/early fall of 2019. The Service believes this monitoring should be continued in any new license condition granted.

Section 5.2.3 Streamflow, Gage Data and Flow Statistics

This section of the PAD does not provide sufficient information for the Service to fully assess the seasonality, duration and magnitude of streamflows inflowing to the reservoir and dam, and the appropriate flow releases for the upcoming license period. The graphs in Appendix E (Flow Duration Curves) are not scaled appropriately to discern the patterns of what occurs in the 5 to 99 percent exceedance flows that we would need to examine. It would be helpful if the maximum flow event(s) and duration for the period record 2016 to 2019 is displayed separately from the rest of the graphs so as not to flatten all other flow interpretation.

The Service does not see the Project Instream Flow Study which is referenced in this section of the PAD, contained in Appendix E, in order to assess its applicability to current and future conditions. Without this information, we have many remaining questions, and would recommend an Instream Flow Study to help us determine appropriate flow releases in the new license articles.

The Service also believes a mussel survey should be conducted downstream in the tailwater area and downstream reaches to assess this valuable component of the aquatic community and potentially help inform our flow regime recommendations for the project.

Section 5.7.2 Rare, Threatened and Endangered Resources and Habitats

Table 5.16 of the PAD identifies four species federally listed under the ESA with the potential to occur in the project area, Indiana bat *(Myotis sodalis*), northern long-eared bat (*Myotis septentrionalis*), running buffalo clover (*Trifolium stoloniferum*), and the flat-spired three-toothed snail (*Triodopsis platysayoides*).

The federally threatened northern long-eared bat and the federally endangered Indiana bat are temperate, insectivorous migratory bats that hibernate in mines and caves during the winter and spend summers in wooded areas. There are no known northern long-eared bat maternity roosts

or hibernacula within the immediate vicinity of this site. Indiana bats are most likely to be in maternity roosts from May 1 to July 31.

Any project-related tree removal (e.g., for maintenance or recreational improvements) should involve consultation with the Service under Section 7 of the ESA, for the protection of the Indiana bat and northern long-eared bat.

The Service filed an August 27, 2019 Proposed Rule in the Federal Register for the de-listing of running buffalo clover (*Trifolium stoloniferum*) found at this web address: https://www.govinfo.gov/content/pkg/FR-2019-08-27/pdf/2019-18413.pdf#page=1. Its current status is still federally endangered as of this comment date. However, we believe this existing project with minor habitat modification of the project area will not likely adversely affect running buffalo clover, a terrestrial plant. We therefore, are not requesting surveys for the plant.

The flat-spired three-toothed snail is found within Monongalia County, West Virginia in close proximity to the project, but is not found within the project boundary. It is found in Coopers Rock State Forest, primarily on the rock bluffs. The area within the project boundary lacks the habitat requirements for the snail, therefore, this project will have "no effect" on the species.

Except for occasional transient individuals, no other federally proposed or listed threatened or endangered species are known to exist within the project area. Should project plans change or if additional information on the distribution of listed or proposed species becomes available, this determination may be reconsidered.

**Study Requests**

The Service has reviewed the evaluation of study proposals in the PAD by the Applicant for the Lake Lynn Hydroelectric project. We feel the proposed presence/absence surveys for rare, threatened, and endangered species may not be warranted, based upon our comments on the PAD. Aside from a field inventory of existing project recreation sites, a creel survey, and a cultural resources examination along the Cheat Lake Trail and Lake Lynn dam and powerhouse, the Applicant is not proposing any other studies. The only protection, mitigation, and environmental (PM&E) measures the Applicant proposes relate to recreation and land use. The Service believes the studies we and other resource agencies have identified are necessary to determine appropriate PM&E measures for the upcoming license period.

The Service requests the opportunity for further review and discussion as the study plans develop from a conceptual phase into more defined proposals.

**Study Request 1: American Eel Monitoring Study**

*Goals and Objectives:* To assess if American eel (*Anguilla rostrata*) is currently present below the Lake Lynn dam on the Cheat River and to help inform project operations and fishway prescription needs.

*Resource Management Goals:* Resource management goals include providing safe, timely, and

effective passage for fish species that migrate. Additional goals include providing passage to fish species which serve as glochidial hosts to freshwater mussels in the Cheat River, in order to prevent negative impacts to fish and mussel populations from the proposed project.

*Public Interest:* The requestor is a resource agency.

*Existing Information:* American eels have been documented in the Monongahela River within the past 10 years as far upstream as the Morgantown Lock and Dam, upstream of the confluence of the Cheat River with the Monongahela River. The Lake Lynn Hydropower Project is 3.7 miles upstream on the Cheat River from its confluence with the Monongahela River, therefore there is significant potential for current and future eel habitat usage within the Cheat River below Lake Lynn Hydroelectric project, and within the upstream miles of the Cheat River and tributaries. A preliminary sampling effort was conducted using the technique of environmental DNA (eDNA) detection technology as detailed in the "Project Report: June 2019 qPCR analysis of eDNA filter samples collected at Lake Lynn Dam, Target species: American eel (*Anguilla rostrata*)," dated December 4, 2019 by the Northeast Fishery Center's Conservation Genetics Lab.

*Study Methodology:* The recommended study uses standardized protocols employed in published literature.

*Level of Effort and Cost:* The methodology employed by the pilot sampling project described in the December 4, 2019 Project Report has shown that this method is a lower cost technique. This new study would seek to improve on sampling conditions to greatly reduce the influence of above dam released water on the collected samples, and to include areas lower in the Cheat River before its confluence with the Monongahela River.

**Study Request 2: Entrainment Study and Mortality Study**

*Goals and Objectives:* The goal of the proposed study is to determine the number of fish that are either entrained or impinged by the project operation, and to examine methods to reduce this injury and mortality to fishes.

*Resource Management Goals:* The Service's strategic conservation priorities include aquatic connectivity efforts that provide for passage, community protection, and enhanced recreational opportunities using the best available science and decision support tools.

*Public Interest:* The requestor is a resource agency.

*Existing Information:* The Service is not aware of previous entrainment studies conducted at the project. The biomonitoring data conducted under prior license conditions and filed in the FERC record can be used to assist in this analysis.

*Nexus To Project Operation:* Due to the large spacing of the current trash racks, certain sizes of fish are able to pass through the racks and become entrained through the turbines as they operate, causing fish mortality of an unknown quantity.

*Study Methodology:* The Applicant could use the Service's Turbine Blade Strike Analysis Model as one component of their assessment of current operational impact on entrainment and mortality of fishes. It can be found at https://www.fws.gov/northeast/fisheries/fishpassageengineering.html, along with other Service guidelines such as the Northeast Region Fish Passage Engineering Design Criteria, Fish Passage Design Criteria, and the Federal Interagency Nature-Like Fishway Passage Design Guidelines. Some literature analysis of mortality from Francis units of the diameter that exist at the project could also be utilized.

*Level of Effort and Cost:* These desktop analyses should be achievable within the one year timeframe.

**Study Request 3: Upstream and Downstream Fish Passage Study**

*Goals and Objectives:* The goals of the study are to assess movement of fish through the project area. It would identify likely routes fish would take under a variety of conditions, and assess the feasibility of incorporating alternative routes or additional fish protection measures.

*Public Interest:* The requestor is a resource agency.

*Existing Information:* The Service is not aware of previous studies examining passage options for the Lake Lynn Hydroelectric Project.

*Nexus To Project Operation*: The dam at the project blocks migration of fishes upstream and likely impedes safe, timely, and effective passage downstream. Downstream migration is currently only available through the dam gates, and through the project's powerhouse.

*Study Methodology:* The methodology would include a literature review of available options for upstream passage of eels, downstream passage bypass of the turbines, and other fish protection measures, in addition to iterative discussions with the Service's fishway engineers and other case studies.

*Level of Effort and Cost:* We anticipate that evaluating feasibility of passage would be fairly straightforward and not a lengthy process. Discussions with engineers would be necessary to properly assess the feasibility of bypass channels or fish protection structures.

We appreciate the opportunity to provide review and comment on the PAD and draft study proposals developed by the Applicant. We look forward to further discussions with you on how the Applicant can incorporate all the above listed studies. Finally, it would be helpful if the study proposals incorporated into the Draft Study Plan are as detailed as possible so that all parties

know exactly what is being agreed upon when the study plan is approved. If you have any questions regarding this matter, please contact Janet Norman of my staff at 410-573-4533 or Janet_Norman@fws.gov.

Sincerely,

Christopher P. Guy

for Genevieve LaRouche
Field Supervisor

cc: Lindy Nelson, Regional Environmental Officer, DOI OPEC

**References**

U.S. Fish and Wildlife Service. Endangered and Threatened Wildlife and Plants; Removing Trifolium stoloniferum (Running Buffalo Clover) From the Federal List of Endangered and Threatened Plants. 84 FR 44832, August 27, 2019. https://www.govinfo.gov/content/pkg/FR-2019-08-27/pdf/2019-18413.pdf#page=1

U.S. Fish and Wildlife Service. 2019. Fish Passage Engineering Design Criteria. USFWS, Northeast Region R5, Hadley, Massachusetts.

Mon River Trails Conservancy

P.O. Box 282
Morgantown
West Virginia
26507-0282

February 9, 2020

Kimberly Bose, Secretary
Federal Energy Regulatory Commission
888 First Street, N.E.
Mailcode PJ- 12.1
Washington, DC 20426

Re: *Information Request for the Pre-Application Document for Relicensing of the Lake Lynn Hydroelectric Project (FERC No. P-2459-005)*

Dear Ms. Bose,

On behalf of the Monongahela River Trails Conservancy Ltd. (MRTC), I am submitting comments concerning the Relicensing of the Lake Lynn Hydroelectric Project (FERC No. P-2459-005). MRTC is a non-profit 501c3 organization founded in 1991 to develop and manage 40 miles of a 48-mile, tri-county rail-trail network in North Central West Virginia. The remaining 8 miles are managed by the city of Morgantown and Star City, with MRTC as an active partner. The Mon River, Caperton, Deckers Creek Trail network was established as a National Recreation Trail in 1996. MRTC shares with other regional stakeholders the vision of having the Cheat Lake Trail connect with the Sheepskin Trail in Pennsylvania and the Mon River Trail network in West Virginia and ultimately be part of a long-distance trail network that extends from Ohio through West Virginia and Pennsylvania to Washington D.C.

Cube Hydro, in now owning and managing the Cheat Lake Dam aka Lake Lynn Facilities, has continued to provide a wide mix of public recreational options to enjoy the area including hiking, biking, birding, paddling, fishing, swimming, and boating. MRTC supports these recreational activities and would like to see improvements to these recreational opportunities be included in this re-licensing process:

1. To restore the Cheat Lake Trail to its 4.5 mile length by repairing a major wash-out that occurred in the summer of 2019.
2. To plan and build a connection of the Cheat Lake Trail to the Sheepskin Trail at the north end of the 4.5 mile Cheat Lake Trail. This would connect the Cheat Lake Trail into a nearly 60 mile rail-trail network and connect many communities including Point Marion, PA, Morgantown, WV, and Fairmont, WV. This involves opening the gate at the north end of trail and working with other stakeholders to build new trail on Cube Hydro property to link into the Sheepskin Trail corridor. The Sheepskin Trail Corridor is owned by Fayette County, PA and is currently being engineered and built. The Sheepskin Trail is not yet built to Cheat Lake Trail but we anticipate it will be in the next 5 years.
3. To extend the Cheat Lake Trail south on Cube Hydro property and in doing so, open up more area to hiking, biking, birding and fishing.
4. To improve fish, bird, and pollinator habitat along the Cheat Lake Trail.

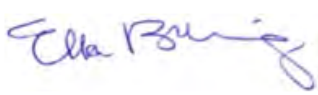
5. To improve recreational promotion of the Cheat Lake recreation area by hiring on-site recreation staff, by improving public communication (website, social media, phone), and by creating a process for holding events on the Cheat Lake Trail such as walks and runs.

Recreation on the river and neighboring rail-trails ties our communities in West Virginia and Pennsylvania together economically and socially. Bass tournament participants cross city, county and state lines. Both the Monongahela River and Cheat Rivers are regionally promoted water trails, and both paddlers and boaters move up and down the rivers to access different communities. Our rail-trails are used for commuting to work and school, trail tourism, and recreation. Our communities are dependent on each other to provide access, amenities, and tourism services in order to recruit new businesses and people to live in the region and entice visitors into extended stays and return visits.

The Cheat Lake Trail is one of a cluster of rail-trails in the region that provides recreation, a social gathering space, and a chance to connect with nature. It is widely used by local groups such as Hike it Baby, an outdoor meet-up group for families with young children, the Mountaineer Chapter of the National Audubon Society for public birding outings and the Christmas Bird Count, and cycling and running groups for exercise and outdoor recreation. Additionally, the Cheat Lake Trail is a part of a growing 1,500+ mile trail network connecting 50+ counties in four states (WV, OH, PA and NY). The Industrial Heartland Trails Coalition is a group comprised of more than 100 organizations, whose vision and mission it is to advance the trail network by closing gaps and connecting communities to bring health and wealth to communities through trail tourism and safe, equitable trail access by local residents.

Thank you for considering these recommendations from community stakeholders as part of the re-licensing process. Please feel free to contact me at 304-692-6782 or ella@montrails.org with any questions or if you need additional information.

Sincerely,
Monongahela River Trails Conservancy, Ltd.



Ella Belling, Executive Director

Document Content(s)

Owen Mulkeen, Kingwood, WV.
On behalf of Friends of the Cheat, I'd like to start by thanking you for the opportunity to submit comments to be included as part of the Pre-Application Document for Relicensing of the Lake Lynn Hydroelectric Project.
For 25 years, Friends of the Cheat (FOC) and our River of Promise (ROP) partners have worked diligently to restore water quality to the Cheat River and Cheat Lake through reclamation of mine lands and the remediation of acid mine drainage (AMD). Irresponsible mining had left the Cheat and nine of its lower tributaries severely damaged by AMD. Walleye were extirpated by the late 1940s. Historic data collected by WV Division of Natural Resources (DNR) show mean lake pH levels less than 5 between the 1950s and early 1990s. A few pollution tolerant fish species including bullhead catfish and white suckers sought refuge in the lake's sheltered embayments. Massive pollution releases from the T&T mine into Muddy Creek in 1994 and 1995 dropped the pH of the lake to 4. As a result, the Cheat River was named one of America's Most Endangered Rivers in 1995 by the national organization American Rivers. These events catalyzed the formation of Friends of the Cheat and the River of Promise task force.
The efforts of FOC and our ROP partners, most notably the US Office of Surface Mining (OSM) and WV Department of Environmental Protection (DEP), have restored water quality to the Cheat River main stem and Cheat Lake. Over 200 land reclamation and water treatment projects have been implemented with millions of dollars of funds resulting in millions of pounds of AMD pollution removed from the Cheat's tributaries. The river and lake have not seen a pH depression below 6 since 2011 and the main stem has been removed from the state's list of impaired waters for pH impairment. The removal of iron (ferrous hydroxide or "yellow boy") as well as aluminum and manganese is visibly noticeable by reduced staining of rocks near the water's edge as well as armoring of fiberglass boat bottoms, which was a prevalent problem through the '90s.
Improved water quality has fostered the rebound of Cheat Lake's fishery. DNR reports a dramatic recovery of species richness (27-34 species per year) including abundant sportfish such as largemouth and smallmouth bass, yellow perch, and walleye. Fishing tournaments now attract anglers from across the country which benefits the local economy. FOC is particularly excited about the walleye, which research shows are spawning up into the northern reaches of the Cheat Canyon.
With a drainage area of roughly 1400 square miles all flowing down to Cheat Lake, not only does the Cheat River constitute a critical piece of the region's ecosystem, it is also home to a large human population that lives, works and plays within the drainage. Friends of the Cheat recognizes that opportunities to recreate and connect with nature and the outdoors can not only improve the quality of life for a region's citizens, but it also leads to the engagement with and appreciation of our resources that can help prevent them from being squandered and abused. Cheat Lake and the surrounding area already Working to restore, preserve, and promote the outstanding natural qualities
of the Cheat River Watershed since 1994

provides a plethora of outdoor activities; including paddling, boating, fishing, hiking, cycling, birding and more. Cube Hydro has already improved and created recreation
opportunities around Cheat Lake. FOC and key partners have identified several opportunities for additional improvement of recreational opportunities that we believe should be considered as part of this next re-licensing process.

FOC is aware and supportive of the proposal to create a public access to the upper reaches of Cheat Lake by improving an existing gated road in Snake Hill Wildlife Management Area along Buzzard Run. This would provide another trailhead for hikers to enter the WMA, fishermen to access this upper section of the lake usually only reachable by boat, and would provide an egress opportunity for whitewater paddlers running the Lower Cheat Canyon. Despite being located in close proximity to the Cheat Lake and Morgantown metropolitan areas, and providing a wonderfully scenic and exciting float through class 2 rapids in a deep canyon, this section is infrequently paddled. This is mostly due to the 4.5 mile paddle across Cheat Lake to the nearest existing public access at the Ices Ferry bridge, which can be a laborious task in short maneuverable whitewater craft that are well suited for the rapids upstream, not to mention the danger of encounters with fast moving power boats. The creation of a new public access by improving Buzzard Run Road would shorten this flatwater paddle to 1.9 miles and thereby make this whitewater trip much more attractive.

Another opportunity for recreation enhancement in the Cheat Lake area would be to improve access and connectivity of both ends of the existing Cheat Lake Trail. Currently the trail follows the eastern shoreline of Cheat Lake for 4.4 miles and provides opportunities for walking, running, biking and fishing. The north end of the trail can be accessed via a trailhead and steep flight of stairs off of Morgan Run Road. The south end of the trail dead ends abruptly. With the future route of the Sheepskin Trail passing by just to the north, and local businesses, residential neighborhoods, and Coopers Rock State Forest to the south, there lies an opportunity to work towards increased connectivity of these trail system. By doing so, we can enhance the value of these isolated trail sections in such a way that their value becomes greater than the sum of their parts. We recommend that possibilities to extend the southern end of the Cheat Lake Trail, around the peninsula where it currently terminates, to a newly developed trailhead be thoroughly investigated, as well as the streamlining of the northern terminus to avoid the steep stairs and improve the connectivity to the future route of the Sheepskin Trail.

Thank you for this opportunity to comment on the upcoming relicensing of the Lake Lynn Hydroelectric Project.

Sincerely,
Owen Mulkeen
Associate Director
Friends of the Cheat

Document Content(s)

Dave Harshbarger, Morgantown, WV.
Pleas see the Cheat Lake Trail restored at the wash-out and re-opened to the public ASAP from the storm damage in summer of 2019.
A commitment to connecting to the Sheepskin Trail once the Sheepskin Trail is developed to this area.
And an entrance for cyclists and walkers on the northern end with a replacement of the gate and fence to a gate with a bike/ped pass-thru on the Cheat Lake Trail.

Document Content(s)

GARY V MARLIN, WESTOVER, WV.
January 9, 2020

I am a member of the Morgantown community and would like to submit some suggestions to be considered for Project # P-2459. I would like to see the slip on the Cheat Lake Trail repaired and to see a passage way from the Trail through the dam facility so that there will be a connection to the Sheepskin Trail when it comes by the dam.
Respectfully,
Gary Marlin

Document Content(s)

**From:** Jody Smet
**To:** Janet_Norman@fws.gov; Megan.K.Gottlieb@usace.army.mil; sean.mcdermott@noaa.gov; Kevin_Mendik@nps.gov; clschref@usgs.gov; smwickle@usgs.gov; Jacob.D.Harrell@wv.gov; Danny.A.Bennett@wv.gov; David.I.Wellman@wv.gov; coopersrocksf@wv.gov; Brian.L.Bridgewater@wv.gov; susan.m.pierce@wv.gov; scwilliams@pa.gov; peiswerth@pa.gov; hsmiles@pa.gov; olbraun@pa.gov; chnagle@pa.gov; agastbray@moncommission.com; dr.hawk@comcast.net; rmcclure@moncommission.com; vvicites@fayettepa.org; harold.peterson@bia.gov; clint.halftown@gmail.com; ec@delawarenation.com; cbrooks@delawaretribe.org; info@oneida-nation.org; admin@onondaganation.org; wfisher@sctribe.com; cassie@shawnee-tribe.com; tonseneca@aol.com; 106NAGPRA@astribe.com; ethompson@delawarenation-nsn.gov; dkelly@delawarenation.com; sbachor@delawaretribe.org; bbarnes@estoo.net; jbergevin@oneida-nation.org; lmisita@oneida-nation.org; jay.toth@sni.org; wtarrant@sctribe.com; tonya@shawnee-tribe.com; darren.bonaparte@srmt-nsn.gov; bprintup@hetf.org; duane330@aol.com; mstrager@gmail.com; ella@montrails.org; amanda@cheat.org; owen@cheat.org; betty.w304@gmail.com; fjernejcic@comcast.net; greystone.poa@hotmail.com; dgriff66@aol.com; seangoodwin@yahoo.com; graceandparke@yahoo.com; kevin@americanwhitewater.org; birvin@americanrivers.org; smoyer@tu.org; colleen@hydroreform.org; DMiller@potesta.com; swelsh@wvu.edu; edgewater@cheatlakedocks.com; stratdouglas@gmail.com; KCampitell@oxforddevelopment.com; shall@jccpgh.org; awagner1595@gmail.com; chestermcgraw@gmail.com; donnaweems@rocketmail.com; davecyndy@frontier.com; szybarnes@yahoo.com; mlutman@comcast.net; Reecejames98@gmail.com; gtrking86@yahoo.com; rogerdalephillips@gmail.com; scalvert@greenrivergroupllc.com; jkotcon@gmail.com; john.spain@ferc.gov; andrew.bernick@ferc.gov; dtrested (Guest); Foster, Joyce; Dale Short; Robert Flickner
**Subject:** [EXTERNAL] Lake Lynn Project Relicensing - Draft Study Plan
**Date:** Wednesday, April 15, 2020 1:08:27 PM
**Attachments:** image001.png
Lake Lynn Draft Study Plan_April 2020_Rev.pdf

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Dear Stakeholders,

Lake Lynn Generation LLC (Lake Lynn) is relicensing the Lake Lynn Hydroelectric Project (FERC No. P-2459) (Project) with the Federal Energy Regulatory Commission (FERC). Lake Lynn initiated the relicensing process in August 2019 by filing a Notice of Intent (NOI) and Pre-Application Document (PAD). At the same time, Lake Lynn requested FERC approval to use the Traditional Licensing Process (TLP). FERC approved the use of the TLP in October 2019, and Lake Lynn held a Joint Meeting and Site Visit in December 2019. Following the Joint Meeting and Site Visit, resource agencies and other stakeholders were afforded the opportunity to comment on the PAD and to request resource studies that they deemed were needed to evaluate Project impacts on natural, cultural and recreational resources. Based on the comments received, we prepared the attached draft Study Plan to document the resource studies we plan to undertake at the Project in 2020.

We would like to convene a meeting via conference **next week** to discuss the attached draft Study Plan. Please respond to the Doodle poll at the link below by the end of this week, close of business on Friday, April 17, to let us know your availability for a call next week. We will schedule a time that works for the majority of the respondents.

https://doodle.com/poll/byziw97sfp7eukz25b4dqrki/private?utm_campaign=poll_invitecontact_participant_invitation_with_message&utm_medium=email&utm_source=poll_transactional&utm_content=participatenow-cta

Please do not hesitate to contact me at (804) 739-0654 or by email at jody.smet@eaglecreekre.com if you have any questions or trouble accessing the Doodle poll.

---

**Jody Smet, AICP | Director, FERC Licensing and Compliance**
**Eagle Creek Renewable Energy**
Desk: 804 739 0654
Mobile: 804 382 1764
Email: jody.smet@eaglecreekre.com *[Please note my new email - Eagle Creek and Cube Hydro have merged!]*

**Lake Lynn Hydroelectric Project (FERC No. P-2459)**
**Draft Study Plan**
**April 2020**

## Background

Lake Lynn Generation LLC (Lake Lynn or Licensee) is relicensing the Lake Lynn Hydroelectric Project (FERC No. P-2459) (Project) with the Federal Energy Regulatory Commission (FERC). The current FERC license for the Project expires on November 30, 2024. The Project is located on the Cheat River in Monongalia County, West Virginia and Fayette County, Pennsylvania (Attachment 1).

Lake Lynn initiated the relicensing process in August 2019 by filing a Notice of Intent (NOI) and Pre-Application Document (PAD). At the same time, Lake Lynn requested FERC approval to use the Traditional Licensing Process (TLP). FERC approved the use of the TLP in October 2019, and in accordance with FERC regulations, Lake Lynn held a Joint Meeting and Site Visit in December 2019. Following the Joint Meeting and Site Visit, resource agencies and other stakeholders were afforded the opportunity to comment on the PAD and to request resource studies that they deemed were needed to evaluate Project impacts on natural, cultural and recreational resources.

In response to the NOI/PAD filing and the Joint Meeting and Site Visit, Lake Lynn received written comments and study requests from the U.S. Fish and Wildlife Service (USFWS), West Virginia Division of Natural Resources (WVDNR), Cheat Lake Environment and Recreation Association (CLEAR), Friends of the Cheat (FOC), Monongahela River Trails Conservancy (MRTC), and individual residents in the local community. A summary of the study requests and comments is provided in Attachment 2. The complete study requests are provided in Attachment 3.

Lake Lynn is utilizing the TLP. There is no requirement to prepare a formal study plan document as is required in the Integrated Licensing Protocol (ILP), and therefore, there is no subsequent study plan determination by FERC. Nonetheless, Lake Lynn has prepared this Study Plan to document and share with resource agencies and stakeholders its plans for conducting resource studies and ongoing monitoring efforts in 2020 to inform the relicensing process. The individual study plans detailed below are proposed for the Project relicensing.

## 1.0 Geology and Soils

### 1.1 Reservoir Shoreline Erosion Survey

***Study Request***

WVDNR requested the Licensee conduct a reservoir sedimentation study at areas that have demonstrated an affinity for a build-up of sediment (i.e., Sunset Beach Marina) and develop a plan to monitor and address any sedimentation issues. WVDNR suggested that the Licensee examine possible sources of sedimentation within the reservoir and identify potential preventive measures that could be taken to reduce the level of sedimentation in those areas where sediment builds up (i.e., Sunset Beach Marina). In addition, CLEAR requested that the Licensee continue monitoring and remediation of the ongoing shoreline erosion.

***Study Goals***

Article 402 of the existing FERC License requires the Licensee to: 1) conduct annual shoreline erosion surveys of the Cheat Lake Park shoreline extending from the dam to the Cheat Haven peninsula and 2) conduct triennial shoreline erosion surveys of the entire Cheat Lake shoreline to identify new areas of erosion. Since 1995, the Licensee has been conducting shoreline erosion surveys and documenting areas of shoreline erosion within the Project boundary, which can influence sedimentation in Cheat Lake. In recent years, no new areas of active shoreline erosion have been identified and previously identified areas have exhibited minimal annual changes, therefore, the Licensee believes that an additional study is not warranted at this time. The goals of this study are to: 1) conduct a visual shoreline erosion survey of the Cheat Lake Park shoreline extending from the dam to the Cheat Haven peninsula to evaluate changes in shoreline erosion monitoring stations where historic erosion has been observed and 2) conduct a shoreline erosion survey of the entire Cheat Lake shoreline to identify new areas of erosion.

***Study Scope***

For the upcoming 2020 annual shoreline erosion survey of the Cheat Lake Park shoreline, the Licensee will conduct a visual survey by boat of the Cheat Lake Park shoreline extending from the dam to the Cheat Haven Peninsula. During the survey, the boat will be kept as close to the shoreline as practical to allow for careful observation. Sixteen (16) shoreline erosion monitoring stations where historic erosion has been observed will be visually inspected and photographed for future reference and comparison. Any evidence of new areas of erosion will be noted and photographed. Additionally, for the 2020 shoreline erosion survey, the same scope will be performed along the entire reservoir shoreline to identify and document any new areas of erosion. The Licensee will prepare a report summarizing the results of the shoreline survey.

***Study Schedule***

The Licensee anticipates that the shoreline erosion survey will be conducted in November or December 2020, when the reservoir level is lowered and vegetation has died back. This timing is consistent with the timing in previous years. It is anticipated that the annual report will be filed with FERC by February 2021.

## 2.0 Water Resources

### 2.1 Water Quality Monitoring

***Study Request***

At this time, no stakeholders have requested new studies related to water quality at the Project. However, the USFWS and WVDNR requested the existing water quality monitoring be continued throughout the term of the new License.

***Study Goals***

In accordance with the existing FERC License (Article 405) and the Project Water Quality Monitoring Plan (West Penn Power Company, 1995), the Licensee will continue to monitor water quality and report the results to USFWS, WVDNR, Pennsylvania Fish and Boat and Commission (PFBC), Pennsylvania Department of Environmental Protection (PDEP), and FERC annually during the relicensing process. The water quality data will be used in the development of the License Application.

***Study Scope***

In accordance with the existing FERC License (Article 405) and the Project Water Quality Monitoring Plan (West Penn Power Company, 1995), the Licensee will continue to monitor and record hourly water quality data from April 1 through October 31 on an annual basis during the relicensing process. For the purposes of this 2020 relicensing study, the Licensee will collect dissolved oxygen and water temperature from April 1, 2020 through October 31, 2020 at the existing three locations in conjunction with U.S. Geological Survey (USGS) gages located in Cheat Lake, the Project tailrace, and downstream of Grassy Run. The Licensee will prepare and provide an annual report of the monitoring results to USFWS, WVDNR, PFBC, and PDEP for review and comment. The Licensee will submit the final annual report to FERC.

***Study Schedule***

For this 2020 relicensing study, the Licensee will monitor and record hourly water quality data from April 1 through October 31, 2020. The Licensee will provide an annual report of the monitoring results to USFWS, WVDNR, PFBC, and PDEP within 90 days (by February 1, 2021) of the end of the monitoring season. The Licensee will file the final annual report with FERC within 150 days following the end of the monitoring season (by April 1, 2021).

### 2.2 Streamflow Data Collaboration

***Additional Information Request***

The USFWS requested additional information so that it could fully evaluate the seasonality, duration, and magnitude of streamflow into the Project. The USFWS requested the existing Project Instream Flow Study (EA Engineering, Science, and Technology, Inc. (EA Engineering), 2014) discussed in the PAD and noted that, without this information, the USFWS may have remaining questions and recommend an Instream Flow Study. The USFWS also requested the graphs (Flow Duration Curves) in Appendix E of the PAD be revised so that the maximum flow event(s) and duration for the period of record (2016 to 2019) is displayed separately from the rest of the graphs.

The Licensee will provide additional information to the USFWS to assist it with evaluating the seasonality, duration, and magnitude of streamflow into the Project. The Licensee will provide the USFWS with the Project Instream Flow Study and supporting information referenced in the PAD. The Licensee will also collaborate with the USFWS on the presentation of the Flow Duration Curves and revise the curves in a manner that will assist the USFWS with its evaluation. The Licensee plans to provide the USFWS with the Project Instream Flow Study by May 2020. The Licensee also plans to collaborate with the USFWS on the presentation of the Flow Duration Curves and provide revised curves by October 2020. .

## 3.0 Fish and Aquatic Resources

### 3.1 Desktop Fish Entrainment Assessment

***Study Request***

The USFWS and WVDNR requested the Licensee conduct a desktop entrainment study to determine the number of fish that are either entrained or impinged by Project operation and to estimate the injury and mortality of fish that pass through the turbines during Project operation. WVNDR also recommended a field component to verify results.

***Study Goals***

The goals of this study are to 1) conduct a desktop assessment of the potential for impingement/entrainment and 2) estimate the numbers of fish entrained at the Project.

***Study Scope***

The Licensee will conduct a desktop fish entrainment assessment for the Project that includes the following:

- A description of the Project reservoir, intake structure, turbine units, and seasonal operational regime;
- Summary of available fisheries information historically collected in the Cheat River upstream of the Project;
- Life history and habitat requirements for target fish species;
- Assessment of impingement and entrainment potential as a function of (1) the existing rack spacing, (2) calculated approach velocities, (3) the physical dimensions of target fish species, and (4) the swim capabilities (i.e., burst speed) of target fish species;
- Review of information contained in the 1997 Electric Power Research Institute (EPRI) database to provide a summary of (1) the size class composition of target fish species, (2) entrainment densities of target fish species, and (3) calculated survival rates of target species for the subset of hydroelectric projects comparable to the Project;
- Calculation of site-specific turbine passage survival rates for target fish species using the USFWS Turbine Blade Strike Analysis Tool (TBSA); and

- Utilize seasonal species/size class-specific entrainment densities from comparable projects and project-specific discharge volumes to generate estimates of numbers of fish entrained at the Project.

The results of the desktop assessment will be documented in a study report.

***Study Schedule***

The desktop fish entrainment assessment will be conducted during the period June through December 2020, with a draft report for agency review anticipated in January 2021.

## 3.2 American Eel Environmental DNA Sampling

***Study Request***

The USFWS requested the Licensee continue the American eel monitoring that was conducted in 2018 and 2019 under the Project Aquatic Biomonitoring Plan (2018-2020) (Lake Lynn, 2018a). For this second year of collecting water samples for American eel environmental DNA (eDNA), USFWS requested that the Licensee improve sampling locations and include areas lower in the Cheat River before the confluence with the Monongahela River. WVDNR supported the USFWS request for additional analysis of Project waters for American eels. The USFWS and WVDNR also requested the Licensee assess movement of fish throughout the Project area and assess the feasibility of incorporating alternative routes or additional fish protection measures at the Project. The USFWS' proposed methodology includes a literature review of available options for upstream passage of eels, downstream passage bypass of the turbines, and other fish protection measures, in addition to discussions with the USFWS fishway engineers.

***Study Goals***

In accordance with the Project Aquatic Biomonitoring Plan (2018-2020) (Lake Lynn, 2018a), developed in consultation with the USFWS, WVDNR, and PFBC, the Licensee worked collaboratively with the USFWS to select four sampling locations in the Project tailwater and to collect quarterly samples in 2018 and 2019 to sample the Project tailwater for American eel environmental DNA (eDNA). No American eel eDNA has been detected to date, however, concerns have been raised by the USFWS and WVDNR regarding the sampling locations.

The goals of the second year of American eel eDNA sampling are to: 1) collaborate with the USFWS, WVDNR, and PFBC to determine if the sampling locations used in the first year of the sampling need to be adjusted; and 2) continue the American eel eDNA sampling performed in 2018 and 2019 to determine whether American eels are present in the tailwater.

***Study Scope***

The Licensee will initiate the second year of sampling by working collaboratively with the USFWS, WVDNR, and PFBC to determine if there should be any adjustments to the four sampling locations in the Project tailwater or any adjustments to the methodology. The Licensee will work with the USFWS to continue to collect quarterly samples at four sampling locations in the Project tailwater in accordance with the USFWS' Protocol, *Field Collection of*

*Environmental DNA (eDNA) Water Samples from Streams* (USFWS, no date) and additional training from the USFWS. The Licensee will coordinate with the USFWS to provide the samples to the USFWS Northeast Fishery Center Conservation Genetics Lab in Lamar, Pennsylvania for analysis. Once the second year of sampling results are available, the Licensee will consult with the USFWS, WVDNR, and PFBC to determine if any additional fish passage assessment is warranted.

***Study Schedule***

The Licensee will finalize the quarterly sampling schedule with the USFWS, WVDNR, and PFBC by May 2020. The Licensee anticipates that the quarterly sample periods will be April-June 2020, July-September 2020, October-December 2020, and January-March 2021. The sample results will be provided to the Licensee by the USFWS Lamar lab. The Licensee will provide the results upon receipt to the USFWS, WVDNR, and PFBC.

### 3.3 Tailwater Mussel Survey

***Study Request***

The USFWS requested that a mussel survey be conducted in the tailwater area and downstream reaches to assess this component of the aquatic community.

***Study Goals***

The goal of this study is to conduct a mussel survey within the Project boundary downstream of the Project dam to document mussel habitat (location, depth, and substrate) and the occurrence density, distribution, and relative abundance of any mussel species present.

***Study Scope***

The Licensee will conduct a mussel survey to evaluate the likelihood of the presence or absence of mussels within the Project boundary downstream of the Project dam (approximately 200 meters downstream of the dam at the furthest point). The area inside the Project boundary downstream of the dam is in West Virginia and ends at the Pennsylvania/West Virginia state line (Attachment 1). A malacologist experienced in mussel collection and qualified to work in West Virginia will lead all mussel sampling efforts.

The Licensee will prepare a survey plan and coordinate with WVDNR for approval. The survey plan will outline the methods and approach for conducting the mussel survey following the West Virginia Mussel Protocol (Protocol) guidelines for hydroelectric projects. WVDNR approval of the survey plan will be required prior to initiating fieldwork.

The Licensee will evaluate for mussel presence/absence within the Project boundary downstream of the dam. The Licensee will survey approximately 5 transects spaced 25 meters apart that will span bank to bank. Snorkeling and surface supplied air diving will be used to visually and tactilely search for mussels at the substrate surface and minor excavation will occur where appropriate to ensure recovery of buried mussels. Qualitative timed searches will be employed based on mussel and habitat distribution along transects throughout the survey area. Search effort will meet minimum Protocol requirements (1 min/$m^2$ in heterogenous substrates).

A report summarizing mussel habitat, survey observations, occurrence, location maps, density, distribution, and relative abundance of any mussel species present within survey area will be prepared. Figures will present mussel distribution and high-quality habitat areas within the survey area.

***Study Schedule***

The mussel survey will be conducted during the period June through October 2020. It is anticipated that a draft report will be available for stakeholder review in December 2020.

## 3.4 Aquatic Habitat Enhancement and Monitoring

***Study Request***

The Project Aquatic Biomonitoring Plan (2018-2020) (Lake Lynn, 2018a), developed in consultation with USFWS, WVDNR, and PFBC, includes the installation and monitoring of fish habitat enhancement structures. The Licensee worked with WVDNR and West Virginia University in 2019 to purchase and install artificial fish habitat structures along the Cheat Lake shoreline and to monitor their effectiveness. The Licensee reviewed the results of the 2019 activities with the USFWS, WVDNR, and PFBC and determined that a second year of monitoring in 2020 was warranted (Lake Lynn, 2020b). A scope for the second year of monitoring was developed in consultation with the USFWS, WVDNR, and PFBC (Welsh, 2019). No new studies related to fish aquatic habitat enhancement and monitoring at the Project have been requested.

***Study Goals***

The goals of the 2020 aquatic habitat enhancement and monitoring are to: 1) document the timing of spawning, as well as examine spawning habitat characteristics, i.e., water depth, distance from shore, and water tubidity; and 2) examine water level fluctuation as a variable of influence on the timing of spawning, as well as its role in the potential for egg dewatering.

***Study Scope***

During February 2020, forty artificial spawning structures were placed (submerged) at two sites on Cheat Lake (Welsh, 2019). Each site will also have four benthic artificial habitat reefs, which were placed during 2019 aquatic habitat enhancement and monitoring efforts. The forty artificial spawning structures and the eight artificial reef areas will be checked daily for the presence of egg masses during the expected spring spawning period. The artificial spawning structures will be checked by removing them from the water, and the reef structures will be checked with an underwater camera. The presence/absence of egg masses will be recorded and the number of egg masses on each spawning or reef structure will be counted.  A subsample of egg masses will be evaluated to estimate the average number of eggs per egg mass.

Additional habitat data will be recorded daily, primarily at the time when spawning structures are checked and will include water depth at the spawning structure, distance of the structure to the nearest shoreline's high water mark (i.e. full pool elevation level), distance of the structure to the nearest shoreline's current water level, surface water temperature, bottom water temperature using data loggers at depth ranges from shallow to deep water consistent with habitat unit placement, and secchi disk depth at each site to provide an index of water turbidity.

A study report will be developed and provided to the USFWS, WVDNR, and PFBC in accordance with the scope for the second year of aquatic habitat enhancement and monitoring (Welsh, 2019).

***Study Schedule***

Artificial spawning structures were placed (submerged) in February 2020 at two sites on Cheat Lake.  The structures will be monitored daily until the end date of the spawning period has been determined.  A study report will be developed and provided to the USFWS, WVDNR, and PFBC by August 2020.

### 3.5 Angler Creel Survey

***Study Request***

The Project Aquatic Biomonitoring Plan (2018-2020) (Lake Lynn, 2018a), developed in consultation with USFWS, WVDNR, and PFBC, includes an angler creel survey component (a sampling survey that targets recreational anglers) to be conducted in 2020 to document a baseline of recreational fishing effort and success.  At this time, no new studies related to angling or creel surveys at the Project have been requested.

***Study Goals***

The goal of the angler creel survey is to document a baseline of recreational fishing effort and success.

***Study Scope***

In accordance with the Project Aquatic Biomonitoring Plan (2018-2020) (Lake Lynn, 2018a), the Licensee consulted with the resource agencies in December 2019 and January 2020 on a workplan (Lake Lynn, 2020a) and survey instrument (Lake Lynn, 2020b) for the angler creel survey.  The Licensee initiated the angler creel survey in January 2020 and will continue collecting surveys through December 2020[1].

The Licensee is conducting the survey utilizing a standardized questionnaire (administered via survey boxes and in-person interviews) at the following locations:

[1] The survey may be temporarily suspended and continued in 2021 due to COVID-19.

- Upper Cheat Lake: Ices Ferry Bridge access, Edgewater Marina, Lakeside Marina;
- Middle Cheat Lake at the Sunset Beach Marina public boat ramp/dock;
- Lower Cheat Lake at Cheat Lake Park (the winter boat ramp, the fishing pier at Morgan Run, and the fishing pier at Rubles Run); and
- Lake Lynn Project Tailwater Fishing Pier.

A report summarizing the results of the survey will be developed in accordance with the Aquatic Biomonitoring Plan (2018-2020) (Lake Lynn, 2018) and the Angler Creel Survey Workplan (Lake Lynn, 2020a). Information collected during the survey will provide useful information on recreational angling.

***Study Schedule***

The Licensee initiated the angler creel survey in January 2020 and will continue collecting surveys through December 2020[2]. A report summarizing the results of the survey will be provided to USFWS, WVDNR, and PFBC, with a report anticipated in February 2021.

## 4.0 Rare, Threatened and Endangered Species

### 4.1 Rare Species Survey

In the PAD, the Licensee proposed to conduct presence/absence surveys for rare, threatened and endangered (RTE) species that are likely to occur within the Project boundary. The USFWS provided comments on the four federally listed species with the potential to occur in the Project area that were discussed in the PAD (Indiana bat, northern long-eared bat, running buffalo clover, and the flat-spired three toothed snail) and noted that except for occasional transient individuals, no other federally proposed or listed threatened or endangered species are known to exist within the Project area. The USFWS noted that the proposed presence/absence surveys for RTE species may not be warranted; therefore, the Licensee is no longer proposing to conduct these surveys.

## 5.0 Recreation and Land Use

### 5.1 Recreation Site Enhancement Feasibility and Assessment

***Study Request***

Several stakeholders have requested recreation site enhancements or new recreation sites at the Project.

MRTC, CLEAR, FOC, and several individuals requested that the Licensee work with stakeholders on planning and building a connection from the Cheat Lake Trail to the Sheepskin Trail, including opening the gate at the northern end of the trail to create a passageway from the northern end of the Cheat Lake Trail through the dam facility. CLEAR also requested a continued commitment for a connection to other regional trails.

[2] The survey may be temporarily suspended and continued in 2021 due to COVID-19.

MRTC and FOC have requested the Licensee extend the Cheat Lake Trail toward the south.

FOC requested the Licensee create public access to the upper reaches of Cheat Lake by improving an existing gated road in the Snake Hill Wildlife Management Area (WMA) along Buzzard Run to provide a trailhead for hikers, angler access to upper Cheat Lake, and egress for whitewater paddlers running the Lower Cheat Canyon. WVDNR commented that it is unequivocally opposed to creating public access to the upper reaches of Cheat Lake by opening a gated road that passes through Snake Hill WMA property because continued maintenance of the access road would be problematic and an undue burden for the State of West Virginia and the Licensee with very little benefit to the WVDNR's prime constituents.

CLEAR requested the Licensee extend the swimming beach area toward the day-use boat docks to create a dog beach. CLEAR also requested the Licensee add additional picnic tables in this area.

***Study Goals***

The goals of this study are to evaluate the feasibility of the recreation site/facility enhancements requested by stakeholders at the Project, as described in the Study Scope.

***Study Scope***

The Licensee will evaluate the feasibility of making certain recreation site/facility enhancements at the Project. Specific enhancements to be evaluated include:

- Connection from the Cheat Lake Trail to the Sheepskin Trail at the northern end of the Cheat Lake Trail;
- Extension of the Cheat Lake Trail toward the south;
- Public access to the upper reaches of Cheat Lake by improving an existing gated road in Snake Hill WMA along Buzzard Run; and
- Extension of the swimming beach area to create a dog beach.

The feasibility assessment will include both desktop and in-field assessments. The desktop phase will examine existing tax and property records to determine property ownership and access limitations associated with each site or enhancement. The Licensee will also assess safety and security concerns and considerations associated with Project operations, including a review of any history of past safety or security concerns at the Project.

With basic information in hand, the Licensee will conduct an in-field assessment of each of the listed enhancements. The field review may be conducted in coordination with appropriate stakeholders and may include specific site visits with adjacent property owners and VDGIF, as appropriate.

The results of the feasibility assessment and any enhancement alternatives developed will be documented in a study report.

***Study Schedule***

The recreation site enhancement feasibility and assessment will be conducted during the period May through December 2020, with a draft report for stakeholder review anticipated in December 2020.

## 5.2 Recreation Use and Recreation Facility Inventory

***Study Request***

At this time, no stakeholders have specifically requested a study related to recreation use at the Project.

***Study Goals***

In accordance with FERC's Order dated August 10, 2018 modifying and approving the 2018 Recreation Plan Update (Lake Lynn, 2018b), the Licensee is collecting recreation use data in 2020 and must file the next Recreation Plan Update with FERC by March 31, 2021 that includes this data. As part of the next Recreation Plan Update, the Licensee will also conduct an inventory of the existing Project recreation sites to update and expand the discussion of the existing Project recreation sites and amenities in the next Recreation Plan Update.

***Study Scope***

In accordance with FERC's Order dated August 10, 2018 modifying and approving the 2018 Recreation Plan Update (Lake Lynn, 2018b), the Licensee initiated the collection of recreation use data in January 2020 and will collect recreation use data through December 2020[3]. This data will be summarized in the next Recreation Plan Update that must be filed with FERC by March 31, 2021.

In the PAD, the Licensee proposed to conduct a field inventory of the existing Project recreation sites that included identifying the amenities or facilities at each site, photographs of the sites, an evaluation of the overall condition of each site, and general observations on site use and accessibility. The Licensee will conduct a field inventory of the existing Project recreation sites in 2020 and include the full recreation site inventory in the next Recreation Plan Update, which is due to be filed with FERC by March 31, 2021.

***Study Schedule***

The Licensee initiated recreation use data collection in January 2020 and will collect recreation use data through December 2020[4]. The Licensee will conduct a field inventory of the existing Project recreation sites during the summer of 2020 and include the full recreation site inventory in the next Recreation Plan Update. The next Recreation Plan Update must be filed with FERC

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[3] The data collection may be temporarily suspended and continued in 2021 due to COVID-19.

[4] The data collection may be temporarily suspended and continued in 2021 due to COVID-19.

by March 31, 2021 and the Licensee anticipates a draft report will be available for stakeholder review by February 2021.

### 5.3 Shoreline Classification and Aquatic Habitat Mapping

***Study Request***

At this time, no stakeholders have specifically requested a study related to shoreline classification at the Project or development of a shoreline management plan.

***Study Goals***

The goals of classifying the Cheat Lake shoreline and developing an aquatic habitat map of Cheat Lake are to: 1) collect information that will be used in the development of a Shoreline Management Plan for the Project and the License Application and 2) create datasets to assist the Licensee in managing shoreline uses.

***Study Scope***

The Licensee will classify the Cheat Lake shoreline (the area up to 100 feet inward from the summer pool elevation of the reservoir) into the following classifications: Forest, Industrial, Private, Public Recreation, and All Other Classes. The shoreline classification will utilize 2018 imagery from the National Aerial Image Program at 1-meter resolution and 1:10,000 scale, which is the best available temporal and spatial resolution imagery for the shoreline classification. The entire 31.3 miles of Cheat Lake shoreline will be classified. The shoreline classification will also indicate the natural versus constructed or converted shoreline habitat areas. A spatially referenced shapefile (polyline) with metadata will be prepared.

An aquatic habitat map of Cheat Lake will be developed based on data collected from an Aquatic Water Drone. The aquatic habitat areas will be digitized as polygon areas and include aquatic vegetation, silt substrate, cobble and boulder substrate, historical river channels, and water depth.

The datasets for the shoreline classification and the aquatic habitat mapping will be added to the online map viewer of the Cheat Lake Dock and property management system developed for the Project in 2019.

***Study Schedule***

The shoreline classification and aquatic habitat mapping will be completed by December 2020. The shoreline classification and aquatic habitat mapping will be used in the development of a Shoreline Management Plan for the Project and the License Application.

## 6.0 Cultural Resources

### 6.1 Cultural Resources (Section 106) Consultation

***Study Request***

At this time, no resource agencies or Tribes have requested studies of cultural resources at the Project. The Cherokee Nation commented that Monongalia County and Fayette County are outside the Cherokee Nation's Area of Interest, thus, the Cherokee Nation defers to federally recognized Tribes that have an interest in this landbase. The Delaware Nation commented that the location of the Project does not endanger cultural or religious sites of interest to the Delaware Nation and requested that if any artifacts are discovered that the Licensee halt work and contact state agencies and its office within 24 hours.

***Study Goals***

The Licensee will initiate formal consultation with the WVSHPO and PHMC to inform the development of the License Application.

***Study Scope***

The Licensee is aware of two potentially significant cultural resources within the Project boundary – the railroad bed along the Cheat Lake Trail (a linear historic archaeological site) and the Lake Lynn powerhouse and dam (potentially eligible for the National Register of Historic Places [NRHP]). The Licensee will consult with the West Virginia State Historic Preservation Office (WVSHPO) and its Interactive Map Viewer and submit the Project information for a formal review. The Licensee will also consult with the Pennsylvania Historical and Museum Commission (PHMC) and the Cultural Resources Geographic Information System (CRGIS) and submit the Project to the PHMC for review.

***Study Schedule***

The Licensee plans to initiate formal consultation with the WVSHPO and PHMC by July 2020.

## 7.0 References


EA Engineering, Science, and Technology, Inc. (EA Engineering). 2014. Instream Flow Study: Lake Lynn Hydroelectric Project. December 2014.

Lake Lynn Generation, LLC (Lake Lynn). 2018a. Lake Lynn Hydroelectric Project (FERC No. 2459) Aquatic Biomonitoring Plan (2018-2020). January 31, 2018.

Lake Lynn Generation, LLC (Lake Lynn). 2018b. Lake Lynn Hydroelectric Project 2018 Recreation Plan Update. April 2018.

Lake Lynn Generation, LLC (Lake Lynn). 2020a. Lake Lynn Hydroelectric Project (FERC No. 2459) Angler Creel Survey Workplan. January 2020.

Lake Lynn Generation, LLC (Lake Lynn). 2020b. Lake Lynn Hydroelectric Project (FERC No. 2459) Aquatic Biomonitoring Plan (2018-2020): 2019 Annual Status Report. 2020.

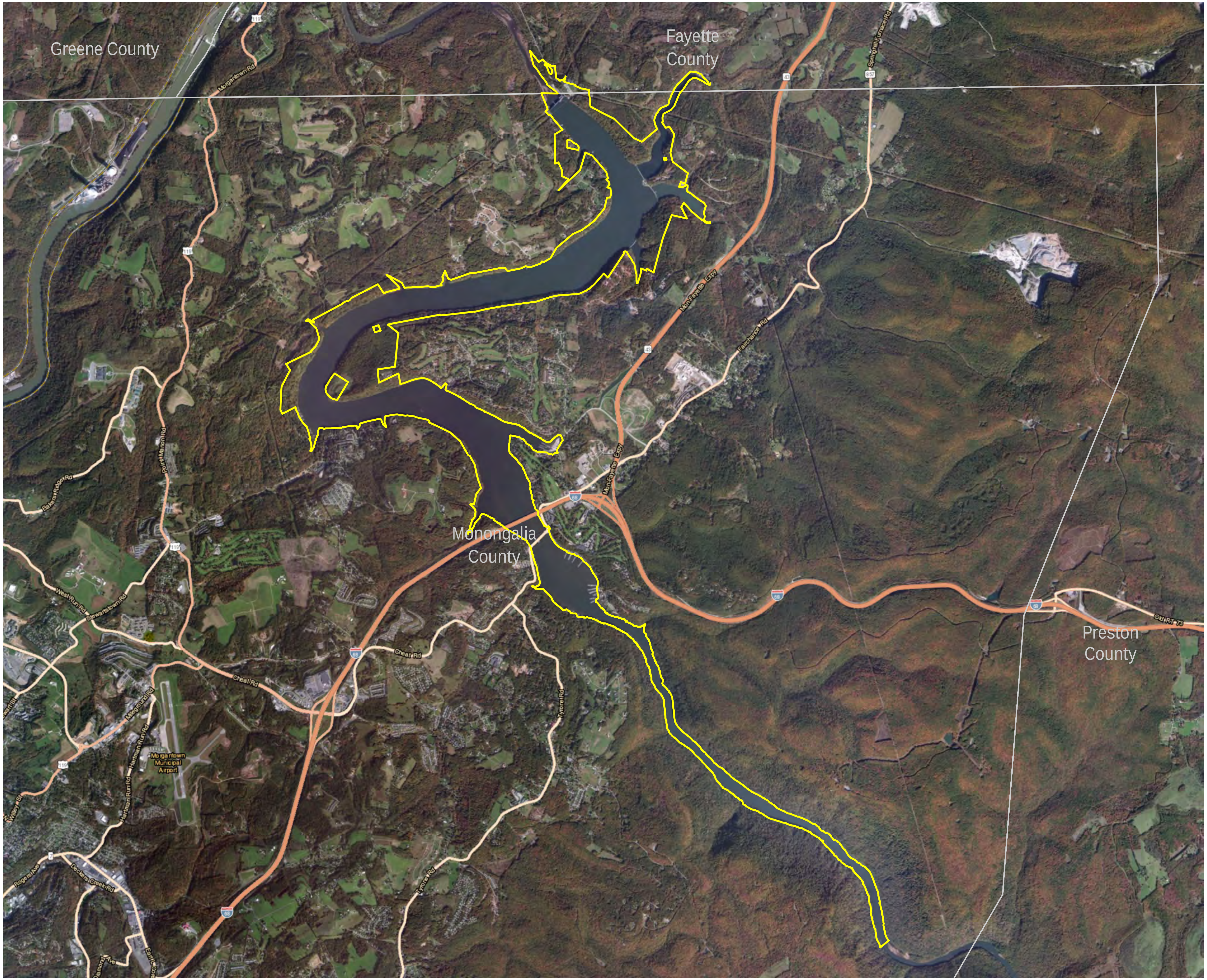
U.S. Fish and Wildlife Service (USFWS) Northeast Fishery Center Conservation Genetics Lab. No date. Field Collection of Environmental DNA (eDNA) Water Samples from Streams. No date.

Welsh, Stuart A. West Virginia Cooperative Fish and Wildlife Research Unit. 2019. Evaluations of Yellow Perch Spawning and Water Level Fluctuations for Cheat Lake, West Virginia: A Research Proposal. November 29, 2019.

West Penn Power Company. 1995. Water Quality Monitoring Plan for Lake Lynn Hydro Station FERC Project No, 2459.  October 6, 1995.

# Attachment 1

# Project Boundary Figure





LEGEND

- FERC Project Boundary
- County Boundary

N

0 0.5 1 2 Miles

PROJECT:

LAKE LYNN GENERATION, LLC

TITLE:

Lake Lynn
Project Boundary

| | |
|---|---|
| DRAWN BY: K. BABCOCK | PROJ. NO.: |
| CHECKED BY: | |
| APPROVED BY: | |
| DATE: AUGUST 2019 | |

TRC

14 Gabriel Drive
Augusta, ME 04330

FILE NO.: Lake_Lynn_Project_Boundary.mxd

TRC - GIS

Coordinate System: NAD 1983 UTM Zone 17N (Foot US)
Map Rotation: 0

Plot Date: LAYOUT: ANSI B(11"x17") S:\1-PROJECTS\Cube_PE_Hydro
Path: \Lake_Lynn_Project_Boundary.mxd

**Attachment 2**
**Summary of Study Related Comments and Study Requests**

| Agency/ Stakeholder | Study Related Comment/ Study Request |
|---|---|
| **SEDIMENTATION AND SHORELINE EROSION** | |
| WVDNR | Requests reservoir sedimentation study at problem areas and a sedimentation plan to monitor/address any future sedimentation issues. Proposed methodology includes examining possible sources of sedimentation within the reservoir and identifying potential preventive measures that could be taken to reduce the level of sedimentation in those areas where sediment builds up (i.e., Sunset Beach). |
| CLEAR | Monitoring and remediation of the on-going shoreline erosion are needed with components of these activities taking place on an annual basis. |
| **WATER QUANTITY AND QUALITY** | |
| USFWS and WVDNR | Requests that water quality monitoring be continued throughout the term of the new License. |
| USFWS | The Project Instream Flow Study is not contained in the PAD. Without this information, the USFWS has remaining questions and would recommend an Instream Flow Study to help determine appropriate flow releases in license articles. |
| **FISH AND AQUATICS** | |
| USFWS | A mussel survey should be conducted downstream in the tailwater area and downstream reaches to assess this component of the aquatic community and inform the USFWS flow regime recommendations. |
| USFWS and WVDNR | Requests a desktop entrainment study. WVNDR recommends a field component to verify results and requests the opportunity to review data for use in the desktop analysis. USFWS suggests that the USFWS Turbine Blade Strike Analysis Model could be used as one component of the assessment. |
| USFWS and WVDNR | Requests American eel monitoring study that improves on sampling conditions and includes areas lower in the Cheat River before the confluence with the Monongahela. WVDNR is not be opposed to any USFWS request regarding additional analysis of Project waters for American eel. |
| USFWS and WVDNR | Requests upstream/downstream fish passage and feasibility study. Proposed methodology includes a literature review of available options for bypass routes/fish protection measures and an analysis on how such measures could be incorporated into current project design. USFWS mentions the methodology would include a literature review of available options for upstream passage of eels. |
| **WILDLIFE AND RARE, THREATENED AND ENDANGERED (RTE) SPECIES** | |
| USFWS | The proposed survey for RTE species may not be warranted. |
| **RECREATION/AESTHETICS** | |
| MRTC and FOC | Trails - Requests the Licensee extend the Cheat Lake Trail toward the south. |
| MRTC, CLEAR, FOC Dave Harshbarger ,and Gary Marlin | Trails - Request License work with stakeholders on planning and building a connection from the Cheat Lake Trail to the Sheepskin Trail, including opening the gate at the northern end of the trail to create a passageway from the northern end of the Cheat Lake Trail through the dam facility. CLEAR also requests a continued commitment for a connection to other regional trails. |

| Agency/ Stakeholder | Study Related Comment/ Study Request |
|---|---|
| WVDNR | Snake Hill Wildlife Management Area (WMA) - WVDNR is unequivocally opposed to creating public access to the upper reaches of Cheat Lake by opening a gated road that passes through Snake Hill WMA property because continued maintenance of the access road would be problematic and an undue burden for the State of West Virginia and the Licensee with very little benefit to the WVDNR's prime constituents. |
| FOC | Snake Hill Wildlife WMA - Supports creating a public access to the upper reaches of Cheat Lake by improving an existing gated road in Snake Hill WMA along Buzzard Run to provide trailhead for hikers, angler access to upper Cheat Lake, and egress for whitewater paddlers running the Lower Cheat Canyon. |
| CLEAR | Dog Beach - The swimming beach area needs to be extended toward the day-use boat docks to include a dog beach and additional picnic tables |
| WVDNR | Boating - Law enforcement records do not show any significant increase in boating incidents. WVDNR is not opposed to the temporary moratorium on new private piers/boat docks and would not be opposed to the moratorium continuing. |
| CLEAR | Boating - Requests boating guidelines and limits consistent with the rules and regulations of the WVDNR. Boat guidelines/regulations, public dock maintenance, channel depth (dredging), and parking lot criteria are all in need of explicit definition and guidance. |
| CLEAR | Recreation Operations and Maintenance (O&M) - Requests clear and complete procedures for trail maintenance and repair. |
| CLEAR | Recreation O&M - Requests clear and complete goals, guidelines and procedures for Sunset Beach Marina and other marinas, including O&M and future. |
| CLEAR | Recreation O&M - Periodic lake cleanup activities need to be continued by CLEAR and others with the support of the Licensee. |
| CLEAR | Recreation O&M - Swimming beach season should match the boating season of May 1-Oct 31. |
| CLEAR | Recreation O&M - Regular maintenance of the swimming beach is needed to remove large debris and to keep quality sand fresh and deep |
| CLEAR | Recreation O&M - For the Fishing Pier, there is a need to identify the opportunities, guidelines, operation and maintenance schedules. |
| CLEAR | Recreation O&M - Hillside slips, ground subsidence, and washouts along the Trails must be prepared for so that temporary work-arounds/repairs can take place in a timely manner. |
| CLEAR | Recreation O&M - For the Recreation Season protocol, there is a need to reiterate the schedule of May 1 thru October 31, with the Trail being open and accessible year-round. |
| CLEAR | Recreation O&M - The boat launch in the Park is essential for summer use by kayak & canoe users and for winter use by fishing boat users. |
| CLEAR | Recreation O&M - There is a need for a description of the functions of (existing & new) recreation personnel, security personnel, park maintenance personnel; and guidelines are needed for the interaction of these people with public. |
| MRTC | Recreation O&M - Requests the Licensee hire onsite recreation staff. |
| WVDNR | Boating - Law enforcement records do not show any significant increase in boating incidents. WVDNR is not opposed to the temporary moratorium on new private piers/boat docks and would not be opposed to the moratorium continuing. |

| Agency/ Stakeholder | Study Related Comment/ Study Request |
|---|---|
| CLEAR | Boating - Requests boating guidelines and limits consistent with the rules and regulations of the WVDNR. Boat guidelines/regulations, public dock maintenance, channel depth (dredging), and parking lot criteria are all in need of explicit definition and guidance. |
| **ENHANCED COMMUNICATIONS/INFORMATION** | |
| CLEAR | Telephone(s) & email address(es) are needed on signs and on web page(s) for information and for emergencies. |
| CLEAR | Formal plans and procedures are needed that assigns responsibilities for the various types of emergency at the dam, on the trails, on Cheat Lake, and downstream. |
| CLEAR | Public brochures are needed that include the history, overview of facilities, rules/regulations, contacts, etc. |
| CLEAR | The website needs additional pages that includes the brochure information, lake level, operational updates, warnings, etc. |
| CLEAR | News releases are needed providing general information, trail closings, warnings and other items for current news. |
| CLEAR | Signage on WV 857 for the Cheat Lake Park and Trail needs to be maintained year-round and the signage on the Trail maintained for public use year-round. |
| CLEAR | For the lake level protocol, need to reiterate the water level ranges vs. months of the year on the website and in the brochure(s). |
| MRTC | Requests improved public communication (website, social media, phone), and creating a process for holding events on the Cheat Lake Trail. |
| **GENERAL** | |
| WVDNR | Supports studies proposed in the PAD. |
| CLEAR | A study of the history of Cheat Lake and the dam is needed to examine the role of the Project affecting WV and PA - whether it is a private "for-profit" entity with public obligations or whether it is "for the public interest" to provide recreation and a public service (electricity). |

# Attachment 3

# Copies of Comments and Study Requests

**DIVISION OF NATURAL RESOURCES**
**Wildlife Resources Section**
**District 1**
**P.O. Box 99**
**1110 Railroad Street**
**Farmington, West Virginia 26571-0099**
**Telephone (304) 825-6787**
**Fax (304) 825-6270**

**Jim Justice**
***Governor***

**Stephen S. McDaniel**
***Director***

February 12, 2020

Electronic file

Kimberly D. Bose, Secretary
Federal Energy Regulatory Commission
888 First Street, N.E.
Washington, DC 20426

**RE: Lake Lynn Hydroelectric Project (FERC no. P-2459); Notice of Intent, Pre-Application Document, and Study Requests**

Dear Secretary Bose:

Thank you for allowing the West Virginia Division of Natural Resources, Wildlife Resources Section (WRS) the opportunity to provide comments with regards to the referenced Pre-Application Document (PAD) for the relicensing of the Lake Lynn Hydroelectric Project (Project), FERC No. 2459. Lake Lynn Generation, LLC (Licensee or Applicant) has elected to utilize the Traditional Licensing Process in preparing for a new license. The current Project license was issued on December 27, 1994 and is set to expire on November 30, 2024. The applicant submitted the referenced NOI/PAD in accordance with FERC regulation and consistent with the requirements of 18 CFR § 5.5.

The Project is an established hydroelectric project located on the Cheat River adjacent to the border between Pennsylvania and West Virginia with Project areas located occupying lands in

both states. The Project has an installed project capacity at 51.2 MW using four Francis generating units. The comments below are being provided pursuant to 18 C.F.R §4.38(b)(5).

**Section 4.2 Project Facilities**

The description of the Project facilities described within this section makes mention of trash racks installed at the intake facility. Beyond that, there is no further information regarding the specifications of the trash racks. Based on a preliminary site visit, it would appear as if the trash racks were of a steel construction and installed with spacing of approximately 5-inches. Such large trash rack spacing allows for the entrainment of larger fish that would be more susceptible to blade strikes and turbine-induced mortality as these fish enter the intake structures and pass through the turbines. In an effort to reduce fish mortality, the WRS would request that the trash rack spacing not exceed 3 inches and have an approach velocity of no more than 2.0 fps. The WRS further recommends angled trash racks be employed as a means to further reduce entrainment.

**Section 4.4 Current and Proposed Project Operations**

The current FERC license requires an operation schedule whereby the lake elevation is maintained between 868 and 870 feet from May 1 to October 31, between 857 and 870 feet from November 1 through March 31, and between 863 feet and 870 feet from April 1 through April 30. The April 1 to April 30 schedule was initially designed as a provision to reduce the Project's impacts on spawning fish populations within the lake, particularly yellow perch and walleye. The thinking at that time was that these fish species predominantly spawned during the early Spring month of April. Recent data has become available through the triennial biomonitoring studies, in particular a recent analysis of yellow perch habitat, which may indicate that in some years, based on temperature and weather conditions, the spawn may begin in mid-March and extend into Mid-April or later. Similar results were observed in a study on the walleye populations within the lake by a member of the WRS staff whereby the walleye spawn was documented as early as mid-March. Considering, there is concern that the lake elevation schedule during the month of March (between 857 and 870 feet) would not be sufficient in protecting the spawn and would have the potential to dewater a great many eggs thus impacting recruitment. It may be necessary, then, to revisit the current project operations and examine possible avenues to protect these species throughout the spawning season. A new schedule could be based on temperature such that in normal years the schedule can remain as is, but in warm years where the WRS, based on water temperature variables (45ºF for a sustained period in March), anticipates that an early spawning period would occur, the April elevation schedule could be moved back to mid-March.

**Section 5.2**

The continuous monitoring of water quality as required by License Article 405 of the existing Project License is an invaluable tool in the management of the resources. As such, the WRS would request that water quality monitoring within the reservoir and tailwaters be continued throughout the term of the upcoming license.

### Section 5.3.2.2 Catadromous and Diadromous Species

This passage asserts that "there is no known occurrence of the American eel in the Cheat River basin, however...eels have been collected in the Ohio River basin from the Kanawha, New, and Greenbrier Rivers." In fact, the American eel has also been collected in the Monongahela River within the past 10 years as far upstream as the Morgantown Lock and Dam. This point is upstream of the confluence of Cheat River with the Monongahela River. It could therefore be assumed that there is a strong likelihood that the American eel may also be located within the Cheat drainage. However, it should be noted that, at least with regards to recent data collection, the American eel has not been observed within the tailwaters of the project. A recent eDNA study of the Project tailwaters resulted in no positive recordings of the American eel. The reasons for the negative results may be because of study design or perhaps because there were no eels in the Cheat River watershed. Nonetheless, it is the WRS' understanding that the US Fish and Wildlife Service (USFWS) will be requesting additional analysis of the Project waters to determine presence or absence of the American eel. The WRS would not be opposed to any USFWS request regarding this particular subject matter.

### Section 5.3.2 Fish Resources and Habitats

As per state rule §47-5A-6, reimbursement for the incidental loss of fish due to project operation will be required. Therefore, the WRS would request that a comprehensive desktop entrainment study be utilized to determine the likely number of fish, fish species, and size classes to become entrained and experience mortality as a result of the Project's operation.

### Section 5.3.2.3 Fish Passage

The major components of a hydropower facility (i.e. the turbines) pose a particular risk to fish passage and an additional impediment to fish passage. Project operations may attract fish moving downstream to pass through the turbines creating an unnecessary risk for mortality. It is the flowing water through the Project that initially attracts the migrating fish. Additionally, passage over the spillway could also be hazardous for fish. To minimize the potential hazards for the downstream movement of fish, the WRS would request that a feasibility study be conducted to explore potential options for a bypass system or diversionary tactics.

### Section 5.8.3.4 Public Boat Launching Facility at Sunset Beach Marina

Sedimentation at the Sunset Beach Marina has become a significant issue over the years and has only worsened to the point by which anglers and boaters are affected. Launching a boat from this area has become more challenging and at some levels, is next to impossible. The Licensee has made great strides in correcting the sedimentation via dredging the embayment. Still, there is concern that this is a temporary fix and without a plan in place to address future sedimentation of the embayment, this is a problem that will likely occur again. Therefore, the WRS would request the licensee draft a sedimentation plan in an effort to minimize future sedimentation and reduce costly dredging activities.

**Section 5.8.5 Boating Carrying Capacity Study**

The results of the boating carrying capacity study would suggest that the number of boaters using Lake Lynn at any given time has exceeded that of a safe operating amount for the lake. Law enforcement records have yet to show any significant increase of incidents. Nevertheless, the WRS is not opposed to the Licensee's moratorium on new private piers/boat docks within the Project reservoir. According to the scoping meeting, the moratorium was enacted by the Licensee as a temporary measure to reduce the number of boats on the lake with the intention to lift the moratorium, or at least re-examine its effectiveness, following the relicensing process. The WRS views the moratorium as being beneficial in reducing the level of impact to shoreline habitat caused by the continued construction of the lake shoreline. Shoreline habitat is critical for a healthy, sustainable fishery and therefore, the WRS would be not be opposed to continuing the moratorium beyond the FERC relicensing of the Project.

**Section 6.2.7.1 Potential Issues and Project Effects**

This section lists a proposal to "create public access to the upper reaches of Cheat Lake by improving an existing gated road in Snake Hill Wildlife Management Area along Buzzard Run." The WRS would be unequivocally opposed to this proposal. The WRS is not interested in opening up the gated road that passes through the WMA property. Continued maintenance of the access road would be problematic and an undue burden for the state and the Licensee with very little benefit to the WRS' prime constituents.

**State 401 Water Quality Certification**

Section 401(a)(1) of the federal Clean Water Act, 33 U.S.C. § 1341(a)(1) provides that any applicant of a federal license or permit must obtain a state certification from the appropriate state certifying agency. This certification is to ensure that any activity conducted under the license are to be in compliance with all applicable provisions of the Clean Water Act. The state of WV will have one year to act on a received 401 application from the date the US Army Corps of Engineers deems the federal 404 application to be complete.

**Study Requests**

The WRS is in support of the studies proposed by the Licensee for the Lake Lynn Hydroelectric Project as identified within the PAD. Additional studies not previously included within the PAD are being provided by the WRS. The WRS makes these requests in support of currently proposed studies, to correct deficiencies in data and to offer a greater level of detail where needed. The WRS further requests the opportunity to review any study plans associated with this project. The request format is in accordance with that described in 18 CFR § 5.9 (b).

**Study Request 1: Entrainment Study**

**Goals and Objectives:**

The goal of the proposed study is to determine the number of fish that are either entrained or impinged and to estimate the injury and mortality of fish that pass through the turbines during

Project operation. The WRS is requesting a desktop entrainment study be conducted on the Lake Lynn Project. The goal of the desktop study will be to estimate mortality for compliance with state code.

As the resource agency, it is the goal of the WRS to manage and protect the resources. To the furtherment of this goal, WV code §47-5A-6 requires that mitigation be completed for any impacts to the resources. In this case, entrainment of fish through the turbines causes undue stress to the fish and can potentially be fatal. Therefore, the WRS would request that any mortality in fish be compensated. In order to properly ascertain the number of fish that succumb to mortality, an entrainment study will need to be performed.

The WRS recommends a desktop entrainment analysis utilizing the EPRI database. Data used for the analysis should be presented by species and by two-inch size classes. The WRS would further recommend that a field component be incorporated to verify results.

**Resource Management Goals:**

The WRS is charged with the protection and management of all wildlife within West Virginia, including within Cheat river and Lake Lynn. As per state rule §47-5A-6, the State would require the applicant to compensate the state for any loss of fish.

**Existing Information:**

To the best of its knowledge, the WRS is not aware of any entrainment studies that have been conducted at the Project. The years of biomonitoring data conducted in accordance with the existing license, will help to inform this entrainment analysis.

**Nexus Between Project Operation:**

During Project operation, fish of a certain size are able to pass through the trash racks and become entrained through the turbines. As the turbines operate, it is likely that some fish will be struck by the turbine blades while others will succumb to changes in barometric pressures as they pass through the intake. The likelihood of a blade strike and turbine-induced mortality increases as the size of the fish increases. Therefore, compensatory mitigation will be required as replacement for the loss of fish.

**Study Methodology:**

The methodology employed should include a combination of desktop entrainment analysis and field verification. The standard practice has been to utilize the Electric Power Research Institute (EPRI) turbine entrainment and survival database as a model in evaluated the potential of entrainment at a facility. The WRS has had concerns that this particular practice lacks the scientific creditability necessary to make informed decisions about the management of the fishery. Therefore, the WRS requests the opportunity to review any entrainment data considered

for use in the desktop entrainment analysis. Further, the WRS may request that a verification procedure be incorporated as a means to test the veracity and accuracy of the desktop entrainment results. Deploying hydroacoustics sampling techniques may be one way to achieve this goal as a more cost-effective method than deploying nets downstream. Data for any type of analysis should be presented by species and by 2-inch class sizes to remain consistent with general state practices. The WRS is willing to further discuss methodologies with the applicant.

**Level of Effort and Cost:**

The level of effort required to conduct a desktop entrainment analysis is relatively minor and most consulting firms/universities are well equipped to perform such an analysis. Additionally, the cost of a desktop entrainment analysis is much more attainable when compared to the alternative of an in-field entrainment analysis. Incorporating an in-field verification procedure with the analysis will increase the level of effort and cost and would require certain levels of training, expertise, and equipment. Nonetheless, an in-field verification procedure is still attainable and within reasonable limits of effort and cost.

**<u>Study Request 2: Upstream/Downstream Fish Passage and Feasibility Study</u>**

**Goals and Objectives:**

The goals of this study are to assess movement of fish through the project area; identify likely routes fish would take under a variety of conditions; and assess the feasibility of incorporating alternative routes or additional fish protection measures.

**Existing Information:**

To the best of its knowledge, the WRS is unaware of any study on upstream/downstream passage at the Project. Any study that may have been completed is likely dated material and incompatible in reflecting current conditions and population dynamics.

**Nexus Between Project Operation:**

Dam features, because of their general nature, impede the upstream and downstream movement of fish. By design, the dam at the Project affords no migration upstream. Downstream migration is offered by one of two routes: through the dam gates; and through the Project's powerhouse. Neither of these two routes provides for a safe migration downstream. The route through the powerhouse would mean risking turbine strikes or dangerous changes in barometric pressure. The route through the dam gates may provide for an equally perilous journey with fish tumbling down rough concrete faces. It is evident, then, that the Project has a direct relationship to fish passage.

**Study Methodology:**

Methodology would include a literature review of all available options for bypass routes and fish protection measures and an analysis on how such measures could be incorporated into the current project designs. Architectural design and structural engineers would need to be consulted for their expertise in determining feasibility of any new structural component at the project.

**Level of Effort and Cost:**

A study such as this would most likely take less than a year to complete with minimal effort. Discussions with engineers and reviews of designed structures would be necessary to properly assess the feasibility of any bypass channels or fish protection structures. Additionally, this study could be completed in concert with study request #1 (entrainment study) to reduce costs and effort. The WRS is not aware of the cost associated with this study but would assume it to be at a nominal rate.

**Study Request 3: Reservoir Sedimentation Study**

The WRS is requesting that a sedimentation study of the Project's reservoir be conducted at the problem areas and a plan to monitor and address any sedimentation issues be developed.

**Goals and Objectives:**

The goal of this survey is to asses sedimentation within certain problem areas within the Project reservoir and to develop a plan to address any deficiencies as they arise.

**Existing Information:**

Reports of sedimentation affecting boaters and anglers have risen in recent years, but as of yet no study that the WRS is aware of has been conducted on the sedimentation and no plan has been developed to address it. Steps to remedy sedimentation are typically taken when the issue rises to unsuitable levels. A more preventive strategy here may reduce future costs of sediment removal and keep recreation areas open without issue.

**Nexus Between Project Operation:**

By their very nature, dams cause sedimentation within the reservoir as the moving water slows down and particles are allowed to settle out. Therefore, the Project operations have a direct influence on the level of sedimentation.

**Study Methodology:**

The methodology should begin by examining possible sources of sedimentation within the reservoir and then by identifying potential preventive measures that could be taken to reduce the level of sedimentation in those areas that have demonstrated an affinity for a build-up of sediment (i.e. Sunset Beach).

**Level of Effort and Cost:**

Most consulting firms and universities would be fully capable of conducting a sedimentation study, including interpreting and analyzing the data. The costs of such a study is variable dependent on contractor used to conduct the study and the level of attention to detail.

The WRS appreciates the opportunity to provide comments and to make study requests. If you have any questions regarding this letter, comments made, or these study requests, please contact me by telephone at (304)825-6787, or by email at Jacob.D.Harrell@wv.gov.

Sincerely Yours,

Jacob Harrell
Hydropower Coordination Biologist

Cc: Jody Smet, Lake Lynn Generation, LLC
David Fox, Lake Lynn Generation, LLC
Janet Norman, USFWS
Paul Johanson, WVDNR
Mark Scott, WVDNR
Zack Brown, WVDNR
David Wellman, WVDNR
Danny Bennett, WVDNR

LAKE LYNN HYDRO PROJECT: ISSUES AND COMMENTS FOR RELICENSING

SUBMITTED BY: Duane Nichols, President, Cheat Lake Environment & Recreation Association, 330 Dream Catcher Circle, Morgantown, WV 26508

RE: Project P-2459, Relicense for Lake Lynn Hydroelectric Project. Date: February 10, 2020

1. Clear and complete procedures are needed for Trail maintenance and repair, for both routine and non-routine circumstances.

2. Clear and complete goals, guidelines and procedures are needed for the Sunset Beach marina and other marinas, to cover the operation, maintenance and planning for the future.

3. Boating is a primary recreational activity on the Lake, so there is a need for boating guidelines and limits consistent with the rules and regulations of the WV DNR. Boat guidelines and regulations, public dock maintenance, channel depth (dredging), parking lot criteria, etc., are all in need of explicit definition and guidance.

4. Periodic lake cleanup activities need to be continued by CLEAR and others with the support of Lake Lynn Hydro to remove plastic and structural debris floating in the lake and backwaters. The CLEAR pontoon boat should be useful for these activities.

5. Given that the Lake is limited in boating capacity during busy weekends, the limit has been reached for the number of marinas, boat slips and personal access area sites.

6. Swimming beach season should match the boating season of May 1st to October 31st

7. Regular maintenance of the swimming beach is needed to remove large debris (mainly tree segments) and to keep quality sand fresh and deep, as mostly children use it.

8. The swimming beach area needs to be extended toward the day-use boat docks to permit the designation of a dog beach, given that dogs interfere with the swimming experience of small children; this will also add space for additional picnic tables, that are already needed.

9. Monitoring and remediation of the on-going shoreline erosion are needed with components of these activities taking place on an annual basis.

10. Hillside slips, ground subsidence and washouts along the Trails must be prepared for, as they are not uncommon, so that monitoring, temporary work-arounds and repairs can take place in a timely manner.

11. Signage on WV 857 for the Cheat Lake Park & Trail needs to be maintained year round and the signage on the Trail maintained for public use year round.

12. Telephone(s) & email address(es) are needed on signs and on web page(s) for information and for emergencies.

13. Formal plans and procedures are needed that assigns responsibilities for the various types of emergency at the Dam, on the Trails, on the Lake, downstream in Pennsylvania, etc.

14. Brochures are needed for public distribution to include the history, overview of facilities, rules/regulations, contacts, etc.

15. The Internet Web-Site is needed with multiple pages to include the brochure information, lake level, operational updates, warnings, etc.

16. News Releases (quarterly & timely) are needed providing general information, trail closings, warnings and other items for current news.

17. For the Fishing Pier, there is a need to identify the opportunities, guidelines, operation and maintenance schedules.

18. A continued commitment to regional trail development should include interfacing with the proposed Sheepskin Trail in Pennsylvania, for a connection to other regional trails, to involve the opening of the trail level gate at the Lake Lynn Dam for daylight walking, hiking, jogging and bicycling.

19. For the Lake level protocol, there is a need to reiterate the water level ranges vs. months of the year on the Web-site and in the Brochure(s).

20. For the Recreation Season protocol, there is a need to reiterate the schedule of May 1 thru October 31, with the Trail being open and accessible year round. The "boat launch" in the Park is essential for summer use by kayak & canoe users and for winter use by fishing boat users.

21. There is a need for a description of the functions of (existing & new) recreation personnel, security personnel, park maintenance personnel; and guidelines are needed for the interaction of these people with public.

22. An Advisory Committee is needed with Quarterly meetings and quarterly reports, consisting of members from Monongalia County, WV-DNR, WVU, WV trail group, PA trail group, PA-DNR/DEP, plus 2 or 3 local environmental/conservation groups.

23. A study of the details of the history of Cheat Lake and the Lake Lynn Dam is needed to examine the role of the project there on the Mason-Dixon Line affecting both West Virginia and Pennsylvania, whether it is a private "for-profit" entity with public obligations or whether it is "for the public interest" to provide recreation and a public service (electricity). These considerations take on a greater significance when foreign ownership is under way.

The Cheat Lake Environment & Recreation Association (CLEAR) has been active to promote the public use of Cheat Lake for over 30 years. The officers are Duane Nichols, President, Mike Strager, Vice President, Ann Chester, Secretary, and Donna Weems, Treasurer.

CONTACT INFORMATION: Duane G. Nichols, 330 Dream Catcher Circle, Morgantown, WV 26508. Phone: 304-216-5535, Email Address: Duane330@aol.com

Submitted by Duane Nichols of CLEAR this 10th day of February 2020.

Document Content(s)

United States Department of the Interior

FISH AND WILDLIFE SERVICE

Chesapeake Bay Field Office
177 Admiral Cochrane Drive
Annapolis, Maryland 21401
http://www.fws.gov/chesapeakebay

February 13, 2020

Jody Smet
Director, FERC Licensing and Compliance
Lake Lynn Generation, LLC
2 Bethesda Metro Center, Suite 1330
Bethesda, MD 20814

Dear Ms. Smet:

The U.S. Fish and Wildlife Service (Service) has reviewed the October 17, 2019 Notice of Intent (NOI) to File for a License and attached Pre-Application Document (PAD) for the Lake Lynn Hydroelectric Project (FERC #2459), filed by Lake Lynn Generation, LLC (Applicant). The Applicant has elected to use the Traditional Licensing Process (TLP) for this re-licensing application of the Lake Lynn Hydroelectric Project on the Cheat River near Morgantown, West Virginia and in Fayette County, Pennsylvania. The current project license was issued on December, 1994 and will expire on November 30, 2024.

The Service attended the Joint Agency meeting and site visit on December 12, 2020 in Morgantown, WV, with the Applicant, state and local agencies, and interested residents. We offer the following recommendations on the PAD and our Study Requests.

The following comments are provided pursuant to the Endangered Species Act (ESA) of 1973 (87 Stat. 884, as amended: 16 U.S.C. 1531 *et seq*.), the Migratory Bird Treaty Act (16 U.S.C. 703-712; Ch. 128; July 13, 1918; 40 Stat.755), and the Fish and Wildlife Coordination Act (48 Stat. 401, as amended; 16 U.S.C. 661 *et seq*.).

The project is a 51.2 megawatt (MW) single development project operated since 1926. It consists of: 1) a 125-foot high by 1,000-foot long concrete gravity-type dam with a 624-foot long spillway controlled by 26 Tainter gates, each 17 feet high by 21 feet long; 2) a reservoir with a surface area of 1,729 acres and containing about 72,00 acre-feet of water at full pool elevation of 870 feet National Geodetic Vertical Datum; 3) a log boom and track racks at the intake facility; 4) eight 12-foot by 18-foot gated penstocks of reinforced concrete; 5) a 72-foot by 165-foot by 68-foot high brick powerhouse containing four identical Francis generating units with a total rated capacity of 51.2 MW; 6) dual 800-foot long 138-kilovolt transmission lines; and 7) appurtenant facilities. In 2018, the licensee completed a turbine replacement and upgrade of Unit 2.

**Pre-Application Document**

Section 4.4 Current and Proposed Project Operations.

The Service supports the concerns of the West Virginia Division of Natural Resources (WV DNR) regarding the quality and timing of available yellow perch (*Perca flavenscens*) and walleye (*Sander vitreus*) habitat within the reservoir lake, with proposed drawdown operations. Their assessment is that the lake elevation schedule during the month of March (between 863 and 870 feet) is likely insufficient to protect the spawning period and could dewater many fish eggs which would hamper recruitment to the populations. We would like to better understand how lake levels, downstream flow releases, and draw down schedules impact fish and wildlife resource needs so we can determine whether there are ways to minimize these impacts.

Section 5.2 Water Resources

The current License Article 405 (continuous monitoring of water quality) has proved very beneficial to the Licensee and resource agencies as this monitoring resulted in effective management of a low flow event during the summer/early fall of 2019. The Service believes this monitoring should be continued in any new license condition granted.

Section 5.2.3 Streamflow, Gage Data and Flow Statistics

This section of the PAD does not provide sufficient information for the Service to fully assess the seasonality, duration and magnitude of streamflows inflowing to the reservoir and dam, and the appropriate flow releases for the upcoming license period. The graphs in Appendix E (Flow Duration Curves) are not scaled appropriately to discern the patterns of what occurs in the 5 to 99 percent exceedance flows that we would need to examine. It would be helpful if the maximum flow event(s) and duration for the period record 2016 to 2019 is displayed separately from the rest of the graphs so as not to flatten all other flow interpretation.

The Service does not see the Project Instream Flow Study which is referenced in this section of the PAD, contained in Appendix E, in order to assess its applicability to current and future conditions. Without this information, we have many remaining questions, and would recommend an Instream Flow Study to help us determine appropriate flow releases in the new license articles.

The Service also believes a mussel survey should be conducted downstream in the tailwater area and downstream reaches to assess this valuable component of the aquatic community and potentially help inform our flow regime recommendations for the project.

Section 5.7.2 Rare, Threatened and Endangered Resources and Habitats

Table 5.16 of the PAD identifies four species federally listed under the ESA with the potential to occur in the project area, Indiana bat *(Myotis sodalis*), northern long-eared bat (*Myotis septentrionalis*), running buffalo clover (*Trifolium stoloniferum*), and the flat-spired three-toothed snail (*Triodopsis platysayoides*).

The federally threatened northern long-eared bat and the federally endangered Indiana bat are temperate, insectivorous migratory bats that hibernate in mines and caves during the winter and spend summers in wooded areas. There are no known northern long-eared bat maternity roosts

or hibernacula within the immediate vicinity of this site. Indiana bats are most likely to be in maternity roosts from May 1 to July 31.

Any project-related tree removal (e.g., for maintenance or recreational improvements) should involve consultation with the Service under Section 7 of the ESA, for the protection of the Indiana bat and northern long-eared bat.

The Service filed an August 27, 2019 Proposed Rule in the Federal Register for the de-listing of running buffalo clover (*Trifolium stoloniferum*) found at this web address: https://www.govinfo.gov/content/pkg/FR-2019-08-27/pdf/2019-18413.pdf#page=1. Its current status is still federally endangered as of this comment date. However, we believe this existing project with minor habitat modification of the project area will not likely adversely affect running buffalo clover, a terrestrial plant. We therefore, are not requesting surveys for the plant.

The flat-spired three-toothed snail is found within Monongalia County, West Virginia in close proximity to the project, but is not found within the project boundary. It is found in Coopers Rock State Forest, primarily on the rock bluffs. The area within the project boundary lacks the habitat requirements for the snail, therefore, this project will have "no effect" on the species.

Except for occasional transient individuals, no other federally proposed or listed threatened or endangered species are known to exist within the project area. Should project plans change or if additional information on the distribution of listed or proposed species becomes available, this determination may be reconsidered.

**Study Requests**

The Service has reviewed the evaluation of study proposals in the PAD by the Applicant for the Lake Lynn Hydroelectric project. We feel the proposed presence/absence surveys for rare, threatened, and endangered species may not be warranted, based upon our comments on the PAD. Aside from a field inventory of existing project recreation sites, a creel survey, and a cultural resources examination along the Cheat Lake Trail and Lake Lynn dam and powerhouse, the Applicant is not proposing any other studies. The only protection, mitigation, and environmental (PM&E) measures the Applicant proposes relate to recreation and land use. The Service believes the studies we and other resource agencies have identified are necessary to determine appropriate PM&E measures for the upcoming license period.

The Service requests the opportunity for further review and discussion as the study plans develop from a conceptual phase into more defined proposals.

**Study Request 1: American Eel Monitoring Study**

*Goals and Objectives:* To assess if American eel (*Anguilla rostrata*) is currently present below the Lake Lynn dam on the Cheat River and to help inform project operations and fishway prescription needs.

*Resource Management Goals:* Resource management goals include providing safe, timely, and

effective passage for fish species that migrate. Additional goals include providing passage to fish species which serve as glochidial hosts to freshwater mussels in the Cheat River, in order to prevent negative impacts to fish and mussel populations from the proposed project.

*Public Interest:* The requestor is a resource agency.

*Existing Information:* American eels have been documented in the Monongahela River within the past 10 years as far upstream as the Morgantown Lock and Dam, upstream of the confluence of the Cheat River with the Monongahela River. The Lake Lynn Hydropower Project is 3.7 miles upstream on the Cheat River from its confluence with the Monongahela River, therefore there is significant potential for current and future eel habitat usage within the Cheat River below Lake Lynn Hydroelectric project, and within the upstream miles of the Cheat River and tributaries. A preliminary sampling effort was conducted using the technique of environmental DNA (eDNA) detection technology as detailed in the "Project Report: June 2019 qPCR analysis of eDNA filter samples collected at Lake Lynn Dam, Target species: American eel (*Anguilla rostrata*)," dated December 4, 2019 by the Northeast Fishery Center's Conservation Genetics Lab.

*Study Methodology:* The recommended study uses standardized protocols employed in published literature.

*Level of Effort and Cost:* The methodology employed by the pilot sampling project described in the December 4, 2019 Project Report has shown that this method is a lower cost technique. This new study would seek to improve on sampling conditions to greatly reduce the influence of above dam released water on the collected samples, and to include areas lower in the Cheat River before its confluence with the Monongahela River.

**Study Request 2: Entrainment Study and Mortality Study**

*Goals and Objectives:* The goal of the proposed study is to determine the number of fish that are either entrained or impinged by the project operation, and to examine methods to reduce this injury and mortality to fishes.

*Resource Management Goals:* The Service's strategic conservation priorities include aquatic connectivity efforts that provide for passage, community protection, and enhanced recreational opportunities using the best available science and decision support tools.

*Public Interest:* The requestor is a resource agency.

*Existing Information:* The Service is not aware of previous entrainment studies conducted at the project. The biomonitoring data conducted under prior license conditions and filed in the FERC record can be used to assist in this analysis.

*Nexus To Project Operation:* Due to the large spacing of the current trash racks, certain sizes of fish are able to pass through the racks and become entrained through the turbines as they operate, causing fish mortality of an unknown quantity.

*Study Methodology:* The Applicant could use the Service's Turbine Blade Strike Analysis Model as one component of their assessment of current operational impact on entrainment and mortality of fishes. It can be found at https://www.fws.gov/northeast/fisheries/fishpassageengineering.html, along with other Service guidelines such as the Northeast Region Fish Passage Engineering Design Criteria, Fish Passage Design Criteria, and the Federal Interagency Nature-Like Fishway Passage Design Guidelines. Some literature analysis of mortality from Francis units of the diameter that exist at the project could also be utilized.

*Level of Effort and Cost:* These desktop analyses should be achievable within the one year timeframe.

**Study Request 3: Upstream and Downstream Fish Passage Study**

*Goals and Objectives:* The goals of the study are to assess movement of fish through the project area. It would identify likely routes fish would take under a variety of conditions, and assess the feasibility of incorporating alternative routes or additional fish protection measures.

*Public Interest:* The requestor is a resource agency.

*Existing Information:* The Service is not aware of previous studies examining passage options for the Lake Lynn Hydroelectric Project.

*Nexus To Project Operation*: The dam at the project blocks migration of fishes upstream and likely impedes safe, timely, and effective passage downstream. Downstream migration is currently only available through the dam gates, and through the project's powerhouse.

*Study Methodology:* The methodology would include a literature review of available options for upstream passage of eels, downstream passage bypass of the turbines, and other fish protection measures, in addition to iterative discussions with the Service's fishway engineers and other case studies.

*Level of Effort and Cost:* We anticipate that evaluating feasibility of passage would be fairly straightforward and not a lengthy process. Discussions with engineers would be necessary to properly assess the feasibility of bypass channels or fish protection structures.

We appreciate the opportunity to provide review and comment on the PAD and draft study proposals developed by the Applicant. We look forward to further discussions with you on how the Applicant can incorporate all the above listed studies. Finally, it would be helpful if the study proposals incorporated into the Draft Study Plan are as detailed as possible so that all parties

know exactly what is being agreed upon when the study plan is approved. If you have any questions regarding this matter, please contact Janet Norman of my staff at 410-573-4533 or Janet_Norman@fws.gov.

Sincerely,

Christopher P. Guy

for Genevieve LaRouche
Field Supervisor

cc: Lindy Nelson, Regional Environmental Officer, DOI OPEC

**References**

U.S. Fish and Wildlife Service. Endangered and Threatened Wildlife and Plants; Removing Trifolium stoloniferum (Running Buffalo Clover) From the Federal List of Endangered and Threatened Plants. 84 FR 44832, August 27, 2019. https://www.govinfo.gov/content/pkg/FR-2019-08-27/pdf/2019-18413.pdf#page=1

U.S. Fish and Wildlife Service. 2019. Fish Passage Engineering Design Criteria. USFWS, Northeast Region R5, Hadley, Massachusetts.

Mon River Trails Conservancy

P.O. Box 282
Morgantown
West Virginia
26507-0282

February 9, 2020

Kimberly Bose, Secretary
Federal Energy Regulatory Commission
888 First Street, N.E.
Mailcode PJ- 12.1
Washington, DC 20426

Re: *Information Request for the Pre-Application Document for Relicensing of the Lake Lynn Hydroelectric Project (FERC No. P-2459-005)*

Dear Ms. Bose,

On behalf of the Monongahela River Trails Conservancy Ltd. (MRTC), I am submitting comments concerning the Relicensing of the Lake Lynn Hydroelectric Project (FERC No. P-2459-005). MRTC is a non-profit 501c3 organization founded in 1991 to develop and manage 40 miles of a 48-mile, tri-county rail-trail network in North Central West Virginia. The remaining 8 miles are managed by the city of Morgantown and Star City, with MRTC as an active partner. The Mon River, Caperton, Deckers Creek Trail network was established as a National Recreation Trail in 1996. MRTC shares with other regional stakeholders the vision of having the Cheat Lake Trail connect with the Sheepskin Trail in Pennsylvania and the Mon River Trail network in West Virginia and ultimately be part of a long-distance trail network that extends from Ohio through West Virginia and Pennsylvania to Washington D.C.

Cube Hydro, in now owning and managing the Cheat Lake Dam aka Lake Lynn Facilities, has continued to provide a wide mix of public recreational options to enjoy the area including hiking, biking, birding, paddling, fishing, swimming, and boating. MRTC supports these recreational activities and would like to see improvements to these recreational opportunities be included in this re-licensing process:

1. To restore the Cheat Lake Trail to its 4.5 mile length by repairing a major wash-out that occurred in the summer of 2019.
2. To plan and build a connection of the Cheat Lake Trail to the Sheepskin Trail at the north end of the 4.5 mile Cheat Lake Trail. This would connect the Cheat Lake Trail into a nearly 60 mile rail-trail network and connect many communities including Point Marion, PA, Morgantown, WV, and Fairmont, WV. This involves opening the gate at the north end of trail and working with other stakeholders to build new trail on Cube Hydro property to link into the Sheepskin Trail corridor. The Sheepskin Trail Corridor is owned by Fayette County, PA and is currently being engineered and built. The Sheepskin Trail is not yet built to Cheat Lake Trail but we anticipate it will be in the next 5 years.
3. To extend the Cheat Lake Trail south on Cube Hydro property and in doing so, open up more area to hiking, biking, birding and fishing.
4. To improve fish, bird, and pollinator habitat along the Cheat Lake Trail.

5. To improve recreational promotion of the Cheat Lake recreation area by hiring on-site recreation staff, by improving public communication (website, social media, phone), and by creating a process for holding events on the Cheat Lake Trail such as walks and runs.

Recreation on the river and neighboring rail-trails ties our communities in West Virginia and Pennsylvania together economically and socially. Bass tournament participants cross city, county and state lines. Both the Monongahela River and Cheat Rivers are regionally promoted water trails, and both paddlers and boaters move up and down the rivers to access different communities. Our rail-trails are used for commuting to work and school, trail tourism, and recreation. Our communities are dependent on each other to provide access, amenities, and tourism services in order to recruit new businesses and people to live in the region and entice visitors into extended stays and return visits.

The Cheat Lake Trail is one of a cluster of rail-trails in the region that provides recreation, a social gathering space, and a chance to connect with nature. It is widely used by local groups such as Hike it Baby, an outdoor meet-up group for families with young children, the Mountaineer Chapter of the National Audubon Society for public birding outings and the Christmas Bird Count, and cycling and running groups for exercise and outdoor recreation. Additionally, the Cheat Lake Trail is a part of a growing 1,500+ mile trail network connecting 50+ counties in four states (WV, OH, PA and NY). The Industrial Heartland Trails Coalition is a group comprised of more than 100 organizations, whose vision and mission it is to advance the trail network by closing gaps and connecting communities to bring health and wealth to communities through trail tourism and safe, equitable trail access by local residents.

Thank you for considering these recommendations from community stakeholders as part of the re-licensing process. Please feel free to contact me at 304-692-6782 or ella@montrails.org with any questions or if you need additional information.

Sincerely,
Monongahela River Trails Conservancy, Ltd.

Ella Belling, Executive Director

Document Content(s)

Owen Mulkeen, Kingwood, WV.
On behalf of Friends of the Cheat, I'd like to start by thanking you for the opportunity to submit comments to be included as part of the Pre-Application Document for Relicensing of the Lake Lynn Hydroelectric Project.
For 25 years, Friends of the Cheat (FOC) and our River of Promise (ROP) partners have worked diligently to restore water quality to the Cheat River and Cheat Lake through reclamation of mine lands and the remediation of acid mine drainage (AMD). Irresponsible mining had left the Cheat and nine of its lower tributaries severely damaged by AMD. Walleye were extirpated by the late 1940s. Historic data collected by WV Division of Natural Resources (DNR) show mean lake pH levels less than 5 between the 1950s and early 1990s. A few pollution tolerant fish species including bullhead catfish and white suckers sought refuge in the lake's sheltered embayments. Massive pollution releases from the T&T mine into Muddy Creek in 1994 and 1995 dropped the pH of the lake to 4. As a result, the Cheat River was named one of America's Most Endangered Rivers in 1995 by the national organization American Rivers. These events catalyzed the formation of Friends of the Cheat and the River of Promise task force.
The efforts of FOC and our ROP partners, most notably the US Office of Surface Mining (OSM) and WV Department of Environmental Protection (DEP), have restored water quality to the Cheat River main stem and Cheat Lake. Over 200 land reclamation and water treatment projects have been implemented with millions of dollars of funds resulting in millions of pounds of AMD pollution removed from the Cheat's tributaries. The river and lake have not seen a pH depression below 6 since 2011 and the main stem has been removed from the state's list of impaired waters for pH impairment. The removal of iron (ferrous hydroxide or "yellow boy") as well as aluminum and manganese is visibly noticeable by reduced staining of rocks near the water's edge as well as armoring of fiberglass boat bottoms, which was a prevalent problem through the '90s.
Improved water quality has fostered the rebound of Cheat Lake's fishery. DNR reports a dramatic recovery of species richness (27-34 species per year) including abundant sportfish such as largemouth and smallmouth bass, yellow perch, and walleye. Fishing tournaments now attract anglers from across the country which benefits the local economy. FOC is particularly excited about the walleye, which research shows are spawning up into the northern reaches of the Cheat Canyon.
With a drainage area of roughly 1400 square miles all flowing down to Cheat Lake, not only does the Cheat River constitute a critical piece of the region's ecosystem, it is also home to a large human population that lives, works and plays within the drainage. Friends of the Cheat recognizes that opportunities to recreate and connect with nature and the outdoors can not only improve the quality of life for a region's citizens, but it also leads to the engagement with and appreciation of our resources that can help prevent them from being squandered and abused. Cheat Lake and the surrounding area already Working to restore, preserve, and promote the outstanding natural qualities
of the Cheat River Watershed since 1994

provides a plethora of outdoor activities; including paddling, boating, fishing, hiking, cycling, birding and more. Cube Hydro has already improved and created recreation
opportunities around Cheat Lake. FOC and key partners have identified several opportunities for additional improvement of recreational opportunities that we believe should be considered as part of this next re-licensing process.

FOC is aware and supportive of the proposal to create a public access to the upper reaches of Cheat Lake by improving an existing gated road in Snake Hill Wildlife Management Area along Buzzard Run. This would provide another trailhead for hikers to enter the WMA, fishermen to access this upper section of the lake usually only reachable by boat, and would provide an egress opportunity for whitewater paddlers running the Lower Cheat Canyon. Despite being located in close proximity to the Cheat Lake and Morgantown metropolitan areas, and providing a wonderfully scenic and exciting float through class 2 rapids in a deep canyon, this section is infrequently paddled. This is mostly due to the 4.5 mile paddle across Cheat Lake to the nearest existing public access at the Ices Ferry bridge, which can be a laborious task in short maneuverable whitewater craft that are well suited for the rapids upstream, not to mention the danger of encounters with fast moving power boats. The creation of a new public access by improving Buzzard Run Road would shorten this flatwater paddle to 1.9 miles and thereby make this whitewater trip much more attractive.

Another opportunity for recreation enhancement in the Cheat Lake area would be to improve access and connectivity of both ends of the existing Cheat Lake Trail. Currently the trail follows the eastern shoreline of Cheat Lake for 4.4 miles and provides opportunities for walking, running, biking and fishing. The north end of the trail can be accessed via a trailhead and steep flight of stairs off of Morgan Run Road. The south end of the trail dead ends abruptly. With the future route of the Sheepskin Trail passing by just to the north, and local businesses, residential neighborhoods, and Coopers Rock State Forest to the south, there lies an opportunity to work towards increased connectivity of these trail system. By doing so, we can enhance the value of these isolated trail sections in such a way that their value becomes greater than the sum of their parts. We recommend that possibilities to extend the southern end of the Cheat Lake Trail, around the peninsula where it currently terminates, to a newly developed trailhead be thoroughly investigated, as well as the streamlining of the northern terminus to avoid the steep stairs and improve the connectivity to the future route of the Sheepskin Trail.

Thank you for this opportunity to comment on the upcoming relicensing of the Lake Lynn Hydroelectric Project.

Sincerely,

Owen Mulkeen
Associate Director
Friends of the Cheat

Document Content(s)

Dave Harshbarger, Morgantown, WV.
Pleas see the Cheat Lake Trail restored at the wash-out and re-opened to the public ASAP from the storm damage in summer of 2019.
A commitment to connecting to the Sheepskin Trail once the Sheepskin Trail is developed to this area.
And an entrance for cyclists and walkers on the northern end with a replacement of the gate and fence to a gate with a bike/ped pass-thru on the Cheat Lake Trail.

Document Content(s)

GARY V MARLIN, WESTOVER, WV.
January 9, 2020

I am a member of the Morgantown community and would like to submit some suggestions to be considered for Project # P-2459. I would like to see the slip on the Cheat Lake Trail repaired and to see a passage way from the Trail through the dam facility so that there will be a connection to the Sheepskin Trail when it comes by the dam.
Respectfully,
Gary Marlin

Document Content(s)

**From:** Jody Smet
**To:** Janet_Norman@fws.gov; Megan.K.Gottlieb@usace.army.mil; sean.mcdermott@noaa.gov; Kevin_Mendik@nps.gov; Pond.greg@Epa.gov; clschref@usgs.gov; smwickle@usgs.gov; Jacob.D.Harrell@wv.gov; Danny.A.Bennett@wv.gov; David.I.Wellman@wv.gov; coopersrocksf@wv.gov; Brian.L.Bridgewater@wv.gov; susan.m.pierce@wv.gov; dadrake@pa.gov; peiswerth@pa.gov; hsmiles@pa.gov; olbraun@pa.gov; chnagle@pa.gov; agastbray@moncommission.com; dr.hawk@comcast.net; rmcclure@moncommission.com; vvicites@fayettepa.org; harold.peterson@bia.gov; clint.halftown@gmail.com; ec@delawarenation.com; cbrooks@delawaretribe.org; info@oneida-nation.org; admin@onondaganation.org; wfisher@sctribe.com; cassie@shawnee-tribe.com; tonseneca@aol.com; 106NAGPRA@astribe.com; epaden@delawarenation-nsn.gov; dkelly@delawarenation.com; sbachor@delawaretribe.org; bbarnes@estoo.net; jbergevin@oneida-nation.org; lmisita@oneida-nation.org; jay.toth@sni.org; wtarrant@sctribe.com; tonya@shawnee-tribe.com; darren.bonaparte@srmt-nsn.gov; bprintup@hetf.org; duane330@aol.com; mstrager@gmail.com; ella@montrails.org; amanda@cheat.org; owen@cheat.org; betty.w304@gmail.com; fjernejcic@comcast.net; greystone.poa@hotmail.com; dgriff66@aol.com; seangoodwin@yahoo.com; graceandparke@yahoo.com; kevin@americanwhitewater.org; birvin@americanrivers.org; smoyer@tu.org; colleen@hydroreform.org; DMiller@potesta.com; swelsh@wvu.edu; edgewater@cheatlakedocks.com; stratdouglas@gmail.com; KCampitell@oxforddevelopment.com; shall@jccpgh.org; awagner1595@gmail.com; chestermcgraw@gmail.com; donnaweems@rocketmail.com; davecyndy@frontier.com; szybarnes@yahoo.com; mlutman@comcast.net; Reecejames98@gmail.com; gtrking86@yahoo.com; rogerdalephillips@gmail.com; scalvert@greenrivergroupllc.com; jkotcon@gmail.com; john.spain@ferc.gov; andrew.bernick@ferc.gov; dtrested (Guest); Foster, Joyce; Dale Short; Robert Flickner; Karen Baldwin
**Subject:** [EXTERNAL] Lake Lynn Project Relicensing (FERC No. 2459) - April 24, 2020 Meeting Notes and REVISED Study Plan
**Date:** Friday, May 8, 2020 2:57:01 PM
**Attachments:** image001.png
Lake Lynn Study Plan_04-24-2019 Meeting_Notes.pdf
Lake Lynn Study Plan_May 2020_revised.pdf

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Dear Stakeholders,

As follow-up to my email dated April 15, 2020 providing the Lake Lynn Hydroelectric Project (FERC No. P-2459) draft Study Plan for the FERC relicensing and the April 24, 2020 conference call/meeting to discuss the draft Study Plan, I have attached several documents for your review. If you have any comments on the attached revised draft Study Plan, please provide them to us within two weeks, or by May 22, 2020. We are planning to convene several calls with the resource agencies as follow-up to the April 24 call.

I have also attached notes from the April 24 call. Please let us know if we did not capture any discussions correctly. Thank you for your time discussing and reviewing the draft Study Plan.

Please do not hesitate to contact me at (804) 739-0654 or by email at jody.smet@eaglecreekre.com if you have any questions.

Thanks,

**Jody Smet, AICP | Director, FERC Licensing and Compliance**
**Eagle Creek Renewable Energy**
Desk: 804 739 0654
Mobile: 804 382 1764
Email: jody.smet@eaglecreekre.com *[Please note my new email - Eagle Creek and Cube Hydro have merged!]*

**LAKE LYNN HYDRO GENERATION, LLC**
**LAKE LYNN HYDROELECTRIC PROJECT (FERC NO. P-2459) RELICENSING**

## Draft Study Plan Meeting Notes

Meeting Date and Time

Date: April 24, 2020
Time: 11:00 a.m. – 12:30 p.m.
Meeting via MS Teams

Meeting Attendees

Janet Norman - U.S. Fish and Wildlife Service (USFWS)
Greg Pond- U.S. Environmental Protection Agency, Wheeling Office (USEPA)
Harold Peterson - Bureau of Indian Affairs (BIA)
Brian Bridgewater - West Virginia Environmental Protection (WVDEP)
Jacob Harrell - West Virginia Division of Natural Resources (WVDNR)
Danny Bennett - WVDNR
David Wellman - WVDNR
Heather Smiles - Pennsylvania Fish and Boat Commission (PFBC)
Cheryl Nagle - Pennsylvania Historical and Museum Commission (PHMC), State Historic Preservation Office (SHPO)
Erin Paden - Delaware Nation
Andrew Gast-Bray - Monongalia County Planning Commission
Duane Nichols - Cheat Lake Environment and Recreation Association (CLEAR)
Ann Chester - CLEAR
Mike Strager - CLEAR and West Virginia University (WVU)
Owen Mulkeen - Friends of the Cheat (FOC)
Sean Goodwin - Greystone Property Owners Association (POA)
Parke Johnson - Greystone Estates
Kelly Campitell - Emma Kaufmann Camp and Oxford Development Company
Amy Wagner - Mariner Village Resident
Richard Scott - Resident
Jody Smet - Lake Lynn Generation, LLC (Lake Lynn)
Dale Short - Lake Lynn
Bob Flickner - Lake Lynn
Karen Baldwin - Lake Lynn
Joyce Foster - TRC
Elizabeth Krchnavek - TRC
Drew Trested - Normandeau Associates

Notes

*Introduction*

Jody Smet (Lake Lynn) opened the call and took attendance. She stated that the purpose of the call was to review the draft Relicensing Study Plan distributed, by email, on April 15, 2020 and gather feedback on the proposed studies. Ms. Smet reminded participants that Lake Lynn, the Licensee for the Lake Lynn Project, is using FERC's Traditional Licensing Process (TLP) to relicense the Project and that there is no requirement to prepare a formal study plan and that there would be no FERC review and prior approval of the plan.

Joyce Foster (TRC) led a discussion of the individual study plans proposed in the draft Study Plan by resource area.

*Reservoir Shoreline Erosion Survey*

Ms. Foster said that WVDNR requested a reservoir sedimentation study at areas where a build-up of sediment occurs (such as Sunset Beach Marina) and develop a plan to monitor and address any sedimentation issues. Ms. Foster added that Lake Lynn conducted a bathymetric survey in the vicinity of the Sunset Beach Marina public boat launch in 2019 and completed sediment removal in early 2020 to restore the public boat launch to full functionality. She said that a report was filed with FERC documenting the completion of this work. She provided an overview of the shoreline erosion surveys of the Cheat Lake shoreline that Lake Lynn will conduct in 2020 in accordance with the existing FERC license.

Duane Nichols (CLEAR) stated that it is important to have a study to look at mitigation options to address any shoreline erosion areas of concern. Ms. Foster responded that the necessity for mitigation as well as mitigation options would be addressed in the License Application.

*Water Quality Monitoring*

Ms. Foster reviewed the 2020 water quality monitoring effort which will be conducted in accordance with the existing FERC license. She explained that Lake Lynn will continue to monitor and record hourly water quality data from April 1 through October 31 in 2020, provide a an annual report of the monitoring results to USFWS, WVDNR, PFBC, and Pennsylvania Department of Environmental Protection (PADEP) by February 1, 2021 for review and comment and then submit the final annual report to FERC by April 1, 2021.

Ms. Smet added that Lake Lynn would be monitoring dissolved oxygen, water temperature, conductivity, and pH, as required under the existing FERC license. She added that Lake Lynn is very interested in relief from monitoring conductivity and pH under the new FERC license since those parameters are not related to Project operation.

Brian Bridgewater (WVDEP) asked that WVDEP also be included on the distribution of the draft report. Ms. Smet responded that WVDEP will be included and added that all stakeholders on the Project relicensing distribution list will receive the draft study reports.

Duane Nichols (CLEAR) asked about coliform bacteria monitoring to protect the public while recreating in Cheat Lake and using the Cheat Lake Park beach. Ms. Smet added that Friends of the Cheat conducts bacteria monitoring, and the data is available online.

Owen Mulkeen (FOC) added that FOC does do water quality sampling at the Cheat Lake Park beach. He said that FOC monitors throughout the Cheat River watershed two times a month during the summer and one time a month during the remainder of the year.

*Streamflow Data Collaboration*

Ms. Foster reviewed the proposed streamflow data collaboration in response to the USFWS comments and additional information request. She noted that the USFWS requested additional information so that it could fully evaluate the seasonality, duration, and magnitude of streamflow into the Project, including the existing Project Instream Flow Study discussed in the PAD, and revised flow duration curves. She said that Lake Lynn will provide the USFWS with the Project Instream Flow Study and collaborate on the presentation of the flow duration curves and revise the curves, as necessary.

Janet Norman (USFWS) stated that the flow duration curves provided in the PAD were insufficient for their review. Ms. Smet acknowledged this comment and suggested scheduling a separate call with USFWS and other interested parties to discuss this further so that Lake Lynn can better understand the USFWS' information needs. She stated that the information developed for this effort would be provided to all stakeholders on the Project relicensing distribution list.

*Desktop Fish Entrainment Assessment*

Ms. Foster provided an overview of the proposed desktop entrainment study to determine the number of fish that are either entrained or impinged by Project operation and to estimate the injury and mortality of fish that pass through the turbines during Project operation. She explained that Lake Lynn is proposing to contract with Normandeau Associates to conduct a desktop fish entrainment assessment for the Project that includes the elements listed in the study plan.

Ms. Norman (USFWS) noted that the USFWS has expertise in this area and advised Lake Lynn to take advantage of this expertise. She suggested that Lake Lynn and Normandeau Associates involve herself and Jessica Pica, a USFWS fishway engineer, early to avoid concerns over the validity of the study later in the process. She stated that the intake velocity measurements is useful for an impingement analysis if the trash rack spacing is small enough to be an exclusion, but if the rack spacing is wide enough to permit entrainment, then velocity is not as meaningful since fish can swim through the trash racks. Bob Flickner (Lake Lynn) confirmed that the trash rack spacing is 4 inches at Lake Lynn. Ms. Norman added that generally ¾ inch spacing is recommended for eels.

Jacob Harrell (WVDNR) asked if the proposed study includes a field component to verify the results. Ms. Smet responded that Lake Lynn will focus on the desktop analysis in Year 1, but a field verification could be a Phase 2 to this study in 2021, if warranted. Ms. Norman added that desktop intake velocity generally looks at averages of various projects, so it is likely that field verification is needed.

Ms. Foster stated that it sounded like a separate call with USFWS would be warranted to discuss further the types of resources and expertise available with USFWS.

*American Eel Environmental DNA Sampling*

Ms. Foster provided an overview of the proposed American Eel environmental DNA (eDNA) sampling. She stated that the USFWS requested that Lake Lynn continue the American eel monitoring that was conducted in 2018 and 2019 under the Project Aquatic Biomonitoring Plan. She added that the USFWS and WVDNR also requested that Lake Lynn assess movement of fish throughout the Project area and assess the feasibility of incorporating alternative routes or additional fish protection measures at the Project.

Ms. Foster explained that Lake Lynn, in accordance with the Project Aquatic Biomonitoring Plan, worked collaboratively with the USFWS to select four sampling locations in the Project tailwater and to collect quarterly samples in 2018 and 2019 to sample the Project tailwater for American eel eDNA. She said that concerns have been raised by the USFWS and WVDNR regarding the sampling locations and whether the locations were representative of the tailwater. She stated that Lake Lynn will initiate the second year of sampling by working collaboratively with the USFWS, WVDNR, and PFBC to determine if there should be any adjustments to the four sampling locations in the Project tailwater or any adjustments to the methodology. She added that Lake Lynn will work with the USFWS to continue to collect the quarterly samples in accordance with the USFWS' Protocol and that Lake Lynn will coordinate with the USFWS to provide the samples to the USFWS Lab in Lamar, PA for analysis. She noted that Lake Lynn anticipates that the quarterly sample periods will be April-June 2020, July-September 2020, October-December 2020, and January-March 2021.

Ms. Foster said that once the second year of sampling results are available, Lake Lynn will consult with the USFWS, WVDNR, and PFBC to determine if any additional fish passage assessment is warranted.

Ms. Norman (USFWS) expressed a concern with the proposed sampling locations and schedule. She said that the sampling locations and schedule will need to be finalized by May to be able to obtain the first sample before the end of June. Ms. Smet acknowledged this concern and said she would schedule a call within the next couple of weeks to discuss the sampling locations. Ms. Norman also asked for an update on the overall schedule in relation to COVID-19. Ms. Smet explained that it is her current understanding that although some regulatory deadlines have been extended due to COVID-19, statutory required dates, such as the Draft License Application, have not been extended.

*Tailwater Mussel Survey*

Ms. Foster provided an overview of the proposed tailwater mussel survey. She noted that this study was added in response to the USFWS request for a mussel survey in the tailwater area to assess this component of the aquatic community. She stated that Lake Lynn will conduct a mussel survey to evaluate the likelihood of the presence or absence of mussels within the Project boundary downstream of the Project dam (approximately 200 meters downstream of the dam at the furthest point). She said that Lake Lynn will prepare a survey plan and coordinate with WVDNR and USFWS for approval. The survey plan will outline the methods and approach for conducting the mussel survey. WVDNR and USFWS review of the survey plan will be required prior to initiating fieldwork.

Ms. Norman (USFWS) expressed a concern that the extent of the surveyed area downstream of the dam is not sufficient. Ms. Norman added that she is not the local expert, so she would welcome opinion from state and local experts. Mr. Harrell (WVDNR) commented that that the current proposed study does not meet the West Virginia Mussel Protocol regarding survey extent below the dam. Mr. Harrel stated that they would generally require the mussel survey area to extend one kilometer below the dam.

Ms. Smet explained that the mussel survey as proposed would be conducted within the Project boundary since the Project boundary is drawn to include the entire area impacted by the Project. She added that the study plan includes development of a survey plan. She suggested having a separate call with interested parties, including WVDNR and USFWS, to further discuss the survey plan and the area that would be surveyed.

*Aquatic Habitat Enhancement and Monitoring*

Ms. Foster provided an overview of the installation and monitoring of fish habitat enhancement structures that is currently underway in accordance with the Project Aquatic Biomonitoring Plan, developed in consultation with USFWS, WVDNR, and PFBC. She stated that Lake Lynn worked with WVDNR and West Virginia University in 2019 to purchase and install artificial fish habitat structures along the Cheat Lake shoreline and to monitor their effectiveness. She explained that Lake Lynn and the resource agencies (USFWS, WVDNR, and PFBC) determined that a second year of monitoring in 2020 was warranted and a scope was developed. She said that during February 2020, artificial spawning structures were placed at two sites on Cheat Lake, which also have benthic artificial habitat reefs that were placed during 2019 aquatic habitat enhancement and monitoring efforts. She said that the structures and reefs were checked daily for the presence of egg masses during the spring spawning period. Ms. Smet added that Stuart Welsh with West Virginia University removed the structures earlier in the week. Ms. Foster stated that a study report will be developed and provided to the USFWS, WVDNR, and PFBC and to all stakeholders on Lake Lynn’s relicensing distribution list.

No comments were provided on this study.

*Angler Creel Survey*

Ms. Foster stated that the most recent Project Aquatic Biomonitoring Plan, developed in consultation with USFWS, WVDNR, and PFBC, includes an angler creel survey to be conducted in 2020 to document baseline recreational fishing effort and success. She added that Lake Lynn consulted with the resource agencies in December 2019 and January 2020 on a workplan and survey instrument for the survey and initiated the angler creel survey in January 2020 utilizing a standardized questionnaire, which has been administered via survey boxes and in-person interviews at public access points at the Project. She explained that Lake Lynn has decided to postpone the continuation of the angler creel survey until 2021 based on recent communication with the WVDNR and concerns about conducting angler surveys, which involve public interaction, during the COVID-19 outbreak and stay-at-home orders. She noted that this decision was made since the draft Study Plan was distributed.

No comments were provided on this proposal.

*Rare Species Survey*

Ms. Foster stated that the PAD proposed a study to conduct presence/absence surveys for rare, threatened and endangered (RTE) species that are likely to occur within the Project boundary. She explained that the USFWS provided comments as follow-up to the Joint Meeting and Site Visit stating that the proposed presence/absence surveys for RTE species may not be warranted. Ms. Foster added that Lake Lynn is no longer proposing to conduct these RTE surveys.

No comments were provided on this proposal.

*Recreation Site Enhancement Feasibility and Assessment*

Ms. Foster provided an overview of a proposed study that was not included in the PAD. She stated that several stakeholders have requested recreation site enhancements or new recreation sites at the Project, including working with stakeholders on planning and building a connection from the Cheat Lake Trail to the Sheepskin Trail, connection to other regional trails, extension of the Cheat Lake Trail toward the south, and extension of the swimming beach area to create a dog beach. She noted that FOC also requested creating public access to the upper reaches of Cheat Lake by improving an existing gated road in the Snake Hill Wildlife Management Area. She added that Lake Lynn will evaluate the feasibility of the recreation site/facility enhancements requested by stakeholders which would include both desktop and in-field assessments.

Mr. Nichols (CLEAR) commented that the previous Project owners committed to making a connection to the Sheepskin Trail once it is developed. He noted that the connection is desirable and beneficial to the region and added that this study really is not necessary. Ms. Smet responded by adding this specific trail connection must consider proximity to the Lake Lynn Powerhouse and Project access and security.

Andrew Gast-Bray (Monongalia County Planning Commission) stated that they support efforts to achieve trail connectivity and offered planning assistance. Ms. Smet thanked Mr. Gast-Bray for the support and stated that Lake Lynn looks forward to working with them.

Ms. Norman (USFWS) stated that connecting people with nature is a USFWS mission. She added that they rely on the National Park Service (NPS), state agencies, and local governments for their expertise in the topic of recreation, and they welcome comments from those entities regarding recreation for USFWS consideration and potential support.

*Recreation Use and Recreation Facility Inventory*

Ms. Foster noted that Lake Lynn began collecting recreation use data in January 2020 in accordance with FERC's approval of the 2018 Recreation Plan Update, and that Lake Lynn will collect the required recreation use data through December 2020. She explained that instead of conducting an independent study to inventory the existing Project recreation sites, as proposed in the PAD, Lake Lynn will conduct the inventory to update and expand the discussion in the next Recreation Plan Update. She added that the field inventory will be conducted during the summer of 2020 and include: identifying the amenities or facilities at each Project recreation site, photographs of the sites, and an evaluation of the overall condition of each site. She noted that recreation use data and inventory will be summarized in the next Recreation Plan Update that must be filed with FERC by March 31, 2021.

No comments were provided on this proposal.

*Shoreline Classification and Aquatic Habitat Mapping*

Ms. Foster provided an overview of the proposed follow-up study to the Cheat Lake Dock and property management system. She reminded the group that this system was discussed and shown during the December 2019 Joint Meeting. She explained that Lake Lynn is proposing to classify the Cheat Lake shoreline and develop an aquatic habitat map of Cheat Lake. Ms. Smet noted that Lake Lynn has Mike Strager, with Strager Consulting/West Virginia University under contract for this effort. She added that this information will be used in the development of a Shoreline Management Plan for the Project and will be used to create datasets to assist Lake Lynn in managing shoreline uses, which has been raised as an issue. She stated that the datasets for the shoreline classification and the aquatic habitat mapping will be added to the online map viewer of the Cheat Lake Dock and property management system that Lake Lynn is using.

No comments were provided on this proposal.

*Cultural Resources (Section 106) Consultation*

Ms. Foster stated that no studies related to cultural resources have been requested at the Project. She explained that Lake Lynn will initiate formal consultation with the West Virginia and Pennsylvania SHPOs to inform the development of the License Application.

Cheryl Nagle (Pennsylvania SHPO) stated that the letter provided from the Pennsylvania SHPO in June 2019 noted that there may be National Register-eligible above ground resources in the Project area. She added that there are structures indirectly related to the construction of the dam outside the Area of Potential Effect (APE). Ms. Nagle also stated that it is likely that an Inadvertent Discovery Plan may be required due to the location of the Project. Ms. Nagle stated that she wanted to confirm that all Tribes with potential interest are consulted. Ms. Foster confirmed that potentially interested Tribes have been included on the Project relicensing distribution list, and will continue to be included.

Erin Paden (Delaware Nation) asked to be kept updated during the study process.

Mr. Nichols (CLEAR) requested that Lake Lynn consider the historic aspects of the Project area, such as the Ices Family First Birth, iron used in Cheat River coal mining, and the millstone industry.

*Wrap-Up*

Mr. Nichols (CLEAR) asked for an update on the Cheat Lake South Trail repair. Ms. Smet responded that Lake Lynn is pursuing various options for repairing the trail. She stated that various permits and consultation are required, and that Lake Lynn is currently working to obtain the required permits and approvals from the U.S. Army Corps of Engineers (USACE), Pennsylvania Department of Environmental Protection (PADEP), WVDNR, and SHPO for replacing the existing culvert with a larger culvert. Mr. Nichols asked if the work to be done is just in the one area. Mr. Flickner stated that most of the work is the washout, but a few small improvements in other locations will be needed.

Mr. Nichols requested an update on the opening of the boating season in relation to potential impacts from COVID-19. Ms. Smet explained that due to COVID-19, certain facilities such as picnic tables, playgrounds, and restrooms have been temporarily closed. Mr. Flickner confirmed that at this time, the boating season is still planned to begin May 1, and the lake level will be raised accordingly.

Ms. Smet said that Lake Lynn will distribute the meeting notes soon and she will schedule follow-up calls specific to several studies with the appropriate agencies. She added that a revised Study Plan will be distributed. She encouraged the participants to reach out to herself or Ms. Foster with any other comments or questions. She concluded the call at 12:30 p.m.

**Lake Lynn Hydroelectric Project (FERC No. P-2459)**
**Revised Study Plan**
**May 2020**

## Background

Lake Lynn Generation LLC (Lake Lynn or Licensee) is relicensing the Lake Lynn Hydroelectric Project (FERC No. P-2459) (Project) with the Federal Energy Regulatory Commission (FERC). The current FERC license for the Project expires on November 30, 2024. The Project is located on the Cheat River in Monongalia County, West Virginia and Fayette County, Pennsylvania (Attachment 1).

Lake Lynn initiated the relicensing process in August 2019 by filing a Notice of Intent (NOI) and Pre-Application Document (PAD). At the same time, Lake Lynn requested FERC approval to use the Traditional Licensing Process (TLP). FERC approved the use of the TLP in October 2019, and in accordance with FERC regulations, Lake Lynn held a Joint Meeting and Site Visit in December 2019. Following the Joint Meeting and Site Visit, resource agencies and other stakeholders were afforded the opportunity to comment on the PAD and to request resource studies that they deemed were needed to evaluate Project impacts on natural, cultural and recreational resources.

In response to the NOI/PAD filing and the Joint Meeting and Site Visit, Lake Lynn received written comments and study requests from the U.S. Fish and Wildlife Service (USFWS), West Virginia Division of Natural Resources (WVDNR), Cheat Lake Environment and Recreation Association (CLEAR), Friends of the Cheat (FOC), Monongahela River Trails Conservancy (MRTC), and individual residents in the local community. A summary of the study requests and comments is provided in Attachment 2. The complete study requests are provided in Attachment 3.

Based on the comments received, Lake Lynn developed and distributed a draft Study Plan to the resource agencies and stakeholders on April 15, 2020 for review. Lake Lynn held a conference call/meeting on April 24, 2020 to review and discuss the draft Study Plan. The draft Study Plan has been revised based on the discussions and a revised Study Plan is being distributed to resource agencies and stakeholders for additional review and comment.

Lake Lynn is utilizing the TLP. There is no requirement to prepare a formal study plan document as is required in the Integrated Licensing Protocol (ILP), and therefore, there is no subsequent study plan determination by FERC. Nonetheless, Lake Lynn has prepared this Study Plan to document and share with resource agencies and stakeholders its plans for conducting resource studies and ongoing monitoring efforts in 2020 to inform the relicensing process. The individual study plans detailed below are proposed for the Project relicensing.

## 1.0 Geology and Soils

### 1.1 Reservoir Shoreline Erosion Survey

***Study Request***

WVDNR requested the Licensee conduct a reservoir sedimentation study at areas that have demonstrated an affinity for a build-up of sediment (i.e., Sunset Beach Marina) and develop a plan to monitor and address any sedimentation issues. WVDNR suggested that the Licensee examine possible sources of sedimentation within the reservoir and identify potential preventive measures that could be taken to reduce the level of sedimentation in those areas where sediment builds up (i.e., Sunset Beach Marina). In addition, CLEAR requested that the Licensee continue monitoring and remediation of the ongoing shoreline erosion.

***Study Goals***

Article 402 of the existing FERC License requires the Licensee to: 1) conduct annual shoreline erosion surveys of the Cheat Lake Park shoreline extending from the dam to the Cheat Haven peninsula and 2) conduct triennial shoreline erosion surveys of the entire Cheat Lake shoreline to identify new areas of erosion. Since 1995, the Licensee has been conducting shoreline erosion surveys and documenting areas of shoreline erosion within the Project boundary, which can influence sedimentation in Cheat Lake. In recent years, no new areas of active shoreline erosion have been identified and previously identified areas have exhibited minimal annual changes, therefore, the Licensee believes that an additional study is not warranted at this time. The goals of this study are to: 1) conduct a visual shoreline erosion survey of the Cheat Lake Park shoreline extending from the dam to the Cheat Haven peninsula to evaluate changes in shoreline erosion monitoring stations where historic erosion has been observed and 2) conduct a shoreline erosion survey of the entire Cheat Lake shoreline to identify new areas of erosion.

***Study Scope***

For the upcoming 2020 annual shoreline erosion survey of the Cheat Lake Park shoreline, the Licensee will conduct a visual survey by boat of the Cheat Lake Park shoreline extending from the dam to the Cheat Haven Peninsula. During the survey, the boat will be kept as close to the shoreline as practical to allow for careful observation. Sixteen (16) shoreline erosion monitoring stations where historic erosion has been observed will be visually inspected and photographed for future reference and comparison. Any evidence of new areas of erosion will be noted and photographed. Additionally, for the 2020 shoreline erosion survey, the same scope will be performed along the entire reservoir shoreline to identify and document any new areas of erosion. The Licensee will prepare a report summarizing the results of the shoreline survey.

***Study Schedule***

The Licensee anticipates that the shoreline erosion survey will be conducted in November or December 2020, when the reservoir level is lowered and vegetation has died back. This timing is consistent with the timing in previous years. It is anticipated that the annual report will be filed with FERC by February 2021 and a copy of the annual report will be provided to stakeholders included on the Project Relicensing Distribution List.

## 2.0 Water Resources

### 2.1 Water Quality Monitoring

***Study Request***

At this time, no stakeholders have requested new studies related to water quality at the Project. However, the USFWS and WVDNR requested the existing water quality monitoring be continued throughout the term of the new License.

***Study Goals***

In accordance with the existing FERC License (Article 405) and the Project Water Quality Monitoring Plan (West Penn Power Company, 1995), the Licensee will continue to monitor water quality and report the results to USFWS, WVDNR, Pennsylvania Fish and Boat and Commission (PFBC), Pennsylvania Department of Environmental Protection (PDEP), West Virginia Department of Environmental Protection (WVDEP), and FERC annually during the relicensing process. The water quality data will be used in the development of the License Application.

***Study Scope***

In accordance with the existing FERC License (Article 405) and the Project Water Quality Monitoring Plan (West Penn Power Company, 1995), the Licensee will continue to monitor and record hourly water quality data from April 1 through October 31 on an annual basis during the relicensing process. For the purposes of this 2020 relicensing study, the Licensee will collect dissolved oxygen and water temperature from April 1, 2020 through October 31, 2020 at the existing three locations in conjunction with U.S. Geological Survey (USGS) gages located in Cheat Lake, the Project tailrace, and downstream of Grassy Run. The Licensee will prepare and provide an annual report of the monitoring results to USFWS, WVDNR, PFBC, and PDEP for review and comment. The Licensee will submit the final annual report to FERC.

***Study Schedule***

For this 2020 relicensing study, the Licensee will monitor and record hourly water quality data from April 1 through October 31, 2020. The Licensee will provide an annual report of the monitoring results to USFWS, WVDNR, PFBC, PDEP, and WVDEP within 90 days (by February 1, 2021) of the end of the monitoring season. The Licensee will file the final annual report with FERC within 150 days following the end of the monitoring season (by April 1, 2021). The Licensee will provide a copy of the annual report to stakeholders included on the Project Relicensing Distribution List.

### 2.2 Streamflow Data Collaboration

***Additional Information Request***

The USFWS requested additional information so that it could fully evaluate the seasonality, duration, and magnitude of streamflow into the Project. The USFWS requested the existing Project Instream Flow Study (EA Engineering, Science, and Technology, Inc. (EA Engineering),

2014) discussed in the PAD and noted that, without this information, the USFWS may have remaining questions and recommend an Instream Flow Study. The USFWS also requested the graphs (Flow Duration Curves) in Appendix E of the PAD be revised so that the maximum flow event(s) and duration for the period of record (2016 to 2019) is displayed separately from the rest of the graphs.

The Licensee will provide additional information to the USFWS, WVDEP, WVDNR, PFBC to assist with evaluating the seasonality, duration, and magnitude of streamflow into the Project. The Licensee will provide the USFWS, WVDEP, WVDNR, and PFBC with the Project Instream Flow Study and supporting information referenced in the PAD. The Licensee will also collaborate with the USFWS , WVDEP, WVDNR, and PFBC on the presentation of the Flow Duration Curves and revise the curves in a manner that will assist the resource agencies with their evaluation. The Licensee plans to provide the USFWS, WVDEP, WVDNR, and PFBC with the Project Instream Flow Study by May 2020. The Licensee also plans to collaborate with the USFWS, WVDEP, WVDNR, and PFBC on the presentation of the Flow Duration Curves and provide revised curves by October 2020. The Licensee will provide a copy of this additional information to stakeholders included on the Project Relicensing Distribution List.

## 3.0 Fish and Aquatic Resources

### 3.1 Desktop Fish Entrainment Assessment

***Study Request***

The USFWS and WVDNR requested the Licensee conduct a desktop entrainment study to determine the number of fish that are either entrained or impinged by Project operation and to estimate the injury and mortality of fish that pass through the turbines during Project operation. WVNDR also recommended a field component to verify results.

***Study Goals***

The goals of this study are to 1) conduct a desktop assessment of the potential for impingement/entrainment and 2) estimate the numbers of fish entrained at the Project.

***Study Scope***

The Licensee will conduct a desktop fish entrainment assessment for the Project that includes the following:

- A description of the Project reservoir, intake structure, turbine units, and seasonal operational regime;
- Summary of available fisheries information historically collected in the Cheat River upstream of the Project;
- Life history and habitat requirements for target fish species;
- Assessment of impingement and entrainment potential as a function of (1) the existing rack spacing, (2) calculated approach velocities, (3) the physical dimensions of target fish species, and (4) the swim capabilities (i.e., burst speed) of target fish species;

- Review of information contained in the 1997 Electric Power Research Institute (EPRI) database to provide a summary of (1) the size class composition of target fish species, (2) entrainment densities of target fish species, and (3) calculated survival rates of target species for the subset of hydroelectric projects comparable to the Project;
- Calculation of site-specific turbine passage survival rates for target fish species using the USFWS Turbine Blade Strike Analysis Tool (TBSA); and
- Utilize seasonal species/size class-specific entrainment densities from comparable projects and project-specific discharge volumes to generate estimates of numbers of fish entrained at the Project.

The results of the desktop assessment will be documented in a study report.

***Study Schedule***

The desktop fish entrainment assessment will be conducted during the period June through December 2020, with a draft report for stakeholder review anticipated in January 2021.

### 3.2 American Eel Environmental DNA Sampling

***Study Request***

The USFWS requested the Licensee continue the American eel monitoring that was conducted in 2018 and 2019 under the Project Aquatic Biomonitoring Plan (2018-2020) (Lake Lynn, 2018a). For this second year of collecting water samples for American eel environmental DNA (eDNA), USFWS requested that the Licensee improve sampling locations and include areas lower in the Cheat River before the confluence with the Monongahela River. WVDNR supported the USFWS request for additional analysis of Project waters for American eels. The USFWS and WVDNR also requested the Licensee assess movement of fish throughout the Project area and assess the feasibility of incorporating alternative routes or additional fish protection measures at the Project. The USFWS' proposed methodology includes a literature review of available options for upstream passage of eels, downstream passage bypass of the turbines, and other fish protection measures, in addition to discussions with the USFWS fishway engineers.

***Study Goals***

In accordance with the Project Aquatic Biomonitoring Plan (2018-2020) (Lake Lynn, 2018a), developed in consultation with the USFWS, WVDNR, and PFBC, the Licensee worked collaboratively with the USFWS to select four sampling locations in the Project tailwater and to collect quarterly samples in 2018 and 2019 to sample the Project tailwater for American eel environmental DNA (eDNA). No American eel eDNA has been detected to date, however, concerns have been raised by the USFWS and WVDNR regarding the sampling locations.

The goals of the second year of American eel eDNA sampling are to: 1) collaborate with the USFWS, WVDNR, and PFBC to determine if the sampling locations used in the first year of the sampling need to be adjusted; and 2) continue the American eel eDNA sampling performed in 2018 and 2019 to determine whether American eels are present in the tailwater.

***Study Scope***

The Licensee will initiate the second year of sampling by working collaboratively with the USFWS, WVDNR, and PFBC to determine if there should be any adjustments to the four sampling locations in the Project tailwater or any adjustments to the methodology. The Licensee will work with the USFWS to continue to collect quarterly samples at four sampling locations in the Project tailwater in accordance with the USFWS' Protocol, *Field Collection of Environmental DNA (eDNA) Water Samples from Streams* (USFWS, no date) and additional training from the USFWS. The Licensee will coordinate with the USFWS to provide the samples to the USFWS Northeast Fishery Center Conservation Genetics Lab in Lamar, Pennsylvania for analysis. Once the second year of sampling results are available, the Licensee will consult with the USFWS, WVDNR, and PFBC to determine if any additional fish passage assessment is warranted.

***Study Schedule***

The Licensee will finalize the quarterly sampling schedule with the USFWS, WVDNR, and PFBC by June 2020. The Licensee anticipates that the quarterly sample periods will be April-June 2020, July-September 2020, October-December 2020, and January-March 2021. The sample results will be provided to the Licensee by the USFWS Lamar lab. The Licensee will provide the results upon receipt to the USFWS, WVDNR, and PFBC. The Licensee will also provide copies of these results to stakeholders included on the Project Relicensing Distribution List.

## 3.3 Tailwater Mussel Survey

***Study Request***

The USFWS requested that a mussel survey be conducted in the tailwater area and downstream reaches to assess this component of the aquatic community.

***Study Goals***

The goal of this study is to conduct a mussel survey within the Project boundary downstream of the Project dam to document mussel habitat (location, depth, and substrate) and the occurrence density, distribution, and relative abundance of any mussel species present.

***Study Scope***

The Licensee will conduct a mussel survey to evaluate the likelihood of the presence or absence of mussels within the Project boundary downstream of the Project dam (approximately 200 meters downstream of the dam at the furthest point). The area inside the Project boundary downstream of the dam is in West Virginia and ends at the Pennsylvania/West Virginia state line (Attachment 1). A malacologist experienced in mussel collection and qualified to work in West Virginia will lead all mussel sampling efforts.

The Licensee will prepare a survey plan and review the survey plan with USFWS and WVDNR. The survey plan will outline the methods and approach for conducting the mussel survey following the West Virginia Mussel Protocol (Protocol) guidelines[1].

The Licensee will evaluate for mussel presence/absence within the Project boundary downstream of the dam. The Licensee will survey approximately 7-8[2] transects spaced 25 meters apart that will span bank to bank and include a downstream buffer of 25 meters. Snorkeling and surface supplied air diving will be used to visually and tactilely search for mussels at the substrate surface and minor excavation will occur where appropriate to ensure recovery of buried mussels. Qualitative timed searches will be employed based on mussel and habitat distribution along transects throughout the survey area. Search effort will meet minimum Protocol requirements (1 min/$m^2$ in heterogenous substrates).

A report summarizing mussel habitat, survey observations, occurrence, location maps, density, distribution, and relative abundance of any mussel species present within survey area will be prepared. Figures will present mussel distribution and high-quality habitat areas within the survey area.

***Study Schedule***

The mussel survey will be conducted during the period June through October 2020. It is anticipated that a draft report will be available for stakeholder review in December 2020.

## 3.4 Aquatic Habitat Enhancement and Monitoring

***Study Request***

The Project Aquatic Biomonitoring Plan (2018-2020) (Lake Lynn, 2018a), developed in consultation with USFWS, WVDNR, and PFBC, includes the installation and monitoring of fish habitat enhancement structures. The Licensee worked with WVDNR and West Virginia University in 2019 to purchase and install artificial fish habitat structures along the Cheat Lake shoreline and to monitor their effectiveness. The Licensee reviewed the results of the 2019 activities with the USFWS, WVDNR, and PFBC and determined that a second year of monitoring in 2020 was warranted (Lake Lynn, 2020b). A scope for the second year of monitoring was developed in consultation with the USFWS, WVDNR, and PFBC (Welsh, 2019). No new studies related to fish aquatic habitat enhancement and monitoring at the Project have been requested.

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[1] Based on the Licensee's review of the West Virginia Mussel Protocol, the study area would be classified as a Group 3 stream for a non-scoping project since the Licensee is not proposing any changes to the Project.

[2] The exact number will depend on how close the first transect can be safely conducted below the dam.

### *Study Goals*

The goals of the 2020 aquatic habitat enhancement and monitoring are to: 1) document the timing of spawning, as well as examine spawning habitat characteristics, i.e., water depth, distance from shore, and water tubidity; and 2) examine water level fluctuation as a variable of influence on the timing of spawning, as well as its role in the potential for egg dewatering.

### *Study Scope*

During February 2020, forty artificial spawning structures were placed (submerged) at two sites on Cheat Lake (Welsh, 2019). Each site will also have four benthic artificial habitat reefs, which were placed during 2019 aquatic habitat enhancement and monitoring efforts. The forty artificial spawning structures and the eight artificial reef areas will be checked daily for the presence of egg masses during the expected spring spawning period. The artificial spawning structures will be checked by removing them from the water, and the reef structures will be checked with an underwater camera. The presence/absence of egg masses will be recorded and the number of egg masses on each spawning or reef structure will be counted. A subsample of egg masses will be evaluated to estimate the average number of eggs per egg mass.

Additional habitat data will be recorded daily, primarily at the time when spawning structures are checked and will include water depth at the spawning structure, distance of the structure to the nearest shoreline's high water mark (i.e. full pool elevation level), distance of the structure to the nearest shoreline's current water level, surface water temperature, bottom water temperature using data loggers at depth ranges from shallow to deep water consistent with habitat unit placement, and secchi disk depth at each site to provide an index of water turbidity.

A study report will be developed and provided to the USFWS, WVDNR, and PFBC in accordance with the scope for the second year of aquatic habitat enhancement and monitoring (Welsh, 2019).

### *Study Schedule*

Artificial spawning structures were placed (submerged) in February 2020 at two sites on Cheat Lake. The structures will be monitored daily until the end date of the spawning period has been determined. A study report will be developed and provided to the USFWS, WVDNR, and PFBC by August 2020. The Licensee will provide a copy of the report to stakeholders included on the Project Relicensing Distribution List.

## 3.5 Angler Creel Survey

### *Study Request*

The Project Aquatic Biomonitoring Plan (2018-2020) (Lake Lynn, 2018a), developed in consultation with USFWS, WVDNR, and PFBC, includes an angler creel survey component (a sampling survey that targets recreational anglers) to be conducted in 2020 to document a baseline of recreational fishing effort and success. At this time, no new studies related to angling or creel surveys at the Project have been requested.

***Study Goals***

The goal of the angler creel survey is to document a baseline of recreational fishing effort and success.

***Study Scope***

In accordance with the Project Aquatic Biomonitoring Plan (2018-2020) (Lake Lynn, 2018a), the Licensee consulted with the resource agencies in December 2019 and January 2020 on a workplan (Lake Lynn, 2020a) and survey instrument (Lake Lynn, 2020b) for the angler creel survey. The Licensee initiated the angler creel survey in January 2020 and temporarily suspended the survey in April 2020 due to COVID-19, but will initiate the survey again in 2021 in consultation with USFWS, WVDNR, and PFBC.

The Licensee will conduct the survey utilizing a standardized questionnaire (administered via survey boxes and in-person interviews) at the following locations:

- Upper Cheat Lake: Ices Ferry Bridge access, Edgewater Marina, Lakeside Marina;
- Middle Cheat Lake at the Sunset Beach Marina public boat ramp/dock;
- Lower Cheat Lake at Cheat Lake Park (the winter boat ramp, the fishing pier at Morgan Run, and the fishing pier at Rubles Run); and
- Lake Lynn Project Tailwater Fishing Pier.

A report summarizing the results of the survey will be developed in accordance with the Aquatic Biomonitoring Plan (2018-2020) (Lake Lynn, 2018) and the Angler Creel Survey Workplan (Lake Lynn, 2020a). Information collected during the survey will provide useful information on recreational angling.

***Study Schedule***

The Licensee initiated the angler creel survey in January 2020 and temporarily suspended the survey in April 2020 due to COVID-19, but will initiate the survey again in 2021 in consultation with USFWS, WVDNR, and PFBC. A report summarizing the results of the survey will be provided to USFWS, WVDNR, and PFBC, with a report anticipated in January 2022. The Licensee will provide a copy of the report to stakeholders included on the Project Relicensing Distribution List.

## 4.0 Rare, Threatened and Endangered Species

### 4.1 Rare Species Survey

In the PAD, the Licensee proposed to conduct presence/absence surveys for rare, threatened and endangered (RTE) species that are likely to occur within the Project boundary. The USFWS provided comments on the four federally listed species with the potential to occur in the Project area that were discussed in the PAD (Indiana bat, northern long-eared bat, running buffalo clover, and the flat-spired three toothed snail) and noted that except for occasional transient individuals, no other federally proposed or listed threatened or endangered species are known to exist within the Project area. The USFWS noted that the proposed presence/absence surveys for

RTE species may not be warranted; therefore, the Licensee is no longer proposing to conduct these surveys.

## 5.0 Recreation and Land Use

### 5.1 Recreation Site Enhancement Feasibility and Assessment

***Study Request***

Several stakeholders have requested recreation site enhancements or new recreation sites at the Project.

MRTC, CLEAR, FOC, and several individuals requested that the Licensee work with stakeholders on planning and building a connection from the Cheat Lake Trail to the Sheepskin Trail, including opening the gate at the northern end of the trail to create a passageway from the northern end of the Cheat Lake Trail through the dam facility. CLEAR also requested a continued commitment for a connection to other regional trails.

MRTC and FOC have requested the Licensee extend the Cheat Lake Trail toward the south.

FOC requested the Licensee create public access to the upper reaches of Cheat Lake by improving an existing gated road in the Snake Hill Wildlife Management Area (WMA) along Buzzard Run to provide a trailhead for hikers, angler access to upper Cheat Lake, and egress for whitewater paddlers running the Lower Cheat Canyon. WVDNR commented that it is unequivocally opposed to creating public access to the upper reaches of Cheat Lake by opening a gated road that passes through Snake Hill WMA property because continued maintenance of the access road would be problematic and an undue burden for the State of West Virginia and the Licensee with very little benefit to the WVDNR's prime constituents.

CLEAR requested the Licensee extend the swimming beach area toward the day-use boat docks to create a dog beach. CLEAR also requested the Licensee add additional picnic tables in this area.

***Study Goals***

The goals of this study are to evaluate the feasibility of the recreation site/facility enhancements requested by stakeholders at the Project, as described in the Study Scope.

***Study Scope***

The Licensee will evaluate the feasibility of making certain recreation site/facility enhancements at the Project. Specific enhancements to be evaluated include:

- Connection from the Cheat Lake Trail to the Sheepskin Trail at the northern end of the Cheat Lake Trail;
- Extension of the Cheat Lake Trail toward the south;
- Public access to the upper reaches of Cheat Lake by improving an existing gated road in Snake Hill WMA along Buzzard Run; and
- Extension of the swimming beach area to create a dog beach.

The feasibility assessment will include both desktop and in-field assessments. The desktop phase will examine existing tax and property records to determine property ownership and access limitations associated with each site or enhancement. The Licensee will also assess safety and security concerns and considerations associated with Project operations, including a review of any history of past safety or security concerns at the Project.

With basic information in hand, the Licensee will conduct an in-field assessment of each of the listed enhancements. The field review may be conducted in coordination with appropriate stakeholders and may include specific site visits with adjacent property owners, as appropriate.

The results of the feasibility assessment and any enhancement alternatives developed will be documented in a study report.

***Study Schedule***

The recreation site enhancement feasibility and assessment will be conducted during the period May through December 2020, with a draft report for stakeholder review anticipated in December 2020.

## 5.2 Recreation Use and Recreation Facility Inventory

***Study Request***

At this time, no stakeholders have specifically requested a study related to recreation use at the Project.

***Study Goals***

In accordance with FERC's Order dated August 10, 2018 modifying and approving the 2018 Recreation Plan Update (Lake Lynn, 2018b), the Licensee is collecting recreation use data in 2020 and must file the next Recreation Plan Update with FERC by March 31, 2021 that includes this data. As part of the next Recreation Plan Update, the Licensee will also conduct an inventory of the existing Project recreation sites to update and expand the discussion of the existing Project recreation sites and amenities in the next Recreation Plan Update.

***Study Scope***

In accordance with FERC's Order dated August 10, 2018 modifying and approving the 2018 Recreation Plan Update (Lake Lynn, 2018b), the Licensee initiated the collection of recreation use data in January 2020 and will collect recreation use data through December 2020. This data will be summarized in the next Recreation Plan Update that must be filed with FERC by March 31, 2021.

In the PAD, the Licensee proposed to conduct a field inventory of the existing Project recreation sites that included identifying the amenities or facilities at each site, photographs of the sites, an evaluation of the overall condition of each site, and general observations on site use and accessibility. The Licensee will conduct a field inventory of the existing Project recreation sites in 2020 and include the full recreation site inventory in the next Recreation Plan Update, which is due to be filed with FERC by March 31, 2021.

***Study Schedule***

The Licensee initiated recreation use data collection in January 2020 and will collect recreation use data through December 2020. The Licensee will conduct a field inventory of the existing Project recreation sites during the summer or fall of 2020 and include the full recreation site inventory in the next Recreation Plan Update. The next Recreation Plan Update must be filed with FERC by March 31, 2021 and the Licensee anticipates a draft will be available for stakeholder review by February 2021.

### 5.3 Shoreline Classification and Aquatic Habitat Mapping

***Study Request***

At this time, no stakeholders have specifically requested a study related to shoreline classification at the Project or development of a shoreline management plan.

***Study Goals***

The goals of classifying the Cheat Lake shoreline and developing an aquatic habitat map of Cheat Lake are to: 1) collect information that will be used in the development of a Shoreline Management Plan for the Project and the License Application and 2) create datasets to assist the Licensee in managing shoreline uses.

***Study Scope***

The Licensee will classify the Cheat Lake shoreline (the area up to 100 feet inward from the summer pool elevation of the reservoir) into the following classifications: Forest, Industrial, Private, Public Recreation, and All Other Classes. The shoreline classification will utilize 2018 imagery from the National Aerial Image Program at 1-meter resolution and 1:10,000 scale, which is the best available temporal and spatial resolution imagery for the shoreline classification. The entire 31.3 miles of Cheat Lake shoreline will be classified. The shoreline classification will also indicate the natural versus constructed or converted shoreline habitat areas. A spatially referenced shapefile (polyline) with metadata will be prepared.

An aquatic habitat map of Cheat Lake will be developed based on data collected from an Aquatic Water Drone. The aquatic habitat areas will be digitized as polygon areas and include aquatic vegetation, silt substrate, cobble and boulder substrate, historical river channels, and water depth.

The datasets for the shoreline classification and the aquatic habitat mapping will be added to the online map viewer of the Cheat Lake Dock and property management system developed for the Project in 2019.

***Study Schedule***

The shoreline classification and aquatic habitat mapping will be completed by December 2020. The shoreline classification and aquatic habitat mapping will be used in the development of a Shoreline Management Plan for the Project and the License Application.

## 6.0 Cultural Resources

### 6.1 Cultural Resources (Section 106) Consultation

***Study Request***

At this time, no resource agencies or Tribes have requested studies of cultural resources at the Project. The Cherokee Nation commented that Monongalia County and Fayette County are outside the Cherokee Nation's Area of Interest, thus, the Cherokee Nation defers to federally recognized Tribes that have an interest in this landbase. The Delaware Nation commented that the location of the Project does not endanger cultural or religious sites of interest to the Delaware Nation and requested that if any artifacts are discovered that the Licensee halt work and contact state agencies and its office within 24 hours.

***Study Goals***

The Licensee will initiate formal consultation with the WVSHPO and PHMC to inform the development of the License Application.

***Study Scope***

The Licensee is aware of two potentially significant cultural resources within the Project boundary – the railroad bed along the Cheat Lake Trail (a linear historic archaeological site) and the Lake Lynn powerhouse and dam (potentially eligible for the National Register of Historic Places [NRHP]). The Licensee will consult with the West Virginia State Historic Preservation Office (WVSHPO) and its Interactive Map Viewer and submit the Project information for a formal review. The Licensee will also consult with the Pennsylvania Historical and Museum Commission (PHMC) and the Cultural Resources Geographic Information System (CRGIS) and submit the Project to the PHMC for review.

***Study Schedule***

The Licensee plans to initiate formal consultation with the WVSHPO and PHMC by July 2020.

## 7.0 References

EA Engineering, Science, and Technology, Inc. (EA Engineering). 2014. Instream Flow Study: Lake Lynn Hydroelectric Project. December 2014.

Lake Lynn Generation, LLC (Lake Lynn). 2018a. Lake Lynn Hydroelectric Project (FERC No. 2459) Aquatic Biomonitoring Plan (2018-2020). January 31, 2018.

Lake Lynn Generation, LLC (Lake Lynn). 2018b. Lake Lynn Hydroelectric Project 2018 Recreation Plan Update. April 2018.

Lake Lynn Generation, LLC (Lake Lynn). 2020a. Lake Lynn Hydroelectric Project (FERC No. 2459) Angler Creel Survey Workplan. January 2020.

Lake Lynn Generation, LLC (Lake Lynn). 2020b. Lake Lynn Hydroelectric Project (FERC No. 2459) Aquatic Biomonitoring Plan (2018-2020): 2019 Annual Status Report. 2020.

U.S. Fish and Wildlife Service (USFWS) Northeast Fishery Center Conservation Genetics Lab. No date. Field Collection of Environmental DNA (eDNA) Water Samples from Streams. No date.

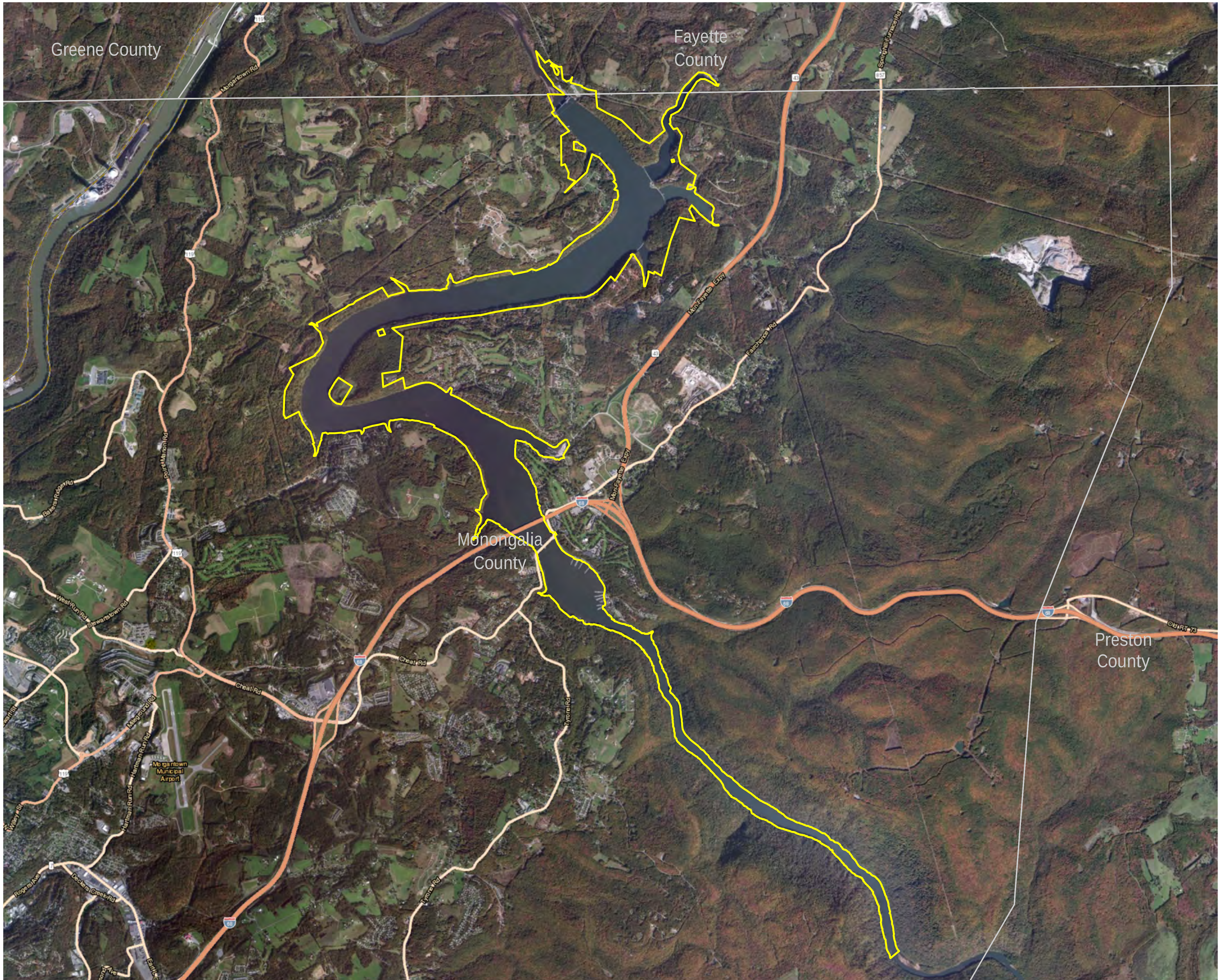
Welsh, Stuart A. West Virginia Cooperative Fish and Wildlife Research Unit. 2019. Evaluations of Yellow Perch Spawning and Water Level Fluctuations for Cheat Lake, West Virginia: A Research Proposal. November 29, 2019.

West Penn Power Company. 1995. Water Quality Monitoring Plan for Lake Lynn Hydro Station FERC Project No, 2459. October 6, 1995.

# Attachment 1

# Project Boundary Figure

TRC - GIS





LEGEND

FERC Project Boundary

County Boundary

N

0 0.5 1 2 Miles

PROJECT:

LAKE LYNN GENERATION, LLC

TITLE:

Lake Lynn
Project Boundary

| | |
|---|---|
| DRAWN BY: K. BABCOCK | PROJ. NO.: |
| CHECKED BY: | |
| APPROVED BY: | |
| DATE: AUGUST 2019 | |

TRC

14 Gabriel Drive
Augusta, ME 04330

FILE NO.: Lake_Lynn_Project_Boundary.mxd

Coordinate System: NAD 1983 UTM Zone 17N (Foot US)
Map Rotation: 0

Plot Date:
Path: LAYOUT: ANSI B(11"x17") S:\1-PROJECTS\Cube_PE_Hydro\Lake_Lynn_Project_Boundary.mxd

**Attachment 2**
**Summary of Study Related Comments and Study Requests**

| Agency/ Stakeholder | Study Related Comment/ Study Request |
|---|---|
| **SEDIMENTATION AND SHORELINE EROSION** | |
| WVDNR | Requests reservoir sedimentation study at problem areas and a sedimentation plan to monitor/address any future sedimentation issues. Proposed methodology includes examining possible sources of sedimentation within the reservoir and identifying potential preventive measures that could be taken to reduce the level of sedimentation in those areas where sediment builds up (i.e., Sunset Beach). |
| CLEAR | Monitoring and remediation of the on-going shoreline erosion are needed with components of these activities taking place on an annual basis. |
| **WATER QUANTITY AND QUALITY** | |
| USFWS and WVDNR | Requests that water quality monitoring be continued throughout the term of the new License. |
| USFWS | The Project Instream Flow Study is not contained in the PAD. Without this information, the USFWS has remaining questions and would recommend an Instream Flow Study to help determine appropriate flow releases in license articles. |
| **FISH AND AQUATICS** | |
| USFWS | A mussel survey should be conducted downstream in the tailwater area and downstream reaches to assess this component of the aquatic community and inform the USFWS flow regime recommendations. |
| USFWS and WVDNR | Requests a desktop entrainment study. WVNDR recommends a field component to verify results and requests the opportunity to review data for use in the desktop analysis. USFWS suggests that the USFWS Turbine Blade Strike Analysis Model could be used as one component of the assessment. |
| USFWS and WVDNR | Requests American eel monitoring study that improves on sampling conditions and includes areas lower in the Cheat River before the confluence with the Monongahela. WVDNR is not be opposed to any USFWS request regarding additional analysis of Project waters for American eel. |
| USFWS and WVDNR | Requests upstream/downstream fish passage and feasibility study. Proposed methodology includes a literature review of available options for bypass routes/fish protection measures and an analysis on how such measures could be incorporated into current project design. USFWS mentions the methodology would include a literature review of available options for upstream passage of eels. |
| **WILDLIFE AND RARE, THREATENED AND ENDANGERED (RTE) SPECIES** | |
| USFWS | The proposed survey for RTE species may not be warranted. |
| **RECREATION/AESTHETICS** | |
| MRTC and FOC | Trails - Requests the Licensee extend the Cheat Lake Trail toward the south. |
| MRTC, CLEAR, FOC Dave Harshbarger ,and Gary Marlin | Trails - Request License work with stakeholders on planning and building a connection from the Cheat Lake Trail to the Sheepskin Trail, including opening the gate at the northern end of the trail to create a passageway from the northern end of the Cheat Lake Trail through the dam facility. CLEAR also requests a continued commitment for a connection to other regional trails. |

| Agency/ Stakeholder | Study Related Comment/ Study Request |
|---|---|
| WVDNR | Snake Hill Wildlife Management Area (WMA) - WVDNR is unequivocally opposed to creating public access to the upper reaches of Cheat Lake by opening a gated road that passes through Snake Hill WMA property because continued maintenance of the access road would be problematic and an undue burden for the State of West Virginia and the Licensee with very little benefit to the WVDNR's prime constituents. |
| FOC | Snake Hill Wildlife WMA - Supports creating a public access to the upper reaches of Cheat Lake by improving an existing gated road in Snake Hill WMA along Buzzard Run to provide trailhead for hikers, angler access to upper Cheat Lake, and egress for whitewater paddlers running the Lower Cheat Canyon. |
| CLEAR | Dog Beach - The swimming beach area needs to be extended toward the day-use boat docks to include a dog beach and additional picnic tables |
| WVDNR | Boating - Law enforcement records do not show any significant increase in boating incidents. WVDNR is not opposed to the temporary moratorium on new private piers/boat docks and would not be opposed to the moratorium continuing. |
| CLEAR | Boating - Requests boating guidelines and limits consistent with the rules and regulations of the WVDNR. Boat guidelines/regulations, public dock maintenance, channel depth (dredging), and parking lot criteria are all in need of explicit definition and guidance. |
| CLEAR | Recreation Operations and Maintenance (O&M) - Requests clear and complete procedures for trail maintenance and repair. |
| CLEAR | Recreation O&M - Requests clear and complete goals, guidelines and procedures for Sunset Beach Marina and other marinas, including O&M and future. |
| CLEAR | Recreation O&M - Periodic lake cleanup activities need to be continued by CLEAR and others with the support of the Licensee. |
| CLEAR | Recreation O&M - Swimming beach season should match the boating season of May 1-Oct 31. |
| CLEAR | Recreation O&M - Regular maintenance of the swimming beach is needed to remove large debris and to keep quality sand fresh and deep |
| CLEAR | Recreation O&M - For the Fishing Pier, there is a need to identify the opportunities, guidelines, operation and maintenance schedules. |
| CLEAR | Recreation O&M - Hillside slips, ground subsidence, and washouts along the Trails must be prepared for so that temporary work-arounds/repairs can take place in a timely manner. |
| CLEAR | Recreation O&M - For the Recreation Season protocol, there is a need to reiterate the schedule of May 1 thru October 31, with the Trail being open and accessible year-round. |
| CLEAR | Recreation O&M - The boat launch in the Park is essential for summer use by kayak & canoe users and for winter use by fishing boat users. |
| CLEAR | Recreation O&M - There is a need for a description of the functions of (existing & new) recreation personnel, security personnel, park maintenance personnel; and guidelines are needed for the interaction of these people with public. |
| MRTC | Recreation O&M - Requests the Licensee hire onsite recreation staff. |
| WVDNR | Boating - Law enforcement records do not show any significant increase in boating incidents. WVDNR is not opposed to the temporary moratorium on new private piers/boat docks and would not be opposed to the moratorium continuing. |

| Agency/ Stakeholder | Study Related Comment/ Study Request |
|---|---|
| CLEAR | Boating - Requests boating guidelines and limits consistent with the rules and regulations of the WVDNR. Boat guidelines/regulations, public dock maintenance, channel depth (dredging), and parking lot criteria are all in need of explicit definition and guidance. |
| **ENHANCED COMMUNICATIONS/INFORMATION** | |
| CLEAR | Telephone(s) & email address(es) are needed on signs and on web page(s) for information and for emergencies. |
| CLEAR | Formal plans and procedures are needed that assigns responsibilities for the various types of emergency at the dam, on the trails, on Cheat Lake, and downstream. |
| CLEAR | Public brochures are needed that include the history, overview of facilities, rules/regulations, contacts, etc. |
| CLEAR | The website needs additional pages that includes the brochure information, lake level, operational updates, warnings, etc. |
| CLEAR | News releases are needed providing general information, trail closings, warnings and other items for current news. |
| CLEAR | Signage on WV 857 for the Cheat Lake Park and Trail needs to be maintained year-round and the signage on the Trail maintained for public use year-round. |
| CLEAR | For the lake level protocol, need to reiterate the water level ranges vs. months of the year on the website and in the brochure(s). |
| MRTC | Requests improved public communication (website, social media, phone), and creating a process for holding events on the Cheat Lake Trail. |
| **GENERAL** | |
| WVDNR | Supports studies proposed in the PAD. |
| CLEAR | A study of the history of Cheat Lake and the dam is needed to examine the role of the Project affecting WV and PA - whether it is a private “for-profit” entity with public obligations or whether it is “for the public interest” to provide recreation and a public service (electricity). |

# Attachment 3

## Copies of Comments and Study Requests

**DIVISION OF NATURAL RESOURCES**
**Wildlife Resources Section**
**District 1**
**P.O. Box 99**
**1110 Railroad Street**
**Farmington, West Virginia 26571-0099**
**Telephone (304) 825-6787**
**Fax (304) 825-6270**

**Jim Justice**
***Governor***

**Stephen S. McDaniel**
***Director***

February 12, 2020

Electronic file

Kimberly D. Bose, Secretary
Federal Energy Regulatory Commission
888 First Street, N.E.
Washington, DC 20426

**RE: Lake Lynn Hydroelectric Project (FERC no. P-2459); Notice of Intent, Pre-Application Document, and Study Requests**

Dear Secretary Bose:

Thank you for allowing the West Virginia Division of Natural Resources, Wildlife Resources Section (WRS) the opportunity to provide comments with regards to the referenced Pre-Application Document (PAD) for the relicensing of the Lake Lynn Hydroelectric Project (Project), FERC No. 2459. Lake Lynn Generation, LLC (Licensee or Applicant) has elected to utilize the Traditional Licensing Process in preparing for a new license. The current Project license was issued on December 27, 1994 and is set to expire on November 30, 2024. The applicant submitted the referenced NOI/PAD in accordance with FERC regulation and consistent with the requirements of 18 CFR § 5.5.

The Project is an established hydroelectric project located on the Cheat River adjacent to the border between Pennsylvania and West Virginia with Project areas located occupying lands in

both states. The Project has an installed project capacity at 51.2 MW using four Francis generating units. The comments below are being provided pursuant to 18 C.F.R §4.38(b)(5).

### Section 4.2 Project Facilities

The description of the Project facilities described within this section makes mention of trash racks installed at the intake facility. Beyond that, there is no further information regarding the specifications of the trash racks. Based on a preliminary site visit, it would appear as if the trash racks were of a steel construction and installed with spacing of approximately 5-inches. Such large trash rack spacing allows for the entrainment of larger fish that would be more susceptible to blade strikes and turbine-induced mortality as these fish enter the intake structures and pass through the turbines. In an effort to reduce fish mortality, the WRS would request that the trash rack spacing not exceed 3 inches and have an approach velocity of no more than 2.0 fps. The WRS further recommends angled trash racks be employed as a means to further reduce entrainment.

### Section 4.4 Current and Proposed Project Operations

The current FERC license requires an operation schedule whereby the lake elevation is maintained between 868 and 870 feet from May 1 to October 31, between 857 and 870 feet from November 1 through March 31, and between 863 feet and 870 feet from April 1 through April 30. The April 1 to April 30 schedule was initially designed as a provision to reduce the Project's impacts on spawning fish populations within the lake, particularly yellow perch and walleye. The thinking at that time was that these fish species predominantly spawned during the early Spring month of April. Recent data has become available through the triennial biomonitoring studies, in particular a recent analysis of yellow perch habitat, which may indicate that in some years, based on temperature and weather conditions, the spawn may begin in mid-March and extend into Mid-April or later. Similar results were observed in a study on the walleye populations within the lake by a member of the WRS staff whereby the walleye spawn was documented as early as mid-March. Considering, there is concern that the lake elevation schedule during the month of March (between 857 and 870 feet) would not be sufficient in protecting the spawn and would have the potential to dewater a great many eggs thus impacting recruitment. It may be necessary, then, to revisit the current project operations and examine possible avenues to protect these species throughout the spawning season. A new schedule could be based on temperature such that in normal years the schedule can remain as is, but in warm years where the WRS, based on water temperature variables (45ºF for a sustained period in March), anticipates that an early spawning period would occur, the April elevation schedule could be moved back to mid-March.

### Section 5.2

The continuous monitoring of water quality as required by License Article 405 of the existing Project License is an invaluable tool in the management of the resources. As such, the WRS would request that water quality monitoring within the reservoir and tailwaters be continued throughout the term of the upcoming license.

### Section 5.3.2.2 Catadromous and Diadromous Species

This passage asserts that "there is no known occurrence of the American eel in the Cheat River basin, however...eels have been collected in the Ohio River basin from the Kanawha, New, and Greenbrier Rivers." In fact, the American eel has also been collected in the Monongahela River within the past 10 years as far upstream as the Morgantown Lock and Dam. This point is upstream of the confluence of Cheat River with the Monongahela River. It could therefore be assumed that there is a strong likelihood that the American eel may also be located within the Cheat drainage. However, it should be noted that, at least with regards to recent data collection, the American eel has not been observed within the tailwaters of the project. A recent eDNA study of the Project tailwaters resulted in no positive recordings of the American eel. The reasons for the negative results may be because of study design or perhaps because there were no eels in the Cheat River watershed. Nonetheless, it is the WRS' understanding that the US Fish and Wildlife Service (USFWS) will be requesting additional analysis of the Project waters to determine presence or absence of the American eel. The WRS would not be opposed to any USFWS request regarding this particular subject matter.

### Section 5.3.2 Fish Resources and Habitats

As per state rule §47-5A-6, reimbursement for the incidental loss of fish due to project operation will be required. Therefore, the WRS would request that a comprehensive desktop entrainment study be utilized to determine the likely number of fish, fish species, and size classes to become entrained and experience mortality as a result of the Project's operation.

### Section 5.3.2.3 Fish Passage

The major components of a hydropower facility (i.e. the turbines) pose a particular risk to fish passage and an additional impediment to fish passage. Project operations may attract fish moving downstream to pass through the turbines creating an unnecessary risk for mortality. It is the flowing water through the Project that initially attracts the migrating fish. Additionally, passage over the spillway could also be hazardous for fish. To minimize the potential hazards for the downstream movement of fish, the WRS would request that a feasibility study be conducted to explore potential options for a bypass system or diversionary tactics.

### Section 5.8.3.4 Public Boat Launching Facility at Sunset Beach Marina

Sedimentation at the Sunset Beach Marina has become a significant issue over the years and has only worsened to the point by which anglers and boaters are affected. Launching a boat from this area has become more challenging and at some levels, is next to impossible. The Licensee has made great strides in correcting the sedimentation via dredging the embayment. Still, there is concern that this is a temporary fix and without a plan in place to address future sedimentation of the embayment, this is a problem that will likely occur again. Therefore, the WRS would request the licensee draft a sedimentation plan in an effort to minimize future sedimentation and reduce costly dredging activities.

## Section 5.8.5 Boating Carrying Capacity Study

The results of the boating carrying capacity study would suggest that the number of boaters using Lake Lynn at any given time has exceeded that of a safe operating amount for the lake. Law enforcement records have yet to show any significant increase of incidents. Nevertheless, the WRS is not opposed to the Licensee's moratorium on new private piers/boat docks within the Project reservoir. According to the scoping meeting, the moratorium was enacted by the Licensee as a temporary measure to reduce the number of boats on the lake with the intention to lift the moratorium, or at least re-examine its effectiveness, following the relicensing process. The WRS views the moratorium as being beneficial in reducing the level of impact to shoreline habitat caused by the continued construction of the lake shoreline. Shoreline habitat is critical for a healthy, sustainable fishery and therefore, the WRS would be not be opposed to continuing the moratorium beyond the FERC relicensing of the Project.

## Section 6.2.7.1 Potential Issues and Project Effects

This section lists a proposal to "create public access to the upper reaches of Cheat Lake by improving an existing gated road in Snake Hill Wildlife Management Area along Buzzard Run." The WRS would be unequivocally opposed to this proposal. The WRS is not interested in opening up the gated road that passes through the WMA property. Continued maintenance of the access road would be problematic and an undue burden for the state and the Licensee with very little benefit to the WRS' prime constituents.

## State 401 Water Quality Certification

Section 401(a)(1) of the federal Clean Water Act, 33 U.S.C. § 1341(a)(1) provides that any applicant of a federal license or permit must obtain a state certification from the appropriate state certifying agency. This certification is to ensure that any activity conducted under the license are to be in compliance with all applicable provisions of the Clean Water Act. The state of WV will have one year to act on a received 401 application from the date the US Army Corps of Engineers deems the federal 404 application to be complete.

## Study Requests

The WRS is in support of the studies proposed by the Licensee for the Lake Lynn Hydroelectric Project as identified within the PAD. Additional studies not previously included within the PAD are being provided by the WRS. The WRS makes these requests in support of currently proposed studies, to correct deficiencies in data and to offer a greater level of detail where needed. The WRS further requests the opportunity to review any study plans associated with this project. The request format is in accordance with that described in 18 CFR § 5.9 (b).

## Study Request 1: Entrainment Study

### Goals and Objectives:

The goal of the proposed study is to determine the number of fish that are either entrained or impinged and to estimate the injury and mortality of fish that pass through the turbines during

Project operation. The WRS is requesting a desktop entrainment study be conducted on the Lake Lynn Project. The goal of the desktop study will be to estimate mortality for compliance with state code.

As the resource agency, it is the goal of the WRS to manage and protect the resources. To the furtherment of this goal, WV code §47-5A-6 requires that mitigation be completed for any impacts to the resources. In this case, entrainment of fish through the turbines causes undue stress to the fish and can potentially be fatal. Therefore, the WRS would request that any mortality in fish be compensated. In order to properly ascertain the number of fish that succumb to mortality, an entrainment study will need to be performed.

The WRS recommends a desktop entrainment analysis utilizing the EPRI database. Data used for the analysis should be presented by species and by two-inch size classes. The WRS would further recommend that a field component be incorporated to verify results.

**Resource Management Goals:**

The WRS is charged with the protection and management of all wildlife within West Virginia, including within Cheat river and Lake Lynn. As per state rule §47-5A-6, the State would require the applicant to compensate the state for any loss of fish.

**Existing Information:**

To the best of its knowledge, the WRS is not aware of any entrainment studies that have been conducted at the Project. The years of biomonitoring data conducted in accordance with the existing license, will help to inform this entrainment analysis.

**Nexus Between Project Operation:**

During Project operation, fish of a certain size are able to pass through the trash racks and become entrained through the turbines. As the turbines operate, it is likely that some fish will be struck by the turbine blades while others will succumb to changes in barometric pressures as they pass through the intake. The likelihood of a blade strike and turbine-induced mortality increases as the size of the fish increases. Therefore, compensatory mitigation will be required as replacement for the loss of fish.

**Study Methodology:**

The methodology employed should include a combination of desktop entrainment analysis and field verification. The standard practice has been to utilize the Electric Power Research Institute (EPRI) turbine entrainment and survival database as a model in evaluated the potential of entrainment at a facility. The WRS has had concerns that this particular practice lacks the scientific creditability necessary to make informed decisions about the management of the fishery. Therefore, the WRS requests the opportunity to review any entrainment data considered

for use in the desktop entrainment analysis. Further, the WRS may request that a verification procedure be incorporated as a means to test the veracity and accuracy of the desktop entrainment results. Deploying hydroacoustics sampling techniques may be one way to achieve this goal as a more cost-effective method than deploying nets downstream. Data for any type of analysis should be presented by species and by 2-inch class sizes to remain consistent with general state practices. The WRS is willing to further discuss methodologies with the applicant.

**Level of Effort and Cost:**

The level of effort required to conduct a desktop entrainment analysis is relatively minor and most consulting firms/universities are well equipped to perform such an analysis. Additionally, the cost of a desktop entrainment analysis is much more attainable when compared to the alternative of an in-field entrainment analysis. Incorporating an in-field verification procedure with the analysis will increase the level of effort and cost and would require certain levels of training, expertise, and equipment. Nonetheless, an in-field verification procedure is still attainable and within reasonable limits of effort and cost.

**Study Request 2: Upstream/Downstream Fish Passage and Feasibility Study**

**Goals and Objectives:**

The goals of this study are to assess movement of fish through the project area; identify likely routes fish would take under a variety of conditions; and assess the feasibility of incorporating alternative routes or additional fish protection measures.

**Existing Information:**

To the best of its knowledge, the WRS is unaware of any study on upstream/downstream passage at the Project. Any study that may have been completed is likely dated material and incompatible in reflecting current conditions and population dynamics.

**Nexus Between Project Operation:**

Dam features, because of their general nature, impede the upstream and downstream movement of fish. By design, the dam at the Project affords no migration upstream. Downstream migration is offered by one of two routes: through the dam gates; and through the Project's powerhouse. Neither of these two routes provides for a safe migration downstream. The route through the powerhouse would mean risking turbine strikes or dangerous changes in barometric pressure. The route through the dam gates may provide for an equally perilous journey with fish tumbling down rough concrete faces. It is evident, then, that the Project has a direct relationship to fish passage.

**Study Methodology:**

Methodology would include a literature review of all available options for bypass routes and fish protection measures and an analysis on how such measures could be incorporated into the current project designs. Architectural design and structural engineers would need to be consulted for their expertise in determining feasibility of any new structural component at the project.

**Level of Effort and Cost:**

A study such as this would most likely take less than a year to complete with minimal effort. Discussions with engineers and reviews of designed structures would be necessary to properly assess the feasibility of any bypass channels or fish protection structures. Additionally, this study could be completed in concert with study request #1 (entrainment study) to reduce costs and effort. The WRS is not aware of the cost associated with this study but would assume it to be at a nominal rate.

**Study Request 3: Reservoir Sedimentation Study**

The WRS is requesting that a sedimentation study of the Project's reservoir be conducted at the problem areas and a plan to monitor and address any sedimentation issues be developed.

**Goals and Objectives:**

The goal of this survey is to asses sedimentation within certain problem areas within the Project reservoir and to develop a plan to address any deficiencies as they arise.

**Existing Information:**

Reports of sedimentation affecting boaters and anglers have risen in recent years, but as of yet no study that the WRS is aware of has been conducted on the sedimentation and no plan has been developed to address it. Steps to remedy sedimentation are typically taken when the issue rises to unsuitable levels. A more preventive strategy here may reduce future costs of sediment removal and keep recreation areas open without issue.

**Nexus Between Project Operation:**

By their very nature, dams cause sedimentation within the reservoir as the moving water slows down and particles are allowed to settle out. Therefore, the Project operations have a direct influence on the level of sedimentation.

**Study Methodology:**

The methodology should begin by examining possible sources of sedimentation within the reservoir and then by identifying potential preventive measures that could be taken to reduce the level of sedimentation in those areas that have demonstrated an affinity for a build-up of sediment (i.e. Sunset Beach).

**Level of Effort and Cost:**

Most consulting firms and universities would be fully capable of conducting a sedimentation study, including interpreting and analyzing the data. The costs of such a study is variable dependent on contractor used to conduct the study and the level of attention to detail.

The WRS appreciates the opportunity to provide comments and to make study requests. If you have any questions regarding this letter, comments made, or these study requests, please contact me by telephone at (304)825-6787, or by email at Jacob.D.Harrell@wv.gov.

Sincerely Yours,

Jacob Harrell
Hydropower Coordination Biologist

Cc: Jody Smet, Lake Lynn Generation, LLC
David Fox, Lake Lynn Generation, LLC
Janet Norman, USFWS
Paul Johanson, WVDNR
Mark Scott, WVDNR
Zack Brown, WVDNR
David Wellman, WVDNR
Danny Bennett, WVDNR

LAKE LYNN HYDRO PROJECT: ISSUES AND COMMENTS FOR RELICENSING

SUBMITTED BY: Duane Nichols, President, Cheat Lake Environment & Recreation Association, 330 Dream Catcher Circle, Morgantown, WV 26508

RE: Project P-2459, Relicense for Lake Lynn Hydroelectric Project. Date: February 10, 2020

1. Clear and complete procedures are needed for Trail maintenance and repair, for both routine and non-routine circumstances.

2. Clear and complete goals, guidelines and procedures are needed for the Sunset Beach marina and other marinas, to cover the operation, maintenance and planning for the future.

3. Boating is a primary recreational activity on the Lake, so there is a need for boating guidelines and limits consistent with the rules and regulations of the WV DNR. Boat guidelines and regulations, public dock maintenance, channel depth (dredging), parking lot criteria, etc., are all in need of explicit definition and guidance.

4. Periodic lake cleanup activities need to be continued by CLEAR and others with the support of Lake Lynn Hydro to remove plastic and structural debris floating in the lake and backwaters. The CLEAR pontoon boat should be useful for these activities.

5. Given that the Lake is limited in boating capacity during busy weekends, the limit has been reached for the number of marinas, boat slips and personal access area sites.

6. Swimming beach season should match the boating season of May 1st to October 31st

7. Regular maintenance of the swimming beach is needed to remove large debris (mainly tree segments) and to keep quality sand fresh and deep, as mostly children use it.

8. The swimming beach area needs to be extended toward the day-use boat docks to permit the designation of a dog beach, given that dogs interfere with the swimming experience of small children; this will also add space for additional picnic tables, that are already needed.

9. Monitoring and remediation of the on-going shoreline erosion are needed with components of these activities taking place on an annual basis.

10. Hillside slips, ground subsidence and washouts along the Trails must be prepared for, as they are not uncommon, so that monitoring, temporary work-arounds and repairs can take place in a timely manner.

11. Signage on WV 857 for the Cheat Lake Park & Trail needs to be maintained year round and the signage on the Trail maintained for public use year round.

12. Telephone(s) & email address(es) are needed on signs and on web page(s) for information and for emergencies.

13. Formal plans and procedures are needed that assigns responsibilities for the various types of emergency at the Dam, on the Trails, on the Lake, downstream in Pennsylvania, etc.

14. Brochures are needed for public distribution to include the history, overview of facilities, rules/regulations, contacts, etc.

15. The Internet Web-Site is needed with multiple pages to include the brochure information, lake level, operational updates, warnings, etc.

16. News Releases (quarterly & timely) are needed providing general information, trail closings, warnings and other items for current news.

17. For the Fishing Pier, there is a need to identify the opportunities, guidelines, operation and maintenance schedules.

18. A continued commitment to regional trail development should include interfacing with the proposed Sheepskin Trail in Pennsylvania, for a connection to other regional trails, to involve the opening of the trail level gate at the Lake Lynn Dam for daylight walking, hiking, jogging and bicycling.

19. For the Lake level protocol, there is a need to reiterate the water level ranges vs. months of the year on the Web-site and in the Brochure(s).

20. For the Recreation Season protocol, there is a need to reiterate the schedule of May 1 thru October 31, with the Trail being open and accessible year round. The “boat launch” in the Park is essential for summer use by kayak & canoe users and for winter use by fishing boat users.

21. There is a need for a description of the functions of (existing & new) recreation personnel, security personnel, park maintenance personnel; and guidelines are needed for the interaction of these people with public.

22. An Advisory Committee is needed with Quarterly meetings and quarterly reports, consisting of members from Monongalia County, WV-DNR, WVU, WV trail group, PA trail group, PA-DNR/DEP, plus 2 or 3 local environmental/conservation groups.

23. A study of the details of the history of Cheat Lake and the Lake Lynn Dam is needed to examine the role of the project there on the Mason-Dixon Line affecting both West Virginia and Pennsylvania, whether it is a private “for-profit” entity with public obligations or whether it is “for the public interest” to provide recreation and a public service (electricity). These considerations take on a greater significance when foreign ownership is under way.

The Cheat Lake Environment & Recreation Association (CLEAR) has been active to promote the public use of Cheat Lake for over 30 years. The officers are Duane Nichols, President, Mike Strager, Vice President, Ann Chester, Secretary, and Donna Weems, Treasurer.

CONTACT INFORMATION: Duane G. Nichols, 330 Dream Catcher Circle, Morgantown, WV 26508. Phone: 304-216-5535, Email Address: Duane330@aol.com

Submitted by Duane Nichols of CLEAR this 10th day of February 2020.

Document Content(s)

# United States Department of the Interior

FISH AND WILDLIFE SERVICE

Chesapeake Bay Field Office
177 Admiral Cochrane Drive
Annapolis, Maryland 21401
http://www.fws.gov/chesapeakebay

February 13, 2020

Jody Smet
Director, FERC Licensing and Compliance
Lake Lynn Generation, LLC
2 Bethesda Metro Center, Suite 1330
Bethesda, MD 20814

Dear Ms. Smet:

The U.S. Fish and Wildlife Service (Service) has reviewed the October 17, 2019 Notice of Intent (NOI) to File for a License and attached Pre-Application Document (PAD) for the Lake Lynn Hydroelectric Project (FERC #2459), filed by Lake Lynn Generation, LLC (Applicant). The Applicant has elected to use the Traditional Licensing Process (TLP) for this re-licensing application of the Lake Lynn Hydroelectric Project on the Cheat River near Morgantown, West Virginia and in Fayette County, Pennsylvania. The current project license was issued on December, 1994 and will expire on November 30, 2024.

The Service attended the Joint Agency meeting and site visit on December 12, 2020 in Morgantown, WV, with the Applicant, state and local agencies, and interested residents. We offer the following recommendations on the PAD and our Study Requests.

The following comments are provided pursuant to the Endangered Species Act (ESA) of 1973 (87 Stat. 884, as amended: 16 U.S.C. 1531 *et seq.*), the Migratory Bird Treaty Act (16 U.S.C. 703-712; Ch. 128; July 13, 1918; 40 Stat.755), and the Fish and Wildlife Coordination Act (48 Stat. 401, as amended; 16 U.S.C. 661 *et seq.*).

The project is a 51.2 megawatt (MW) single development project operated since 1926. It consists of: 1) a 125-foot high by 1,000-foot long concrete gravity-type dam with a 624-foot long spillway controlled by 26 Tainter gates, each 17 feet high by 21 feet long; 2) a reservoir with a surface area of 1,729 acres and containing about 72,00 acre-feet of water at full pool elevation of 870 feet National Geodetic Vertical Datum; 3) a log boom and track racks at the intake facility; 4) eight 12-foot by 18-foot gated penstocks of reinforced concrete; 5) a 72-foot by 165-foot by 68-foot high brick powerhouse containing four identical Francis generating units with a total rated capacity of 51.2 MW; 6) dual 800-foot long 138-kilovolt transmission lines; and 7) appurtenant facilities. In 2018, the licensee completed a turbine replacement and upgrade of Unit 2.

**Pre-Application Document**

Section 4.4 Current and Proposed Project Operations.

The Service supports the concerns of the West Virginia Division of Natural Resources (WV DNR) regarding the quality and timing of available yellow perch (*Perca flavenscens*) and walleye (*Sander vitreus*) habitat within the reservoir lake, with proposed drawdown operations. Their assessment is that the lake elevation schedule during the month of March (between 863 and 870 feet) is likely insufficient to protect the spawning period and could dewater many fish eggs which would hamper recruitment to the populations. We would like to better understand how lake levels, downstream flow releases, and draw down schedules impact fish and wildlife resource needs so we can determine whether there are ways to minimize these impacts.

Section 5.2 Water Resources

The current License Article 405 (continuous monitoring of water quality) has proved very beneficial to the Licensee and resource agencies as this monitoring resulted in effective management of a low flow event during the summer/early fall of 2019. The Service believes this monitoring should be continued in any new license condition granted.

Section 5.2.3 Streamflow, Gage Data and Flow Statistics

This section of the PAD does not provide sufficient information for the Service to fully assess the seasonality, duration and magnitude of streamflows inflowing to the reservoir and dam, and the appropriate flow releases for the upcoming license period. The graphs in Appendix E (Flow Duration Curves) are not scaled appropriately to discern the patterns of what occurs in the 5 to 99 percent exceedance flows that we would need to examine. It would be helpful if the maximum flow event(s) and duration for the period record 2016 to 2019 is displayed separately from the rest of the graphs so as not to flatten all other flow interpretation.

The Service does not see the Project Instream Flow Study which is referenced in this section of the PAD, contained in Appendix E, in order to assess its applicability to current and future conditions. Without this information, we have many remaining questions, and would recommend an Instream Flow Study to help us determine appropriate flow releases in the new license articles.

The Service also believes a mussel survey should be conducted downstream in the tailwater area and downstream reaches to assess this valuable component of the aquatic community and potentially help inform our flow regime recommendations for the project.

Section 5.7.2 Rare, Threatened and Endangered Resources and Habitats

Table 5.16 of the PAD identifies four species federally listed under the ESA with the potential to occur in the project area, Indiana bat (*Myotis sodalis*), northern long-eared bat (*Myotis septentrionalis*), running buffalo clover (*Trifolium stoloniferum*), and the flat-spired three-toothed snail (*Triodopsis platysayoides*).

The federally threatened northern long-eared bat and the federally endangered Indiana bat are temperate, insectivorous migratory bats that hibernate in mines and caves during the winter and spend summers in wooded areas. There are no known northern long-eared bat maternity roosts

or hibernacula within the immediate vicinity of this site. Indiana bats are most likely to be in maternity roosts from May 1 to July 31.

Any project-related tree removal (e.g., for maintenance or recreational improvements) should involve consultation with the Service under Section 7 of the ESA, for the protection of the Indiana bat and northern long-eared bat.

The Service filed an August 27, 2019 Proposed Rule in the Federal Register for the de-listing of running buffalo clover (*Trifolium stoloniferum*) found at this web address: https://www.govinfo.gov/content/pkg/FR-2019-08-27/pdf/2019-18413.pdf#page=1. Its current status is still federally endangered as of this comment date. However, we believe this existing project with minor habitat modification of the project area will not likely adversely affect running buffalo clover, a terrestrial plant. We therefore, are not requesting surveys for the plant.

The flat-spired three-toothed snail is found within Monongalia County, West Virginia in close proximity to the project, but is not found within the project boundary. It is found in Coopers Rock State Forest, primarily on the rock bluffs. The area within the project boundary lacks the habitat requirements for the snail, therefore, this project will have "no effect" on the species.

Except for occasional transient individuals, no other federally proposed or listed threatened or endangered species are known to exist within the project area. Should project plans change or if additional information on the distribution of listed or proposed species becomes available, this determination may be reconsidered.

**Study Requests**

The Service has reviewed the evaluation of study proposals in the PAD by the Applicant for the Lake Lynn Hydroelectric project. We feel the proposed presence/absence surveys for rare, threatened, and endangered species may not be warranted, based upon our comments on the PAD. Aside from a field inventory of existing project recreation sites, a creel survey, and a cultural resources examination along the Cheat Lake Trail and Lake Lynn dam and powerhouse, the Applicant is not proposing any other studies. The only protection, mitigation, and environmental (PM&E) measures the Applicant proposes relate to recreation and land use. The Service believes the studies we and other resource agencies have identified are necessary to determine appropriate PM&E measures for the upcoming license period.

The Service requests the opportunity for further review and discussion as the study plans develop from a conceptual phase into more defined proposals.

**Study Request 1: American Eel Monitoring Study**

*Goals and Objectives:* To assess if American eel (*Anguilla rostrata*) is currently present below the Lake Lynn dam on the Cheat River and to help inform project operations and fishway prescription needs.

*Resource Management Goals:* Resource management goals include providing safe, timely, and

effective passage for fish species that migrate. Additional goals include providing passage to fish species which serve as glochidial hosts to freshwater mussels in the Cheat River, in order to prevent negative impacts to fish and mussel populations from the proposed project.

*Public Interest:* The requestor is a resource agency.

*Existing Information:* American eels have been documented in the Monongahela River within the past 10 years as far upstream as the Morgantown Lock and Dam, upstream of the confluence of the Cheat River with the Monongahela River. The Lake Lynn Hydropower Project is 3.7 miles upstream on the Cheat River from its confluence with the Monongahela River, therefore there is significant potential for current and future eel habitat usage within the Cheat River below Lake Lynn Hydroelectric project, and within the upstream miles of the Cheat River and tributaries. A preliminary sampling effort was conducted using the technique of environmental DNA (eDNA) detection technology as detailed in the "Project Report: June 2019 qPCR analysis of eDNA filter samples collected at Lake Lynn Dam, Target species: American eel (*Anguilla rostrata*)," dated December 4, 2019 by the Northeast Fishery Center's Conservation Genetics Lab.

*Study Methodology:* The recommended study uses standardized protocols employed in published literature.

*Level of Effort and Cost:* The methodology employed by the pilot sampling project described in the December 4, 2019 Project Report has shown that this method is a lower cost technique. This new study would seek to improve on sampling conditions to greatly reduce the influence of above dam released water on the collected samples, and to include areas lower in the Cheat River before its confluence with the Monongahela River.

**Study Request 2: Entrainment Study and Mortality Study**

*Goals and Objectives:* The goal of the proposed study is to determine the number of fish that are either entrained or impinged by the project operation, and to examine methods to reduce this injury and mortality to fishes.

*Resource Management Goals:* The Service's strategic conservation priorities include aquatic connectivity efforts that provide for passage, community protection, and enhanced recreational opportunities using the best available science and decision support tools.

*Public Interest:* The requestor is a resource agency.

*Existing Information:* The Service is not aware of previous entrainment studies conducted at the project. The biomonitoring data conducted under prior license conditions and filed in the FERC record can be used to assist in this analysis.

*Nexus To Project Operation:* Due to the large spacing of the current trash racks, certain sizes of fish are able to pass through the racks and become entrained through the turbines as they operate, causing fish mortality of an unknown quantity.

*Study Methodology:* The Applicant could use the Service's Turbine Blade Strike Analysis Model as one component of their assessment of current operational impact on entrainment and mortality of fishes. It can be found at https://www.fws.gov/northeast/fisheries/fishpassageengineering.html, along with other Service guidelines such as the Northeast Region Fish Passage Engineering Design Criteria, Fish Passage Design Criteria, and the Federal Interagency Nature-Like Fishway Passage Design Guidelines. Some literature analysis of mortality from Francis units of the diameter that exist at the project could also be utilized.

*Level of Effort and Cost:* These desktop analyses should be achievable within the one year timeframe.

**Study Request 3: Upstream and Downstream Fish Passage Study**

*Goals and Objectives:* The goals of the study are to assess movement of fish through the project area. It would identify likely routes fish would take under a variety of conditions, and assess the feasibility of incorporating alternative routes or additional fish protection measures.

*Public Interest:* The requestor is a resource agency.

*Existing Information:* The Service is not aware of previous studies examining passage options for the Lake Lynn Hydroelectric Project.

*Nexus To Project Operation*: The dam at the project blocks migration of fishes upstream and likely impedes safe, timely, and effective passage downstream. Downstream migration is currently only available through the dam gates, and through the project's powerhouse.

*Study Methodology:* The methodology would include a literature review of available options for upstream passage of eels, downstream passage bypass of the turbines, and other fish protection measures, in addition to iterative discussions with the Service's fishway engineers and other case studies.

*Level of Effort and Cost:* We anticipate that evaluating feasibility of passage would be fairly straightforward and not a lengthy process. Discussions with engineers would be necessary to properly assess the feasibility of bypass channels or fish protection structures.

We appreciate the opportunity to provide review and comment on the PAD and draft study proposals developed by the Applicant. We look forward to further discussions with you on how the Applicant can incorporate all the above listed studies. Finally, it would be helpful if the study proposals incorporated into the Draft Study Plan are as detailed as possible so that all parties

know exactly what is being agreed upon when the study plan is approved. If you have any questions regarding this matter, please contact Janet Norman of my staff at 410-573-4533 or Janet_Norman@fws.gov.

Sincerely,

Christopher P. Guy

for Genevieve LaRouche
Field Supervisor

cc: Lindy Nelson, Regional Environmental Officer, DOI OPEC

**References**

U.S. Fish and Wildlife Service. Endangered and Threatened Wildlife and Plants; Removing Trifolium stoloniferum (Running Buffalo Clover) From the Federal List of Endangered and Threatened Plants. 84 FR 44832, August 27, 2019. https://www.govinfo.gov/content/pkg/FR-2019-08-27/pdf/2019-18413.pdf#page=1

U.S. Fish and Wildlife Service. 2019. Fish Passage Engineering Design Criteria. USFWS, Northeast Region R5, Hadley, Massachusetts.

Mon River Trails Conservancy
P.O. Box 282
Morgantown
West Virginia
26507-0282

February 9, 2020

Kimberly Bose, Secretary
Federal Energy Regulatory Commission
888 First Street, N.E.
Mailcode PJ- 12.1
Washington, DC 20426

Re: *Information Request for the Pre-Application Document for Relicensing of the Lake Lynn Hydroelectric Project (FERC No. P-2459-005)*

Dear Ms. Bose,
On behalf of the Monongahela River Trails Conservancy Ltd. (MRTC), I am submitting comments concerning the Relicensing of the Lake Lynn Hydroelectric Project (FERC No. P-2459-005). MRTC is a non-profit 501c3 organization founded in 1991 to develop and manage 40 miles of a 48-mile, tri-county rail-trail network in North Central West Virginia. The remaining 8 miles are managed by the city of Morgantown and Star City, with MRTC as an active partner. The Mon River, Caperton, Deckers Creek Trail network was established as a National Recreation Trail in 1996. MRTC shares with other regional stakeholders the vision of having the Cheat Lake Trail connect with the Sheepskin Trail in Pennsylvania and the Mon River Trail network in West Virginia and ultimately be part of a long-distance trail network that extends from Ohio through West Virginia and Pennsylvania to Washington D.C.

Cube Hydro, in now owning and managing the Cheat Lake Dam aka Lake Lynn Facilities, has continued to provide a wide mix of public recreational options to enjoy the area including hiking, biking, birding, paddling, fishing, swimming, and boating. MRTC supports these recreational activities and would like to see improvements to these recreational opportunities be included in this re-licensing process:

1. To restore the Cheat Lake Trail to its 4.5 mile length by repairing a major wash-out that occurred in the summer of 2019.
2. To plan and build a connection of the Cheat Lake Trail to the Sheepskin Trail at the north end of the 4.5 mile Cheat Lake Trail. This would connect the Cheat Lake Trail into a nearly 60 mile rail-trail network and connect many communities including Point Marion, PA, Morgantown, WV, and Fairmont, WV. This involves opening the gate at the north end of trail and working with other stakeholders to build new trail on Cube Hydro property to link into the Sheepskin Trail corridor. The Sheepskin Trail Corridor is owned by Fayette County, PA and is currently being engineered and built. The Sheepskin Trail is not yet built to Cheat Lake Trail but we anticipate it will be in the next 5 years.
3. To extend the Cheat Lake Trail south on Cube Hydro property and in doing so, open up more area to hiking, biking, birding and fishing.
4. To improve fish, bird, and pollinator habitat along the Cheat Lake Trail.

5. To improve recreational promotion of the Cheat Lake recreation area by hiring on-site recreation staff, by improving public communication (website, social media, phone), and by creating a process for holding events on the Cheat Lake Trail such as walks and runs.

Recreation on the river and neighboring rail-trails ties our communities in West Virginia and Pennsylvania together economically and socially. Bass tournament participants cross city, county and state lines. Both the Monongahela River and Cheat Rivers are regionally promoted water trails, and both paddlers and boaters move up and down the rivers to access different communities. Our rail-trails are used for commuting to work and school, trail tourism, and recreation. Our communities are dependent on each other to provide access, amenities, and tourism services in order to recruit new businesses and people to live in the region and entice visitors into extended stays and return visits.

The Cheat Lake Trail is one of a cluster of rail-trails in the region that provides recreation, a social gathering space, and a chance to connect with nature. It is widely used by local groups such as Hike it Baby, an outdoor meet-up group for families with young children, the Mountaineer Chapter of the National Audubon Society for public birding outings and the Christmas Bird Count, and cycling and running groups for exercise and outdoor recreation. Additionally, the Cheat Lake Trail is a part of a growing 1,500+ mile trail network connecting 50+ counties in four states (WV, OH, PA and NY). The Industrial Heartland Trails Coalition is a group comprised of more than 100 organizations, whose vision and mission it is to advance the trail network by closing gaps and connecting communities to bring health and wealth to communities through trail tourism and safe, equitable trail access by local residents.

Thank you for considering these recommendations from community stakeholders as part of the re-licensing process. Please feel free to contact me at 304-692-6782 or ella@montrails.org with any questions or if you need additional information.

Sincerely,
Monongahela River Trails Conservancy, Ltd.

Ella Belling

Ella Belling, Executive Director

Document Content(s)

Owen Mulkeen, Kingwood, WV.
On behalf of Friends of the Cheat, I’d like to start by thanking you for the opportunity to submit comments to be included as part of the Pre-Application Document for Relicensing of the Lake Lynn Hydroelectric Project.
For 25 years, Friends of the Cheat (FOC) and our River of Promise (ROP) partners have worked diligently to restore water quality to the Cheat River and Cheat Lake through reclamation of mine lands and the remediation of acid mine drainage (AMD). Irresponsible mining had left the Cheat and nine of its lower tributaries severely damaged by AMD. Walleye were extirpated by the late 1940s. Historic data collected by WV Division of Natural Resources (DNR) show mean lake pH levels less than 5 between the 1950s and early 1990s. A few pollution tolerant fish species including bullhead catfish and white suckers sought refuge in the lake’s sheltered embayments. Massive pollution releases from the T&T mine into Muddy Creek in 1994 and 1995 dropped the pH of the lake to 4. As a result, the Cheat River was named one of America’s Most Endangered Rivers in 1995 by the national organization American Rivers. These events catalyzed the formation of Friends of the Cheat and the River of Promise task force.
The efforts of FOC and our ROP partners, most notably the US Office of Surface Mining (OSM) and WV Department of Environmental Protection (DEP), have restored water quality to the Cheat River main stem and Cheat Lake. Over 200 land reclamation and water treatment projects have been implemented with millions of dollars of funds resulting in millions of pounds of AMD pollution removed from the Cheat’s tributaries. The river and lake have not seen a pH depression below 6 since 2011 and the main stem has been removed from the state’s list of impaired waters for pH impairment. The removal of iron (ferrous hydroxide or “yellow boy”) as well as aluminum and manganese is visibly noticeable by reduced staining of rocks near the water’s edge as well as armoring of fiberglass boat bottoms, which was a prevalent problem through the ‘90s.
Improved water quality has fostered the rebound of Cheat Lake’s fishery. DNR reports a dramatic recovery of species richness (27-34 species per year) including abundant sportfish such as largemouth and smallmouth bass, yellow perch, and walleye. Fishing tournaments now attract anglers from across the country which benefits the local economy. FOC is particularly excited about the walleye, which research shows are spawning up into the northern reaches of the Cheat Canyon.
With a drainage area of roughly 1400 square miles all flowing down to Cheat Lake, not only does the Cheat River constitute a critical piece of the region’s ecosystem, it is also home to a large human population that lives, works and plays within the drainage. Friends of the Cheat recognizes that opportunities to recreate and connect with nature and the outdoors can not only improve the quality of life for a region’s citizens, but it also leads to the engagement with and appreciation of our resources that can help prevent them from being squandered and abused. Cheat Lake and the surrounding area already Working to restore, preserve, and promote the outstanding natural qualities
of the Cheat River Watershed since 1994

provides a plethora of outdoor activities; including paddling, boating, fishing, hiking, cycling, birding and more. Cube Hydro has already improved and created recreation
opportunities around Cheat Lake. FOC and key partners have identified several opportunities for additional improvement of recreational opportunities that we believe should be considered as part of this next re-licensing process.

FOC is aware and supportive of the proposal to create a public access to the upper reaches of Cheat Lake by improving an existing gated road in Snake Hill Wildlife Management Area along Buzzard Run. This would provide another trailhead for hikers to enter the WMA, fishermen to access this upper section of the lake usually only reachable by boat, and would provide an egress opportunity for whitewater paddlers running the Lower Cheat Canyon. Despite being located in close proximity to the Cheat Lake and Morgantown metropolitan areas, and providing a wonderfully scenic and exciting float through class 2 rapids in a deep canyon, this section is infrequently paddled. This is mostly due to the 4.5 mile paddle across Cheat Lake to the nearest existing public access at the Ices Ferry bridge, which can be a laborious task in short maneuverable whitewater craft that are well suited for the rapids upstream, not to mention the danger of encounters with fast moving power boats. The creation of a new public access by improving Buzzard Run Road would shorten this flatwater paddle to 1.9 miles and thereby make this whitewater trip much more attractive.

Another opportunity for recreation enhancement in the Cheat Lake area would be to improve access and connectivity of both ends of the existing Cheat Lake Trail. Currently the trail follows the eastern shoreline of Cheat Lake for 4.4 miles and provides opportunities for walking, running, biking and fishing. The north end of the trail can be accessed via a trailhead and steep flight of stairs off of Morgan Run Road. The south end of the trail dead ends abruptly. With the future route of the Sheepskin Trail passing by just to the north, and local businesses, residential neighborhoods, and Coopers Rock State Forest to the south, there lies an opportunity to work towards increased connectivity of these trail system. By doing so, we can enhance the value of these isolated trail sections in such a way that their value becomes greater than the sum of their parts. We recommend that possibilities to extend the southern end of the Cheat Lake Trail, around the peninsula where it currently terminates, to a newly developed trailhead be thoroughly investigated, as well as the streamlining of the northern terminus to avoid the steep stairs and improve the connectivity to the future route of the Sheepskin Trail.

Thank you for this opportunity to comment on the upcoming relicensing of the Lake Lynn Hydroelectric Project.

Sincerely,

Owen Mulkeen
Associate Director
Friends of the Cheat

Document Content(s)

Dave Harshbarger, Morgantown, WV.
Pleas see the Cheat Lake Trail restored at the wash-out and re-opened to the public ASAP from the storm damage in summer of 2019.
A commitment to connecting to the Sheepskin Trail once the Sheepskin Trail is developed to this area.
And an entrance for cyclists and walkers on the northern end with a replacement of the gate and fence to a gate with a bike/ped pass-thru on the Cheat Lake Trail.

Document Content(s)

GARY V MARLIN, WESTOVER, WV.
January 9, 2020

I am a member of the Morgantown community and would like to submit some suggestions to be considered for Project # P-2459. I would like to see the slip on the Cheat Lake Trail repaired and to see a passage way from the Trail through the dam facility so that there will be a connection to the Sheepskin Trail when it comes by the dam.
Respectfully,
Gary Marlin

Document Content(s)

## Foster, Joyce

| | |
|---|---|
| **Subject:** | FW: [EXTERNAL] Lake Lynn Relicensing - Draft Mussel Survey Plan |
| **Location:** | Microsoft Teams Meeting |
| **Start:** | Wed 5/20/2020 11:00 AM |
| **End:** | Wed 5/20/2020 12:00 PM |
| **Show Time As:** | Tentative |
| **Recurrence:** | (none) |
| **Meeting Status:** | Not yet responded |
| **Organizer:** | Jody Smet |

-----Original Appointment-----
**From:** Jody Smet <Jody.Smet@eaglecreekre.com>
**Sent:** Monday, May 18, 2020 11:04 PM
**To:** Jody Smet; Janet_Norman@fws.gov; Jacob Harrell; Heather Smiles; Foster, Joyce
**Cc:** Robert Flickner; Dale Short
**Subject:** [EXTERNAL] Lake Lynn Relicensing - Draft Mussel Survey Plan
**When:** Wednesday, May 20, 2020 11:00 AM-12:00 PM (UTC-05:00) Eastern Time (US & Canada).
**Where:** Microsoft Teams Meeting



All,

Based on the responses received to the Doodle poll, I would also like to schedule a conference call at 11 a.m. on Wednesday, May 20, to discuss the attached draft survey plan for the proposed Lake Lynn Project mussel survey. We anticipate that this call will last no more than an hour. Please join by phone, or MS Teams link, below. Please forward this invitation to others, as appropriate.

Thank you.

________________________________________________________________________________

## Join Microsoft Teams Meeting

+1 920-393-6252 United States, Green Bay (Toll)

Conference ID: 578 406 16#

Local numbers | Reset PIN | Learn more about Teams | Meeting options

________________________________________________________________________________

Project Justification

Lake Lynn Generation LLC (Lake Lynn) is relicensing the Lake Lynn Hydroelectric Project (FERC No. P-2459) (Project) with the Federal Energy Regulatory Commission (FERC). The current FERC license was issued in December 1994 and will expire on November 30, 2024. The Project is located on the Cheat River near Morgantown, West Virginia in Monongalia County, West Virginia and Fayette County, Pennsylvania (**Figure 1**). Lake Lynn filed a Notice of Intent (NOI) and Pre-Application Document (PAD) with FERC on August 29, 2019 and held a Joint Meeting and Site Visit in December 2019. Following the Joint Meeting and Site Visit, resource agencies and other stakeholders were afforded the opportunity to comment on the PAD and to request resource studies that they deemed were needed to evaluate Project impacts on natural, cultural and recreational resources. The U.S. Fish and Wildlife Service (USFWS) reviewed NOI and PAD and requested that a mussel survey be conducted in the tailwater area of the Project and downstream to assess this component of the aquatic community. The objective of this mussel survey is to survey within the Project boundary downstream of the Project dam to document mussel habitat (location, depth, and substrate) and the occurrence density, distribution, and relative abundance of any mussel species present.

The Project is a 51.2 megawatt (MW) single dam development operated since 1926. It consists of:

- a 125-foot high by 1,000-foot long concrete gravity-type dam with a 624-foot long spillway controlled by 26 Tainter gates, each 17 feet high by 21 feet long;
- a reservoir with a surface area of 1,729 acres and containing about 72,00 acre-feet of water at full pool elevation of 870 feet National Geodetic Vertical Datum;
- a log boom and track racks at the intake facility;
- eight 12-foot by 18-foot gated penstocks of reinforced concrete;
- a 72-foot by 165-foot by 68-foot high brick powerhouse containing four identical Francis generating units with a total rated capacity of 51.2 MW;
- dual 800-foot long 13 8-kilovolt transmission lines; and
- appurtenant facilities.

Survey Plan

Survey efforts will be coordinated and led by a West Virginia Approved Malacologist (Lindsey Jakovljevic). Ms. Jakovljevic will provide survey oversight and guidance on execution of the survey and will be the lead taxonomist in the field for the duration of the work. The mussel survey will follow West Virginia Protocol guidance for effort required for Group 3 streams (West Virginia Division of Natural Resources [WVDNR], 2020). The survey area includes the Project boundary that extends approximately 200 meters downstream of the dam and a downstream buffer (DSB) limit of 25 meters. TRC has preliminarily defined the survey area as depicted on the attached **Figure 2**.

TRC will perform a transect survey to evaluate for mussel presence/absence within the survey area downstream of the dam. Seven transects will be placed in the Project boundary and two transects will be placed in the DSB (**Figure 2**). Each transect will span the width of the river (approximately 200 meters). Transects will be set perpendicular to flow and marked into 10-meter segments; each segment constitutes a separate sample. Transects will be visually searched in a 1-meter wide swath along the line. If no mussels are observed in two adjacent transects, with at least one of the transects containing apparent suitable mussel habitat, then a Qualitative timed search will be employed between the two transects in the area of suitable mussel habitat, for a minimum of 10-minutes. If any live and/or fresh dead mussels are found between the two transects, then an additional transect will be placed bank to bank in suitable mussel habitat between the two transects. All search effort will meet minimum Protocol requirements which includes a minimum effort of 1.0 min/$m^2$ search time in areas of heterogeneous substrate and 0.5 min/$m^2$ search time in areas of homogenous substrate.

This survey will consist of visually and tactilely searching the survey area for presence of mussels and to determine limits of any mussel concentrations. Snorkeling and surface supplied air diving will be used to visually and tactilely search for mussels at the substrate surface; moving cobble and woody debris; hand sweeping away silt, sand and/or small detritus; and disturbing/probing the upper 5cm (2in) of substrate in order to ensure recovery of buried mussels. Data will be collected separately for Project boundary and the DSB.

**If any federally listed species are observed during survey or efforts, efforts will stop and WVDNR and USFWS will be immediately contacted.**

Data Collection

Photographs will be taken of the survey area and a minimum of one representative photo of each mussel species will be taken for verification purposes. Live mussels will be kept in stream water in mesh collection bags and out of water time will be kept to one minute or less during processing. At a minimum, data to be recorded includes: time for each 10 meter sample; substrate composition of each sample (visual percentage based on Wentworth scale; water depth (centimeters); mussel species, individual size (length, height, and width to the nearest millimeter), sex (where applicable), and age (external annuli count); mussel shells (classified as fresh dead, weathered dead, or relic shell); where applicable, catch per unit effort (CPUE) as the number live per hour and surface density as the number live per 10 square meters; Global Positioning System (GPS) coordinates of the survey area, mussel aggregation limits; and other notable features such as land use and general observations about the stream.

Reporting

A report documenting the results of the mussel survey will be prepared upon completion of field work. Reports will follow technical reporting guidelines and will include an introduction, methods, results, and discussion with associated tables, figures, and appendices. Maps showing the survey area, mussel distribution, and habitat conditions will also be included, along with photo documentation of the survey area and mussel species encountered. Reporting will follow Protocol recommendations.

References

West Virginia Division of Natural Resources (WVDNR). 2020. West Virginia Mussel Survey Protocols. West Virginia Division of Natural Resources. unpublished. 25pp + app.

# Mussel Survey Scope of Work Summary Sheet

Form Date 3/16/2020

## Project Title: Mussel Survey for the Lake Lynn Hydroelectric Project (FERC #2459), Cheat River, Monongalia County, West Virginia and Fayette County, Pennsylvania

Project Company: Lake Lynn Generation, LLC
Date Submitted:
Mussel Contractor: TRC Environmental Corporation, Inc.
Date Revised:
Lead Malacologist: Lindsey Jakovljevic
Project Contractor:
Collectors: if applicable Lindsey Jakovljevic, Thomas Radford, Tony Tredway
County: Monongalia, WV Fayette, PA
Group (Circle One): 1 2 (3) 4
Stream: Cheat River
Location Description:
Navigational Pool if Applicable:
If Group 1 or 2, Receiving Stream:

Project Type: FERC Re-licensing; Hydroelectric project (corresponds to Table 3, WV Mussel Survey Protocol)

| | | | | | |
|---|---|---|---|---|---|
| ADI Length: | 200 m | ADI Width: | 200 m | Salvage area ($m^2$): | |
| US Buffer Length: | NA | US Buffer Width: | NA | USS Buffer Length: | |
| DS Buffer Length: | 25 m | DS Buffer Width: | 100 m | DSS Buffer Length: | |
| Lateral Buffer Length: | BB | Lateral Buffer Width: | NA | Lateral S Buffer Width: | |

Phase 1 Survey Method Transect [X] Cells [ ] Other [ ]

| # Transects/Length (m): | | Cell Size (mxm): | Cell Search Effort ($Min/m^2$) |
|---|---|---|---|
| 6/200 m | ADI: | | 1 $min/m^2$ |
| NA | USB: | | 1 $min/m^2$ |
| 2/200 m | DSB: | | 1 $min/m^2$ |

25 m Spacing Between Transects (M)

Coordinates (Decimal Degrees, NAD83)

| | | | | |
|---|---|---|---|---|
| Upstream End US Buffer: | Long. | NA | Lat. | NA |
| Upstream End ADI: | Long. | -79.8572 | Lat. | 39.719375 |
| ADI Center: | Long. | -79.8578 | Lat. | 39.720092 |
| Downstream End ADI: | Long. | -79.8581 | Lat. | 39.720741 |
| Downstream End DS Buffer: | Long. | -79.8586 | Lat. | 39.721185 |
| RELOCATION AREA: | Long. | NA | Lat. | NA |

Map: Show ADI, USB, DSB and survey layout with outine of proposed impact.

Did you provide? Justification must be provided in scope of work

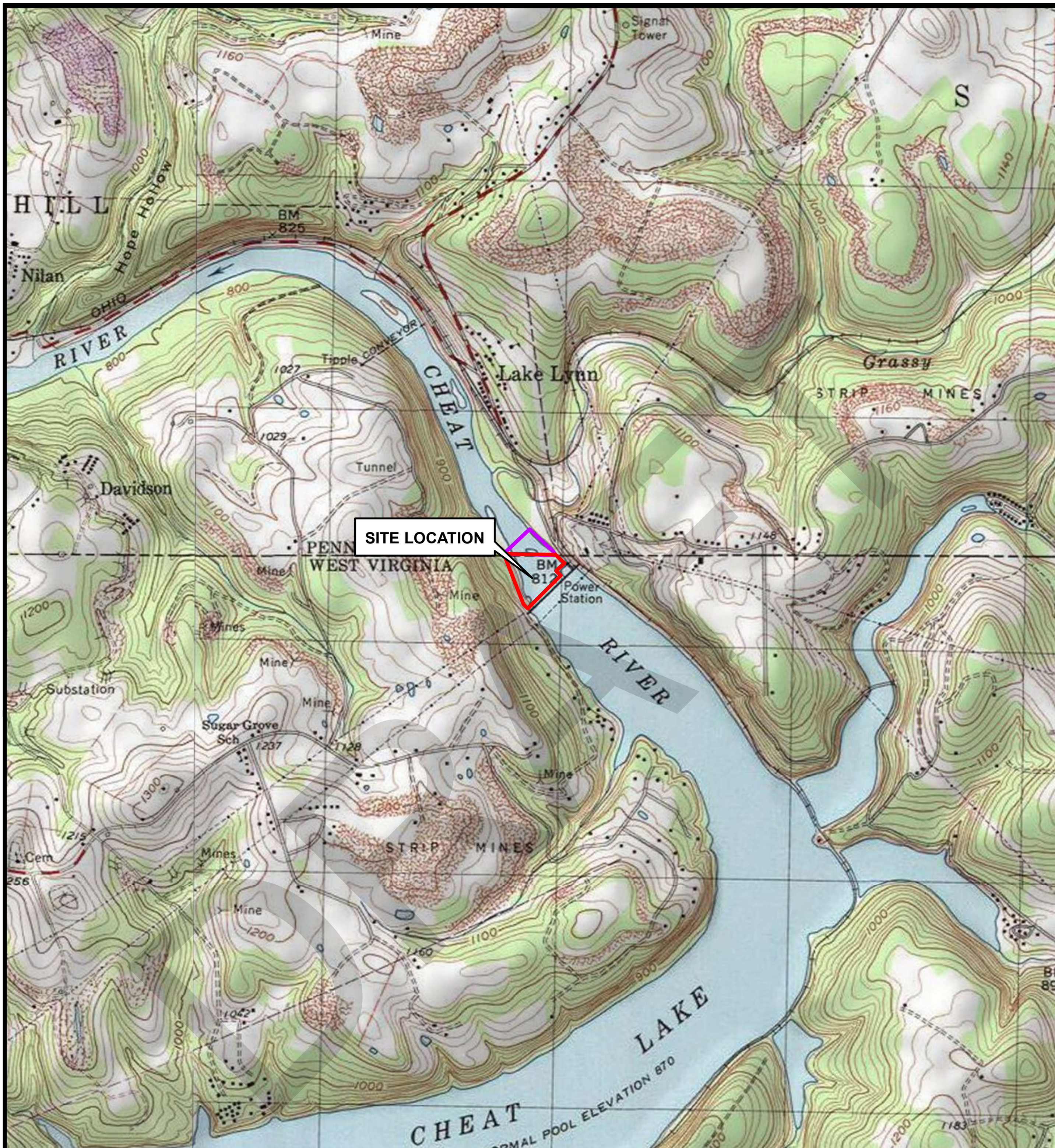
Addressed Alternative Methods [X] Yes Provide Description in Scope
Addressed Alternative Sites [X] Yes Provide Description in Scope

Phase 2 requested?: [ ] Yes [X] No

Request for Relocation: [ ] Yes [X] No

Method:
(check one)
[ ] Cell Size (mxm):
[ ] Moving Transect:
[ ] Other:

Multiple passes are to be made through the area until less than 5 % of the number collected on the first two passes combined are recovered




BASE MAP FROM USGS TOPOGRAPHIC MAP WEB SERVICE, QUAD: LAKE LYNN

NORTH

1 " = 2,000 '
1:24,000

0 1,000 2,000 FEET



TRC
1382 West Ninth Street
Suite 400
Cleveland, OH 44113
Phone: 216-344-3072
TRC - GIS


PROJECT:

**LAKE LYNN HYDROELECTRIC PROJECT**
**MONONGALIA COUNTY, WEST VIRGINIA**

TITLE:

**SITE LOCATION MAP**

**FIGURE 1**

S:\1-PROJECTS\Cube_PE_Hydro\282346_LakeLynnHydro\Fig01_SLM.mxd -- Saved By: MOPEL on 5/12/2020, 12:04:25 PM


Project Boundary
Downstream Survey Buffer
Transect


0 150 300 Feet

1 " = 150 ' 1:1,800

N

**LAKE LYNN HYDROELECTRIC PROJECT**
**MONONGALIA COUNTY, WEST VIRGINIA**

**FIGURE 2**
**SURVEY AREA LIMITS**

TRC

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Cleveland, OH 44113
Phone: 216-344-3072

MAY 2020 Fig02_SurveyArea.mxd

TRC - GIS

Plot Date:5/12/2020, 12:03:07 PM by MOPEL -- LAYOUT: ANSI B(11"x17")
Path: S:\1-PROJECTS\Cube_PE_Hydro\262346_LakeLynnHydro\Fig02_SurveyArea.mxd

| | |
|---|---|
| **From:** | Jody Smet |
| **To:** | Smiles, Heather A |
| **Subject:** | [EXTERNAL] RE: Lake Lynn Relicensing - Draft Mussel Survey Plan |
| **Date:** | Tuesday, May 19, 2020 8:16:18 AM |



Great, thanks Heather.

Jody J. Smet, AICP
Vice President Regulatory Affairs
Eagle Creek Renewable Energy

Please note my new email address – jody.smet@eaglecreekre.com

-----Original Appointment-----
**From:** Smiles, Heather A <hsmiles@pa.gov>
**Sent:** Tuesday, May 19, 2020 8:15 AM
**To:** Jody Smet
**Subject:** Accepted: Lake Lynn Relicensing - Draft Mussel Survey Plan
**When:** Wednesday, May 20, 2020 11:00 AM-12:00 PM (UTC-05:00) Eastern Time (US & Canada).
**Where:** Microsoft Teams Meeting

Jody,

Our Malacologist, Nevin Welte, will join the meeting. For your records, below is his information.

Thanks,

**Heather A. Smiles** | Chief, Division of Environmental Services
PA Fish and Boat Commission
595 East Rolling Ridge Drive | Bellefonte, PA 16823
Phone: 814.359.5194
Email: hsmiles@pa.gov
www.fishandboat.com

Nevin Welte
Malacologist/Nongame Biologist, Natural Diversity Section
Pennsylvania Fish & Boat Commission
Centre Region Office
595 E. Rolling Ridge Dr.
Bellefonte, PA 16823
c-nwelte@pa.gov

412-586-2334

| | |
|---|---|
| **From:** | Jody Smet |
| **To:** | Norman, Janet; Harrell, Jacob D; Heather Smiles; c-nwelte@pa.gov |
| **Cc:** | Dale Short; Robert Flickner; Michael Scarzello; Matthew Nini; Foster, Joyce |
| **Subject:** | [EXTERNAL] Lake Lynn Relicensing – Revised Draft Mussel Survey Plan |
| **Date:** | Thursday, July 9, 2020 11:11:10 AM |
| **Attachments:** | image001.png<br>Lake Lynn Mussel Survey Plan_REV 1.pdf |



All,

As follow-up to our call on May 20 discussing the draft Lake Lynn Mussel Survey Plan and review of the 1993 Lake Lynn Instream Flow Study Report, we have attached a revised draft Lake Lynn Mussel Survey Plan for your review.  Please provide your comments on the revised Survey Plan by July 17.

Thank you,

**Jody J. Smet, AICP | Vice President Regulatory Affairs**
**Eagle Creek Renewable Energy**
Desk: 804 739 0654
Mobile: 804 382 1764
Email: jody.smet@eaglecreekre.com

EAGLE CREEK RENEWABLE ENERGY
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2020 MUSSEL SURVEY PLAN (JUNE 2020)
CHEAT RIVER – LAKE LYNN HYDROELECTRIC PROJECT
MONONGALIA COUNTY, WEST VIRGINIA AND FAYETTE COUNTY, PENNSYLVANIA

Survey Background and Justification

Lake Lynn Generation LLC (Lake Lynn) is relicensing the Lake Lynn Hydroelectric Project (FERC No. P-2459) (Project) with the Federal Energy Regulatory Commission (FERC). The current FERC license was issued in December 1994 and will expire on November 30, 2024. The Project is located on the Cheat River near Morgantown, West Virginia in Monongalia County, West Virginia and Fayette County, Pennsylvania (**Figure 1**). Lake Lynn filed a Notice of Intent (NOI) and Pre-Application Document (PAD) with FERC on August 29, 2019 and held a Joint Meeting and Site Visit in December 2019. Following the Joint Meeting and Site Visit, resource agencies and other stakeholders were afforded the opportunity to comment on the PAD and to request resource studies that they deemed were needed to evaluate Project impacts on natural, cultural and recreational resources. The U.S. Fish and Wildlife Service (USFWS) reviewed the NOI and PAD and requested that a mussel survey be conducted downstream of the dam.

By email dated May 18, 2020, Lake Lynn provided a draft Mussel Survey Plan to the USFWS, Pennsylvania Fish and Boat Commission (PBFC), and West Virginia Division of Natural Resources (WVDNR). Lake Lynn convened a meeting via MS Teams and conference call on May 20, 2020 to discuss the draft Mussel Survey Plan. The draft Mussel Survey Plan proposed following West Virginia Protocol guidance for effort required for Group 3 streams (WVDNR, 2020) and defining the survey area as the area inside the Project boundary and a downstream buffer (DSB) limit of 25 meters beyond the Project boundary. The Resource Agencies expressed concerns about limiting the survey area and requested that the survey area extend 1 mile downstream of the Project since they considered this project as a scoping project without a full hydraulic study. As an action item, Lake Lynn agreed to share the 1993 Project Instream Flow Study to provide additional information about the Project's operational influence downstream of the dam and the geographic scope of the survey.

Lake Lynn distributed the 1993 Project Instream Flow Study to the Resource Agencies on June 2, 2020. The 1993 Project Instream Flow Study reported that water level fluctuations due to Project operation are greatest in the segment of river extending 1.02 mile below the Project dam. The 1993 Project Instream Flow Study also reported that the water depth in the Cheat River segment from the 1.02-mile point below the Project dam to the confluence with the Monongahela is dependent upon and maintained by Pool 7 water elevations during Project shutdown.

The draft Mussel Survey Plan has been revised based on additional information and comments received. The objective of this mussel survey is to conduct a habitat assessment survey to delineate any mussel beds/habitat from the Project dam to one mile downstream to document mussel habitat (location, depth, and substrate) and the occurrence density, distribution, and relative abundance of any mussel species present.

The Project is a 51.2 megawatt (MW) single development project operated since 1926. It consists of:

- a 125-foot high by 1,000-foot long concrete gravity-type dam with a 624-foot long spillway controlled by 26 Tainter gates, each 17 feet high by 21 feet long;
- a reservoir with a surface area of 1,729 acres and containing about 72,00 acre-feet of water at full pool elevation of 870 feet National Geodetic Vertical Datum;
- a log boom and track racks at the intake facility;
- eight 12-foot by 18-foot gated penstocks of reinforced concrete;

- a 72-foot by 165-foot by 68-foot high brick powerhouse containing four identical Francis generating units with a total rated capacity of 51.2 MW;
- dual 800-foot long 13 8-kilovolt transmission lines; and
- appurtenant facilities.

Survey Plan

Habitat assessment survey efforts will be coordinated and led by a West Virginia and Pennsylvania approved malacologist. The qualified malacologist will provide survey oversight and guidance on execution of the survey and will be the lead taxonomist in the field for the duration of the work. The habitat assessment survey will follow modified West Virginia Protocol guidance (West Virginia Division of Natural Resources [WVDNR], 2020) with additional guidance from the American Fisheries Society Monograph 8 (Strayer and Smith, 2003). The survey area includes the Project boundary that extends approximately 200 meters downstream of the Project dam and will continue one mile downstream. TRC has preliminarily defined the survey area as depicted on the attached **Figure 2**.

TRC will perform a habitat assessment survey to determine areas of suitable mussel habitat and evaluate for mussel presence/absence within the survey area downstream of the dam. The habitat assessment will start one mile downstream of the Project boundary and move upstream to the Project dam (**Figure 2**). The banks will be searched for shell material and the substrate will be evaluated to identify suitable mussel habitat (stable burrowable substrates including sand, gravel, cobble, etc.). Once suitable mussel habitat is located, a qualitative timed search will be employed for a minimum of 10-minutes to search for live mussels and shell material. If no suitable habitat is found within a 100-meter stretch of the survey area, then a qualitative search will be performed in the best possible substrate at once least every 100 meters. If live mussels are collected, the area will be searched until the limits of the mussel bed are delineated.

This survey will consist of visually and tactilely searching the survey area for presence of mussels and to determine limits of any mussel concentrations. Snorkeling and surface supplied air diving will be used to visually and tactilely search for mussels at the substrate surface; moving cobble and woody debris; hand sweeping away silt, sand and/or small detritus; and disturbing/probing the upper 5cm (2in) of substrate in order to ensure recovery of buried mussels. Data will be collected separately for each qualitative search.

**If any federally listed species are observed during survey or efforts, efforts will stop and PBFC, WVDNR, and USFWS will be immediately contacted.**

Data Collection

Photographs will be taken of the survey area and a minimum of one representative photo of each mussel species will be taken for verification purposes. Live mussels will be kept in stream water in mesh collection bags and out of water time will be kept to one minute or less during processing. At a minimum, data to be recorded includes: substrate composition of each sample (visual percentage based on Wentworth scale; water depth (meters); mussel species, individual size (length, height, and width to the nearest millimeter), sex (where applicable), and age (external annuli count); mussel shells (classified as fresh dead, weathered dead, or relic shell); where applicable; Global Positioning System (GPS) coordinates of the survey area, mussel aggregation limits; and other notable features such as land use and general observations about the stream.

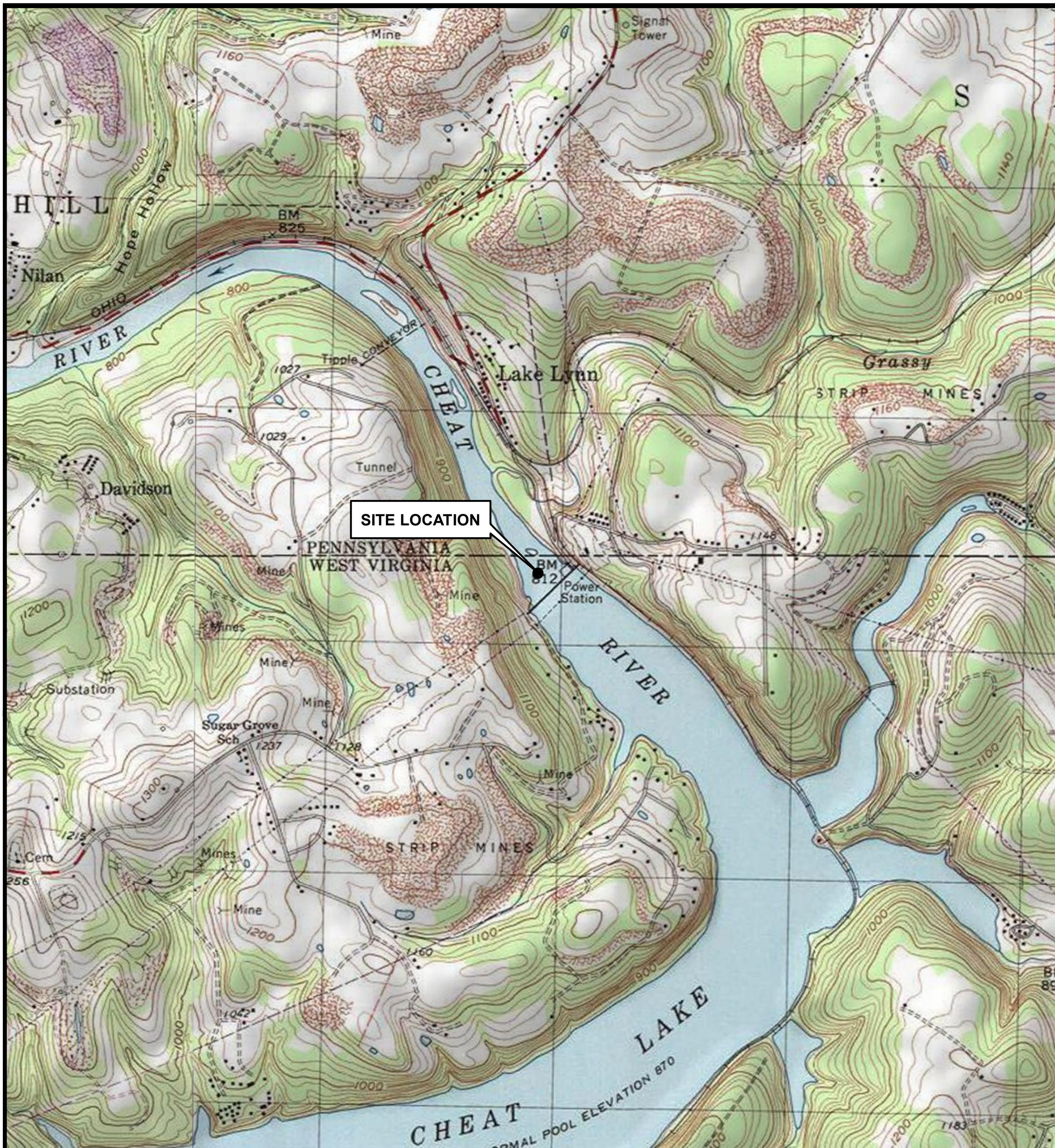
Reporting

A report documenting the results of the habitat assessment survey will be prepared upon completion of field work. Reports will follow technical reporting guidelines and will include an introduction, methods, results, and discussion with associated tables, figures, and appendices. Maps showing the survey area, mussel distribution, and habitat conditions will also be included, along with photo documentation of the survey area and mussel species encountered. Reporting will follow Protocol recommendations.

References

Strayer, D.L., and D.R. Smith. 2003. A guide to sampling freshwater mussel populations. American Fisheries Society, Monograph 8, Bethesda, Maryland.

West Virginia Division of Natural Resources (WVDNR). 2020. West Virginia Mussel Survey Protocols. West Virginia Division of Natural Resources. unpublished. 25pp + app.




BASE MAP FROM USGS TOPOGRAPHIC MAP WEB SERVICE, QUAD: LAKE LYNN

NORTH

1 " = 2,000 '
1:24,000

0 1,000 2,000 FEET

TRC
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Suite 400
Cleveland, OH 44113
Phone: 216-344-3072
TRC - GIS

PROJECT:

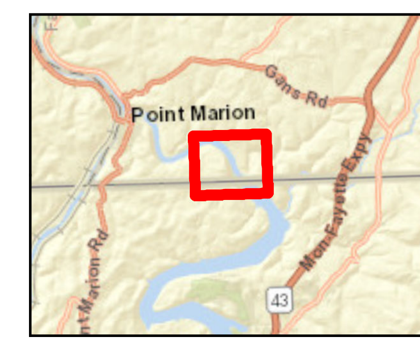
**LAKE LYNN HYDROELECTRIC PROJECT**
**MONONGALIA COUNTY, WEST VIRGINIA**

TITLE:

**SITE LOCATION MAP**


**FIGURE 1**


Project Boundary
Downstream Survey Buffer




0 600 1,200 Feet
1 " = 600 ' 1:7,200

**LAKE LYNN HYDROELECTRIC PROJECT**
**MONONGALIA COUNTY, WEST VIRGINIA**

**FIGURE 2**
**SURVEY AREA LIMITS**

TRC
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Suite 400
Cleveland, OH 44113
Phone: 216-344-3072

JUNE 2020 Fig02_SurveyArea.mxd

TRC - GIS

**Plot Date:** 6/4/2020, 14:27:42 PM by MOPEL -- LAYOUT: ANSI B(11"x17")
**Path:** S:\1-PROJECTS\Cube_PE_Hydro\282346_LakeLynnHydro\Fig02_SurveyArea.mxd

| | |
|---|---|
| **From:** | Jody Smet |
| **To:** | Foster, Joyce |
| **Subject:** | [EXTERNAL] FW: Lake Lynn Mussel Survey Plan Comments |
| **Date:** | Thursday, July 30, 2020 9:39:25 AM |
| **Attachments:** | Lake Lynn Mussel Survey Plan Revision Comments.pdf |



FYI, I haven't seen any others.

Jody J. Smet, AICP
Vice President Regulatory Affairs
Eagle Creek Renewable Energy

Please note my new email address – jody.smet@eaglecreekre.com

---

**From:** Harrell, Jacob D <Jacob.D.Harrell@wv.gov>
**Sent:** Tuesday, July 21, 2020 2:37 PM
**To:** Jody Smet <Jody.Smet@eaglecreekre.com>
**Subject:** Lake Lynn Mussel Survey Plan Comments

Jody,

Please see the attached comments concerning the Lake Lynn Mussel Survey Plan. Comments by our Diversity section are included within.

Thanks,

Jacob Harrell

Coordination Unit
WVDNR – Wildlife Resources Section
1110 Railroad Street
Farmington, WV 26571
(304)704-9328
Jacob.D.Harrell@wv.gov

**DIVISION OF NATURAL RESOURCES**
**Wildlife Resources Section**
**District I**
**PO Box 99, 1110 Railroad Street**
**Farmington, West Virginia 26571-0099**
**Telephone 304 825-6787**
**Fax 304 825-6270**
**TDD 800-354-6087**

**Stephen S. McDaniel**
**Director**

July 20, 2020

Jody Smet, AICP
Vice President Regulatory Affairs
Eagle Creek Renewable Energy
2 Bethesda Metro Center, Suite 1330
Bethesda, MD 20814

**RE: Lake Lynn Hydroelectric Project, FERC no. 2459; Lake Lynn Mussel Survey Plan Revision**

Dear Ms. Smet:

Thank you for allowing the West Virginia Division of Natural Resources, Wildlife Resources Section (WRS) the opportunity to review the Mussel Survey Plan as part of the relicensing process for the Lake Lynn Hydroelectric Project, FERC no. 2459. The WRS has reviewed the plan and offers the following comments for your consideration.

As provided, it is unclear if the intent of the surveys is for scoping or to identify potential impacts related to the project. Such intent should be made clear on the first page of the mussel survey plan. If the intent is to conduct a reconnaissance scoping survey to identify what mussels, if any, may be within the project impact area, then the methodology as provided would be sufficient. However, if the intent of the survey is to identify potential impacts that may occur due to project operation, then the methodology provided is insufficient and would fail to meet the standards of the 2020 West Virginia Mussel Survey Protocols which would require additional work (i.e. transect surveys).

Within West Virginia, the Cheat River is a Group 3 stream (large river not expected to have federally threatened and endangered mussel species). Transect surveys on Group 3 streams must include a minimum of 500 linear meters of surveyed area and contain a minimum of 5 transects (up to a maximum of 10 transectes).

With further regard to the methodology, the handling of mussels should be addressed within the survey plan. Mussels that are bagged and held for identification need to be hand placed back into their respective habitat where they were collected.

A summary protocol form, see attached, must also be completed and attached to the mussel survey plan. The mussel survey plan must also be approved by the Diversity Section of the West Virginia Division of Natural Resources and a scientific collection permit would need to be obtained to survey the sections of the survey within West Virginia.

Thank you again for the opportunity to provide comments regarding the mussel survey plan. If you have any questions or comments concerning the mussel survey plan please contact me at (304)989-0208 or by email at jacob.d.harrell@wv.gov.

Sincerely Yours,

Jacob Harrell
Hydropower Coordination Biologist

# Mussel Survey Scope of Work Summary Sheet

Form Date: 3/16/2020

## Project Title: ______________________

Project Company: ______________________ Date Submitted: ______________________
Mussel Contractor: ______________________ Date Revised: ______________________
Lead Malacologist: ______________________
Project Contractor: ______________________
Collectors: if applicable ______________________
County: ______________________ Group (Circle One): 1 2 3 4
Stream: ______________________ Location Description: ______________________
Navigational Pool if Applicable: ______________________
If Group 1 or 2, Receiving Stream: ______________________

Project Type: ______________________ **(corresponds to Table 3, WV Mussel Survey Protocol)**

| | | | | | |
|---|---|---|---|---|---|
| ADI Length: | ____ | ADI Width: | ____ | Salvage area ($m^2$): | ____ |
| US Buffer Length: | ____ | US Buffer Width: | ____ | USS Buffer Length: | ____ |
| DS Buffer Length: | ____ | DS Buffer Width: | ____ | DSS Buffer Length: | ____ |
| Lateral Buffer Length: | ____ | Lateral Buffer Width: | ____ | Lateral S Buffer Width: | ____ |

Phase 1 Survey Method: Transect ☐ Cells ☐ Other ☐ ______

| # Transects/Length (m): | | Cell Size (mxm): | Cell Search Effort (Min/$m^2$) |
|---|---|---|---|
| ______ | ADI: | ____ | ____ |
| ______ | USB: | ____ | ____ |
| ______ | DSB: | ____ | ____ |

______ Spacing Between Transects (M)

Coordinates (Decimal Degrees, NAD83)

| | | |
|---|---|---|
| Upstream End US Buffer: | Long. ______ | Lat. ______ |
| Upstream End ADI: | Long. ______ | Lat. ______ |
| ADI Center: | Long. ______ | Lat. ______ |
| Downstream End ADI: | Long. ______ | Lat. ______ |
| Downstream End DS Buffer: | Long. ______ | Lat. ______ |
| RELOCATION AREA: | Long. ______ | Lat. ______ |

Map: Show ADI, USB, DSB and survey layout with outine of proposed impact.

Did you provide? Justification must be provided in scope of work

Addressed Alternative Methods ☐ Yes Provide Description in Scope
Addressed Alternative Sites ☐ Yes Provide Description in Scope

Phase 2 requested?: ☐ Yes ☐ No

Request for Relocation: ☐ Yes ☐ No

Method:
(check one)
☐ Cell Size (mxm): ______
☐ Moving Transect:
☐ Other: ______

Multiple passes are to be made through the area until less than 5 % of the number collected on the first two passes combined are recovered on the

| | |
|---|---|
| **From:** | Jody Smet |
| **To:** | Norman, Janet; Harrell, Jacob D; Heather Smiles; c-nwelte@pa.gov |
| **Cc:** | Dale Short; Robert Flickner; Michael Scarzello; Matthew Nini; Foster, Joyce |
| **Subject:** | [EXTERNAL] RE: Lake Lynn Relicensing – Revised Draft Mussel Survey Plan |
| **Date:** | Thursday, July 30, 2020 9:41:00 AM |
| **Attachments:** | image001.png |



All,

Comments were due on the revised mussel survey plan on 7/17. We received comments from WVDNR. We are working to finalize this study plan so that we are prepared to be in the field in late August / early September.

Thank you,

Jody J. Smet, AICP
Vice President Regulatory Affairs
Eagle Creek Renewable Energy

Please note my new email address – jody.smet@eaglecreekre.com

---

**From:** Jody Smet
**Sent:** Thursday, July 9, 2020 11:10 AM
**To:** Norman, Janet <janet_norman@fws.gov>; Harrell, Jacob D <Jacob.D.Harrell@wv.gov>; Heather Smiles <hsmiles@pa.gov>; c-nwelte@pa.gov
**Cc:** Dale Short <Dale.Short@eaglecreekre.com>; Robert Flickner <Robert.Flickner@eaglecreekre.com>; Michael Scarzello <Michael.Scarzello@eaglecreekre.com>; Matthew Nini <Matthew.Nini@eaglecreekre.com>; Foster, Joyce <JFoster@trccompanies.com>
**Subject:** Lake Lynn Relicensing – Revised Draft Mussel Survey Plan

All,

As follow-up to our call on May 20 discussing the draft Lake Lynn Mussel Survey Plan and review of the 1993 Lake Lynn Instream Flow Study Report, we have attached a revised draft Lake Lynn Mussel Survey Plan for your review. Please provide your comments on the revised Survey Plan by July 17.

Thank you,

**Jody J. Smet, AICP | Vice President Regulatory Affairs**
**Eagle Creek Renewable Energy**
Desk: 804 739 0654
Mobile: 804 382 1764
Email: jody.smet@eaglecreekre.com

| | |
|---|---|
| **From:** | Jody Smet |
| **To:** | Foster, Joyce |
| **Subject:** | FW: [External] RE: Lake Lynn Relicensing – Revised Draft Mussel Survey Plan - PFBC Comments |
| **Date:** | Monday, August 3, 2020 12:29:10 PM |
| **Attachments:** | image001.png |

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Jody J. Smet, AICP
Vice President Regulatory Affairs
Eagle Creek Renewable Energy

Please note my new email address – jody.smet@eaglecreekre.com

**From:** Smiles, Heather A <hsmiles@pa.gov>
**Sent:** Monday, August 3, 2020 11:35 AM
**To:** Jody Smet <Jody.Smet@eaglecreekre.com>
**Subject:** RE: [External] RE: Lake Lynn Relicensing – Revised Draft Mussel Survey Plan - PFBC Comments

Dear Jody,

Thanks for the opportunity to review the proposed study plan. While PFBC agrees with the proposed survey methodologies, we disagree with the limits of the study area being restricted to 1.02 miles downstream of the dam.

Per the study plan, the study area was restricted based upon the area of fluctuating water elevations, but wetted width of a river is but one component of regulated rivers that may have an adverse effect on freshwater mussel communities. Discharge water temperature is another critical component to the survival and persistence of a viable mussel community. Discharge temperatures are controlled by where water is being released from within the impoundment, and coldwater releases have a well-documented effect on freshwater mussel communities including limiting gametogenesis, growth, as well as altering the host fish community which affects mussel community composition. The Lake Lynn study limit should, at minimum, consider the entire length of the Cheat that has temperature affected by the discharge of the dam.

In lieu of a temperature study delimits the downstream thermal effects of the dam, a mussel study that focuses on potential mussel habitat from the dam downstream to its confluence with the Monongahela River would be appropriate to ascertain what species if any, occur in the Cheat River.

If such a survey effort results in the detection of no mussels or a limited community in the Cheat River then it would be a worthy biological objective of relicensing to try and mimic, to the extent practicable, the natural flow  and/or thermal regime as much as possible to maintain the river's restoration potential.

The proximity of the project to recent/known populations of state listed species (e.g., Snuffbox, Salamander Mussel, and Pistolgrip) approximately ~ 2.4 miles from the confluence of the Cheat and Monongahela River confluence suggests that it is a possibility that these species could occur in the Cheat, could disperse there in the future, and thus may be affected by Lake Lynn dam operations.

As you may know, the Cheat contained a diverse mussel fauna including the state and federal listed Clubshell (*Pleurobema clava*), a species undergoing a federal status assessment (SSA) (Longsolid, *Fusconaia subrotunda*), as well as two species that haven't been seen in Pennsylvania in over 100 years (Pimpleback, *Cyclonaias pustulosa* and Purple Wartyback, *C. tuberculata*). This Cheat River population was likely an extension of the Monongahela River population which was also quite diverse (e.g., Fanshell, *Cyprogenia stegaria*) until the effects of the steel and associated industries became too severe, before 1900. The Monongahela River, like the Ohio River (21 mussel species in PA), is a river in recovery since water quality improvements began in the 1970s.

Despite the effects of that industry, Dunkard Creek – a tributary to the Monongahela River just 2.4 miles downstream of the Cheat – was considered the crown jewel of the Monongahela River system until 2009, when a toxic event wiped that fauna out. Dunkard Creek harbored – as of 2009 – the state and federally endangered Snuffbox (*Epioblasma triquetra*), the state endangered Salamander Mussel (*Simpsonaias ambigua*, also undergoing a federal SSA), and the state endangered Pistolgrip (*Tritogonia verrucosa*). Numerous other species also occurred in Dunkard and PFBC and WVDNR are actively working to restore Dunkard with common mussels and via propagation and augmentation efforts. It's not unreasonable to suspect that glochidia-inoculated host fishes from Dunkard Creek were able to traverse the short distance to the Cheat River.
Although the Cheat River has not been examined recently to detect freshwater mussels it is possible that species have recolonized the Cheat in areas that contain suitable mussel habitat. A survey of the Pennsylvania stretch of the Cheat would entail a scouting trip to determine areas of potentially suitable habitat followed by a qualitative survey of these areas (similar to the Large Scoping Projects in the WV mussel protocol). Such an effort would be necessary to determine whether mussels are present and to determine, to some extent, what the effects of the existing management of Lake Lynn are having on the Cheat River downstream of the dam.

We look forward to reviewing a modified mussel survey plan.

**Heather A. Smiles** | Chief, Division of Environmental Services
PA Fish and Boat Commission
595 East Rolling Ridge Drive | Bellefonte, PA 16823
Phone: 814.359.5194
Email: hsmiles@pa.gov
www.fishandboat.com

---

**From:** Jody Smet <Jody.Smet@eaglecreekre.com>
**Sent:** Thursday, July 30, 2020 9:41 AM

**To:** Norman, Janet <janet_norman@fws.gov>; Harrell, Jacob D <Jacob.D.Harrell@wv.gov>; Smiles, Heather A <hsmiles@pa.gov>; Welte, Nevin <c-nwelte@pa.gov>
**Cc:** Dale Short <Dale.Short@eaglecreekre.com>; Robert Flickner <Robert.Flickner@eaglecreekre.com>; Michael Scarzello <Michael.Scarzello@eaglecreekre.com>; Matthew Nini <Matthew.Nini@eaglecreekre.com>; Foster, Joyce <JFoster@trccompanies.com>
**Subject:** [External] RE: Lake Lynn Relicensing – Revised Draft Mussel Survey Plan



All,

Comments were due on the revised mussel survey plan on 7/17. We received comments from WVDNR. We are working to finalize this study plan so that we are prepared to be in the field in late August / early September.

Thank you,

Jody J. Smet, AICP
Vice President Regulatory Affairs
Eagle Creek Renewable Energy

Please note my new email address – jody.smet@eaglecreekre.com

---

**From:** Jody Smet
**Sent:** Thursday, July 9, 2020 11:10 AM
**To:** Norman, Janet <janet_norman@fws.gov>; Harrell, Jacob D <Jacob.D.Harrell@wv.gov>; Heather Smiles <hsmiles@pa.gov>; c-nwelte@pa.gov
**Cc:** Dale Short <Dale.Short@eaglecreekre.com>; Robert Flickner <Robert.Flickner@eaglecreekre.com>; Michael Scarzello <Michael.Scarzello@eaglecreekre.com>; Matthew Nini <Matthew.Nini@eaglecreekre.com>; Foster, Joyce <JFoster@trccompanies.com>
**Subject:** Lake Lynn Relicensing – Revised Draft Mussel Survey Plan

All,

As follow-up to our call on May 20 discussing the draft Lake Lynn Mussel Survey Plan and review of the 1993 Lake Lynn Instream Flow Study Report, we have attached a revised draft Lake Lynn Mussel Survey Plan for your review. Please provide your comments on the revised Survey Plan by July 17.

Thank you,

---

**Jody J. Smet, AICP | Vice President Regulatory Affairs**
**Eagle Creek Renewable Energy**
Desk: 804 739 0654
Mobile: 804 382 1764
Email: jody.smet@eaglecreekre.com

| | |
|---|---|
| **From:** | Welte, Nevin |
| **To:** | Sarah Veselka |
| **Cc:** | Jacob.D.Harrell@wv.gov; Smiles, Heather A; Jody Smet; Foster, Joyce; Jakovljevic, Lindsey; Urban, Chris; Anderson, Robert M |
| **Subject:** | RE: [External] FW: Lake Lynn Survey Plan |
| **Date:** | Friday, September 11, 2020 9:29:47 AM |



Hi Sarah,

Thanks for sharing with us a revised study plan. PFBC concurs with the proposed survey methodology and extent of the study area. Please keep us posted on anticipated survey dates and we may join you in the field.

Thanks again and good luck with the survey,

Nevin

Nevin Welte
Malacologist/Nongame Biologist, Natural Diversity Section
Pennsylvania Fish & Boat Commission
Centre Region Office
595 E. Rolling Ridge Dr.
Bellefonte, PA 16823
c-nwelte@pa.gov

**From:** Sarah Veselka <sveselka@envirosciencеinc.com>
**Sent:** Thursday, September 10, 2020 5:10 PM
**To:** Welte, Nevin <c-nwelte@pa.gov>
**Cc:** Jacob.D.Harrell@wv.gov; Smiles, Heather A <hsmiles@pa.gov>; Jody.Smet@eaglecreekre.com; Foster, Joyce <JFoster@trccompanies.com>; Jakovljevic, Lindsey <LJakovljevic@trccompanies.com>; Urban, Chris <curban@pa.gov>; Anderson, Robert M <Robert_M_Anderson@fws.gov>
**Subject:** RE: [External] FW: Lake Lynn Survey Plan

Hi Nevin,

Thank you for your comments. Please find the requested revised survey plan attached here for your review.

Thank you,

Sarah

**Sarah Veselka**
**EnviroScienceInc.com**
**"Excellence in Any Environment"**

---

**From:** Welte, Nevin <c-nwelte@pa.gov>
**Sent:** Tuesday, September 8, 2020 8:51 AM
**To:** Sarah Veselka <sveselka@enviroscienceinc.com>; Sargent, Barbara D <Barbara.D.Sargent@wv.gov>
**Cc:** Jacob.D.Harrell@wv.gov; Smiles, Heather A <hsmiles@pa.gov>; Jody.Smet@eaglecreekre.com; Foster, Joyce <JFoster@trccompanies.com>; Jakovljevic, Lindsey <LJakovljevic@trccompanies.com>; Urban, Chris <curban@pa.gov>; Anderson, Robert M <Robert_M_Anderson@fws.gov>
**Subject:** RE: [External] FW: Lake Lynn Survey Plan

Hi Sarah,

Thanks for the email and the attached survey plan. While PFBC agrees with the proposed survey methods (i.e., "how to look for mussels") we continue to disagree with the extent of the study area (1.0 mile downstream of the project). The extent of the study area was not revised based upon recent PFBC comments submitted by Heather Smiles (email dated August 3, 2020) and no biological rationale was given for maintaining a limited study area. Any data collected from this limited study area will be continue to be insufficient data to answer the question of whether or not this dam or its operations have an effect on Pennsylvania's freshwater mussels. We continue to advise that the study scope be revised and extended to include the length of the Cheat River in Pennsylvania using the approach described in Heather's email (in quotes below).

"Although the Cheat River has not been examined recently to detect freshwater mussels it is possible
that species have recolonized the Cheat in areas that contain suitable mussel habitat. A survey of the Pennsylvania stretch of the Cheat would entail a scouting trip to determine areas of potentially suitable habitat followed by a qualitative survey of these areas (similar to the Large Scoping Projects in the WV mussel protocol). Such an effort would be necessary to determine whether mussels are present and to determine, to some extent, what the effects of the existing management of Lake Lynn are having on the Cheat River downstream of the dam."

We look forward to reviewing a revised study plan.

Thanks,

Nevin

Nevin Welte
Malacologist/Nongame Biologist, Natural Diversity Section
Pennsylvania Fish & Boat Commission
Centre Region Office

595 E. Rolling Ridge Dr.
Bellefonte, PA 16823
c-nwelte@pa.gov

---

**From:** Sarah Veselka <sveselka@enviroscienceinc.com>
**Sent:** Monday, September 7, 2020 4:19 PM
**To:** Welte, Nevin <c-nwelte@pa.gov>; Sargent, Barbara D <Barbara.D.Sargent@wv.gov>
**Cc:** Jacob.D.Harrell@wv.gov; Smiles, Heather A <hsmiles@pa.gov>; Jody.Smet@eaglecreekre.com; Foster, Joyce <JFoster@trccompanies.com>; Jakovljevic, Lindsey <LJakovljevic@trccompanies.com>
**Subject:** [External] FW: Lake Lynn Survey Plan



Hello Nevin and Barb,

On behalf of Lake Lynn Generation and TRC, please find the attached mussel survey plan for the Lake Lynn Hydroelectric Project for your review and approval. I will be acting as the WV/PA qualified malacologist for the Project.

Thank you,

Sarah

**Sarah Veselka**
**EnviroScienceInc.com**
**"Excellence in Any Environment"**

| | |
|---|---|
| **From:** | Sarah Veselka |
| **To:** | Foster, Joyce; Jakovljevic, Lindsey |
| **Subject:** | FW: [External] FW: Lake Lynn Survey Plan |
| **Date:** | Monday, September 14, 2020 9:22:59 AM |
| **Attachments:** | veselka_sAdd08.pdf |

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**Sarah Veselka**
**EnviroScienceInc.com**
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---

**From:** Sargent, Barbara D <Barbara.D.Sargent@wv.gov>
**Sent:** Wednesday, September 9, 2020 10:20 AM
**To:** Sarah Veselka <sveselka@enviroscienceinc.com>
**Cc:** Harrell, Jacob D <Jacob.D.Harrell@wv.gov>
**Subject:** RE: [External] FW: Lake Lynn Survey Plan

Hi Sarah—

I have attached your addenda for the Lake Lynn project. The Scope is approved only for the WV portion; we defer to PA for their portion.

b.

---

**From:** Sarah Veselka [mailto:sveselka@enviroscienceinc.com]
**Sent:** Monday, September 07, 2020 4:19 PM
**To:** Welte, Nevin; Sargent, Barbara D
**Cc:** Harrell, Jacob D; hsmiles@pa.gov; Jody.Smet@eaglecreekre.com; Foster, Joyce; Jakovljevic, Lindsey
**Subject:** [External] FW: Lake Lynn Survey Plan

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Thank you,

Sarah

**Sarah Veselka**
**EnviroScienceInc.com**
**"Excellence in Any Environment"**

**DIVISION OF NATURAL RESOURCES**
**Wildlife Resources Section**
**Elkins Operations Center**
**738 Ward Rd., PO Box 67**
**Elkins, WV 26241**
**Telephone 304-637-0245**
**Fax 304-637-0250**

**Stephen S. McDaniel**
**Director**

# ADDENDUM TO SCIENTIFIC COLLECTING PERMIT NO. 2020.111

Permittee: Sarah Veselka
Address: EnviroScience, Inc.
West Virginia – Appalachia Operations
129 Greenbag Road
Morgantown, WV 26501

Expiration Date: October 1, 2020

THE FOLLOWING PROVISIONS ARE ADDED TO THIS PERMIT: The Scope of Work is approved for the West Virginia portion of the project only. The WVDNR defers to the Pennsylvania Fish and Boat Commission for surveys conducted in their waters.

Mussel surveys are permitted in the Cheat River in Monongalia at the West Virginia – Pennsylvania state line (Lake Lynn Hydroelectric Relicensing)

**THIS ADDENDUM MUST BE ATTACHED TO ORIGINAL PERMIT.**

Must be signed before valid.

______________________________
Signature of permittee

______________________________ 9/9/2020
Scientific Collecting Permit Coordinator Date of Issue

| | |
|---|---|
| **From:** | Sarah Veselka |
| **To:** | Foster, Joyce; Jakovljevic, Lindsey |
| **Subject:** | FW: [External] FW: Lake Lynn Survey Plan |
| **Date:** | Monday, September 14, 2020 9:22:59 AM |
| **Attachments:** | veselka_sAdd08.pdf |

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**Sarah Veselka**
**EnviroScienceInc.com**
**"Excellence in Any Environment"**


---

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**Sent:** Wednesday, September 9, 2020 10:20 AM
**To:** Sarah Veselka <sveselka@enviroscienceinc.com>
**Cc:** Harrell, Jacob D <Jacob.D.Harrell@wv.gov>
**Subject:** RE: [External] FW: Lake Lynn Survey Plan

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b.

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**Sent:** Monday, September 07, 2020 4:19 PM
**To:** Welte, Nevin; Sargent, Barbara D
**Cc:** Harrell, Jacob D; hsmiles@pa.gov; Jody.Smet@eaglecreekre.com; Foster, Joyce; Jakovljevic, Lindsey
**Subject:** [External] FW: Lake Lynn Survey Plan

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Thank you,

Sarah

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**"Excellence in Any Environment"**

**DIVISION OF NATURAL RESOURCES**
**Wildlife Resources Section**
**Elkins Operations Center**
**738 Ward Rd., PO Box 67**
**Elkins, WV 26241**
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**Stephen S. McDaniel**
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**THIS ADDENDUM MUST BE ATTACHED TO ORIGINAL PERMIT.**

Must be signed before valid.

______________________________
Signature of permittee

______________________________ 9/9/2020
Scientific Collecting Permit Coordinator Date of Issue

TRC
50101 Governors Dr.
Suite 250
Chapel Hill, NC 27517
T 919.475.5507
TRCcompanies.com

26 October 2020

Ms. Susan Pierce (via email)
Deputy State Historic Preservation Officer
West Virginia Division of Culture and History
The Culture Center, Capitol Complex
1900 Kanawha Boulevard East
Charleston, West Virginia 25305-0300

Re: Lake Lynn Hydroelectric Relicensing Project, Monongalia County, West Virginia
Section 106 Review for Compliance

Dear Ms. Pierce:

The Lake Lynn Hydroelectric Project (Project) is an existing hydroelectric facility located on the Cheat River in Monongalia County, West Virginia and Fayette County, Pennsylvania, approximately 10 miles northeast of Morgantown, West Virginia and about 3.7 miles upstream of the confluence with the Monongahela River (Figure 1). The operator, Lake Lynn Generation, LLC (Lake Lynn) intends to file an application with the Federal Energy Regulatory Commission (FERC) for a new license for the Project (FERC No. 2459) using the Traditional Licensing Process (TLP). Following TLP requirements, Lake Lynn filed a Notice of Intent (NOI) and Pre-Application Document (PAD) with FERC on 29 August 2019, and the Director of the Division of Hydropower Licensing approved Lake Lynn's request to use the TLP on 17 October 2019. The current Project license was issued on December 27, 1994 and expires on November 30, 2024. Lake Lynn intends to complete and distribute the Draft License Application for the Project by 30 November 2021, and a final License Application is scheduled to be filed with FERC no later than 30 November 2022.

The Project consists of a concrete gravity-type dam and spillway controlled by 26 Tainter gates; a reservoir with a surface area of 1,700 acres; a log boom and trash racks at the intake facility; eight gated penstocks of reinforced concrete; a brick powerhouse containing four identical Francis generating units with a total rated capacity of 51.2 MW; dual 138-kV transmission lines; and appurtenant facilities (Figures 2–8). A turbine replacement and upgrade of Unit 2 was completed in 2018. The Project operates as a dispatchable peaking hydroelectric facility with storage capability, and no changes to Project facilities or operations are proposed. The proposed FERC Project Area of Potential Effects (APE) includes approximately 2,269.5 acres within West Virginia.

The NOI and PAD documents were sent to a distribution list comprised of federal and state agencies, tribes, local government representatives, non-governmental organizations (NGOs), and interested parties. Lake Lynn also published a newspaper announcement with information about the Project in *The Herald-Standard* and *The Dominion Post*. FERC provided Project details to the Delaware Nation, Oklahoma, the Delaware Tribe of Indians, and the Osage Nation on 27 June 2019 requesting a response by 2 August 2019 regarding their interest in the Project. As of 28 September 2020, FERC has not received any responses from that request. In addition, Lake Lynn sent Project details on 20 May 2019 to these and 16 additional Native American tribes (the Absentee-Shawnee Tribe of Oklahoma, the Seneca Nation of Indians, the Cayuga Nation, the Shawnee Tribe, the Cherokee Nation, the Stockbridge-Munsee Band of the Mohican Nation of Wisconsin, the Eastern Band of Cherokee Indians, the St. Regis Mohawk Tribe, the Eastern Shawnee Tribe of Oklahoma, the Tonawanda Band of Seneca, the Oneida Indian Nation, the Tuscarora Nation, the Oneida Indian Nation of Wisconsin, the United Keetoowah Band of Cherokee

Indians in Oklahoma, the Onondaga Nation, and the Seneca-Cayuga Tribe of Oklahoma) inviting participation in the relicensing process, Lake Lynn has received a response from one Native American tribe. The Cherokee Nation indicated that the Project was outside of its area of interest. Although no specific tribal interests have been identified, Lake Lynn and FERC will continue to communicate with the Native American tribes throughout the relicensing process. Lake Lynn also contacted the Bureau of Indian Affairs (BIA) and requested any information on tribal resources or tribal interests in the vicinity of the Project but has not received a response from the BIA regarding the Project. Lake Lynn is not aware that the Project affects any Native American tribal lands, tribal cultural sites, or tribal interests.

There is not a comprehensive Cultural Resources Management Plan (CRMP) for the Project, however, individual plans for cultural resources studies have been developed for SHPO review prior to any modifications involving ground disturbance following the stipulations in License Article 414. A Phase I archaeological survey was conducted for the proposed development of Cheat Lake Park and the Cheat Lake Trail and reported on 26 April 1996 and additional survey was conducted for that project and reported on 13 April 1998; both studies were conducted by Christine Davis Consultants, Inc. (90-148-MG). A letter dated 26 May 1998 from your office stated that the proposed Cheat Lake Trail would have no effect on any historic properties at the Project and that no further archaeological investigation was required for that project. Additional review was requested from your office by letter on 28 April 2020 regarding proposed repair for a small section of the Cheat Lake South Trail that was washed out during heavy rains in 2019. A response from your office issued on 8 May 2020 indicated that the proposed project would have no effect on NRHP eligible or potentially eligible resources and that no further cultural resources studies would be necessary for that project.

Several cultural resources are documented within the APE and several are located just outside the APE. The Phase I survey for the Cheat Lake Park and the Cheat Lake Trail identified nineteenth and twentieth century foundations (46MG214), six millstones (46MG212), a coal tipple (46MG211), and the Cheat Haven & Bruceton Railroad bed (46MG213), all within the APE. Also within the APE, the early twentieth century Ices Ferry Bridge (MG-0052) spans Cheat Lake southwest of Lake Lynn. The early twentieth century Lake Lynn powerhouse and dam have not been formally documented but are located within the APE in West Virginia. A survey conducted for the proposed Falling Water Development Project to the east of the APE identified two prehistoric isolated finds (46MG253 and 46MG254). Two other archaeological sites are recorded outside but in some proximity to the APE—46MG83 and 46MG84, both prehistoric rockshelter sites recorded in 1985.

Lake Lynn Hydro LLC respectively requests your participation in this process as we collaborate with the FERC and other state, federal, and tribal agencies to identify and resolve any cultural resources issues related to this Project. We look forward to hearing from you at your earliest convenience. Please do not hesitate to contact me at (919) 475-5507 or hmillis@trccompanies.com should you have any questions concerning this letter or the project.

Sincerely,

Heather Millis

Heather Millis
Office Practice Leader, Cultural Resources

cc: Jody Smet, Lake Lynn Generation
Joyce Foster, TRC Environmental Corporation

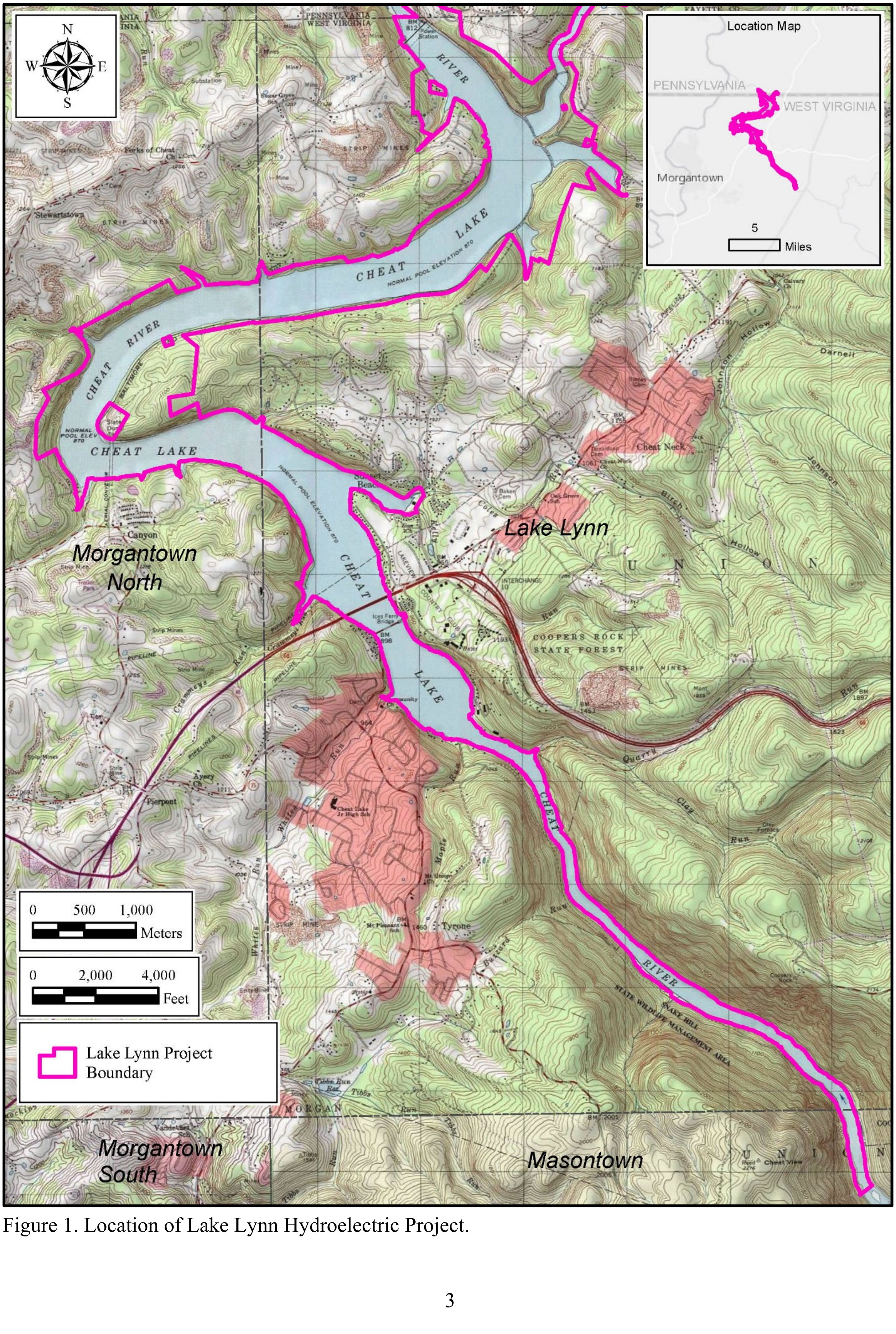


Figure 1. Location of Lake Lynn Hydroelectric Project.

Figure 2. View of Powerhouse and Dam at Lake Lynn Hydroelectric Project.

Figure 3. View of Powerhouse and Dam at Lake Lynn Hydroelectric Project.

Figure 4. View of Dam at Lake Lynn Hydroelectric Project.

Figure 5. View of Powerhouse at Lake Lynn Hydroelectric Project.

Figure 6. View of Interior of Powerhouse at Lake Lynn Hydroelectric Project.

Figure 7. View of Tailrace Fishing Pier at Lake Lynn Hydroelectric Project.


Figure 8. View of Sluice at Lake Lynn Hydroelectric Project.

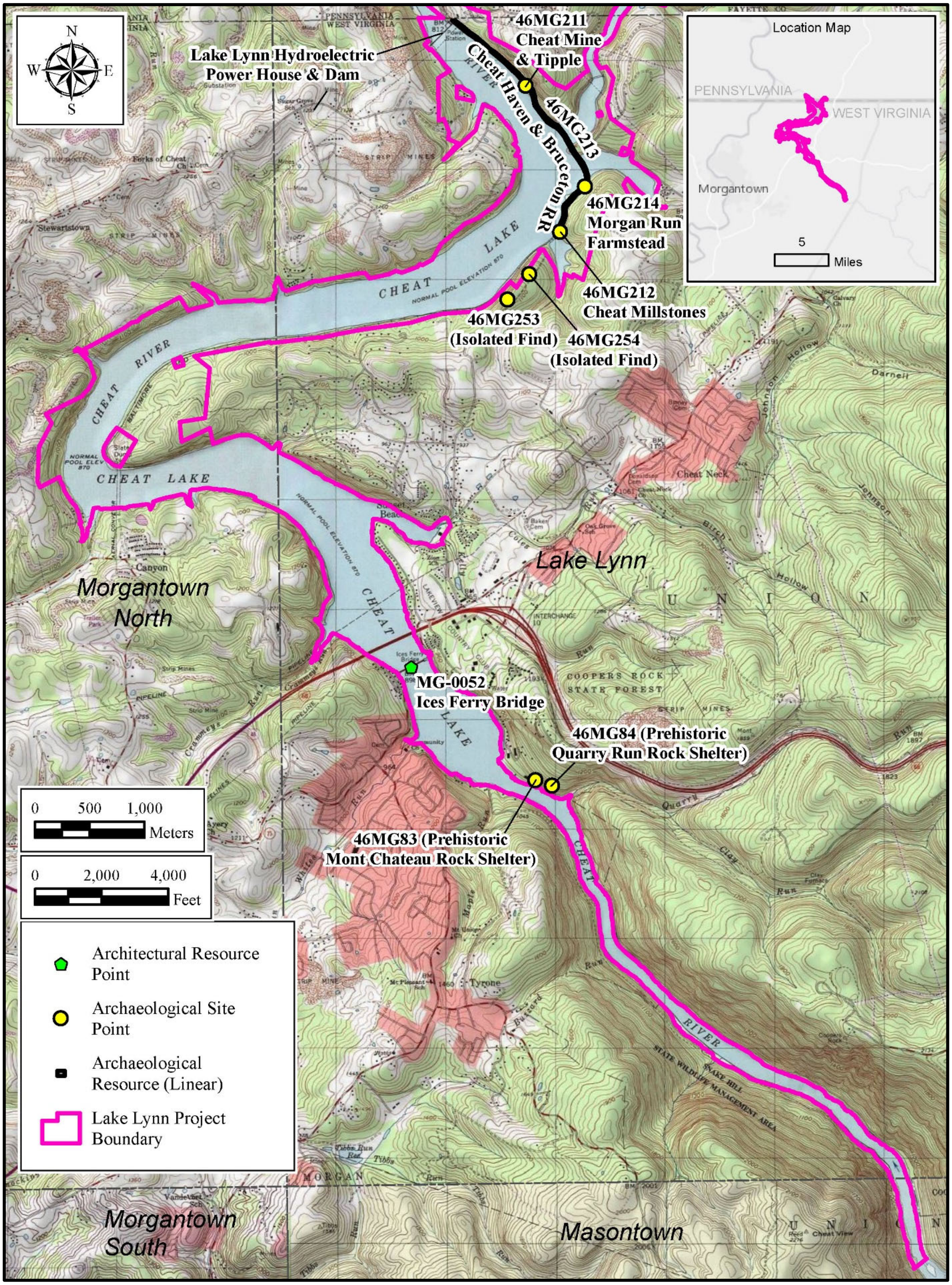

Figure 9. Location of Lake Lynn Hydroelectric Project Showing Nearby Cultural Resources.

Lake Lynn Hydroelectric Relicensing Project, Fayette County, Pennsylvania
Section 106 Review for Compliance

The Lake Lynn Hydroelectric Project (Project) is an existing hydroelectric facility located on the Cheat River in Monongalia County, West Virginia and Fayette County, Pennsylvania, approximately 10 miles northeast of Morgantown, West Virginia and about 3.7 miles upstream of the confluence with the Monongahela River (Figure 1). The operator, Lake Lynn Generation, LLC (Lake Lynn) intends to file an application with the Federal Energy Regulatory Commission (FERC) for a new license for the Project (FERC No. 2459) using the Traditional Licensing Process (TLP). Following TLP requirements, Lake Lynn filed a Notice of Intent (NOI) and Pre-Application Document (PAD) with FERC on 29 August 2019, and the Director of the Division of Hydropower Licensing approved Lake Lynn's request to use the TLP on 17 October 2019. The current Project license was issued on December 27, 1994 and expires on November 30, 2024. Lake Lynn intends to complete and distribute the Draft License Application for the Project by 30 November 2021, and a final License Application is scheduled to be filed with FERC no later than 30 November 2022.

The Project consists of a concrete gravity-type dam and spillway controlled by 26 Tainter gates; a reservoir with a surface area of 1,700 acres; a log boom and trash racks at the intake facility; eight gated penstocks of reinforced concrete; a brick powerhouse containing four identical Francis generating units with a total rated capacity of 51.2 MW; dual 138-kV transmission lines; and appurtenant facilities (Figures 2–8). A turbine replacement and upgrade of Unit 2 was completed in 2018. The Project operates as a dispatchable peaking hydroelectric facility with storage capability, and no changes to Project facilities or operations are proposed. The proposed FERC Project Area of Potential Effects (APE) includes approximately 39.7 acres within Pennsylvania.

The NOI and PAD documents were sent to a distribution list comprised of federal and state agencies, tribes, local government representatives, non-governmental organizations (NGOs), and interested parties. Lake Lynn also published a newspaper announcement with information about the Project in *The Herald-Standard* and *The Dominion Post*. FERC provided Project details to the Delaware Nation, Oklahoma, the Delaware Tribe of Indians, and the Osage Nation on 27 June 2019 requesting a response by 2 August 2019 regarding their interest in the Project. As of 28 September 2020, FERC has not received any responses from that request. In addition, Lake Lynn sent Project details on 20 May 2019 to these and 16 additional Native American tribes (the Absentee-Shawnee Tribe of Oklahoma, the Seneca Nation of Indians, the Cayuga Nation, the Shawnee Tribe, the Cherokee Nation, the Stockbridge-Munsee Band of the Mohican Nation of Wisconsin, the Eastern Band of Cherokee Indians, the St. Regis Mohawk Tribe, the Eastern Shawnee Tribe of Oklahoma, the Tonawanda Band of Seneca, the Oneida Indian Nation, the Tuscarora Nation, the Oneida Indian Nation of Wisconsin, the United Keetoowah Band of Cherokee Indians in Oklahoma, the Onondaga Nation, and the Seneca-Cayuga Tribe of Oklahoma) inviting participation in the relicensing process, Lake Lynn has received a response from one Native American tribe. The Cherokee Nation indicated that the Project was outside of its area of interest. Although no specific tribal interests have been identified, Lake Lynn and FERC will continue to communicate with the Native American tribes throughout the relicensing process. Lake Lynn also contacted the Bureau of Indian Affairs (BIA) and requested any information on tribal resources or tribal interests in the vicinity of the Project but has not received a response from the BIA regarding the Project. Lake Lynn is not aware that the Project affects any Native American tribal lands, tribal cultural sites, or tribal interests.

There is not a comprehensive Cultural Resources Management Plan (CRMP) for the Project, however, individual plans for cultural resources studies have been developed for SHPO review prior to any modifications involving ground disturbance following the stipulations in License Article 414.

Several cultural resources are documented within the APE and several are located just outside the APE (Figure 2). Resources within or partially within the APE include the Fairmont, Morgantown & Pittsburgh Railroad (097804), the Catawba Path (210394), Bridge No. 1 (133794), and archaeological site 36FA0073. The mapped boundary of the Lake Lynn Dam Penn Hill Housing property (101383) extends into the APE, although all of the resources appear to be located outside the APE to the north. A portion of the Lake Lynn Historic District (105909) is located outside the APE to the northeast. The Fairmont, Morgantown & Pittsburg Railroad, constructed in the late nineteenth century, has been determined eligible for the National Register of Historic Places (NRHP) by the PHMC. Bridge No. 1 was constructed in 1949 and has been determined not eligible for the NRHP. The Catawba Path is part of a Native American footpath system that ran from New York to the Carolinas that was documented by Paul Wallace in his 1965 publication Indian Paths of Pennsylvania. This resource is unevaluated for NRHP eligibility. Site 36FA0073 is a prehistoric site dating to an unknown time period that was recorded in 1964 and is unevaluated for NRHP eligibility.

Lake Lynn Hydro LLC respectively requests your participation in this process as we collaborate with the FERC and other state, federal, and tribal agencies to identify and resolve any cultural resources issues related to this Project. We look forward to hearing from you at your earliest convenience. Please do not hesitate to contact me at (919) 475-5507 or hmillis@trccompanies.com should you have any questions concerning this letter or the project.

Sincerely,

Heather Millis

Heather Millis
Office Practice Leader, Cultural Resources

cc: Jody Smet, Lake Lynn Generation
Joyce Foster, TRC Environmental Corporation

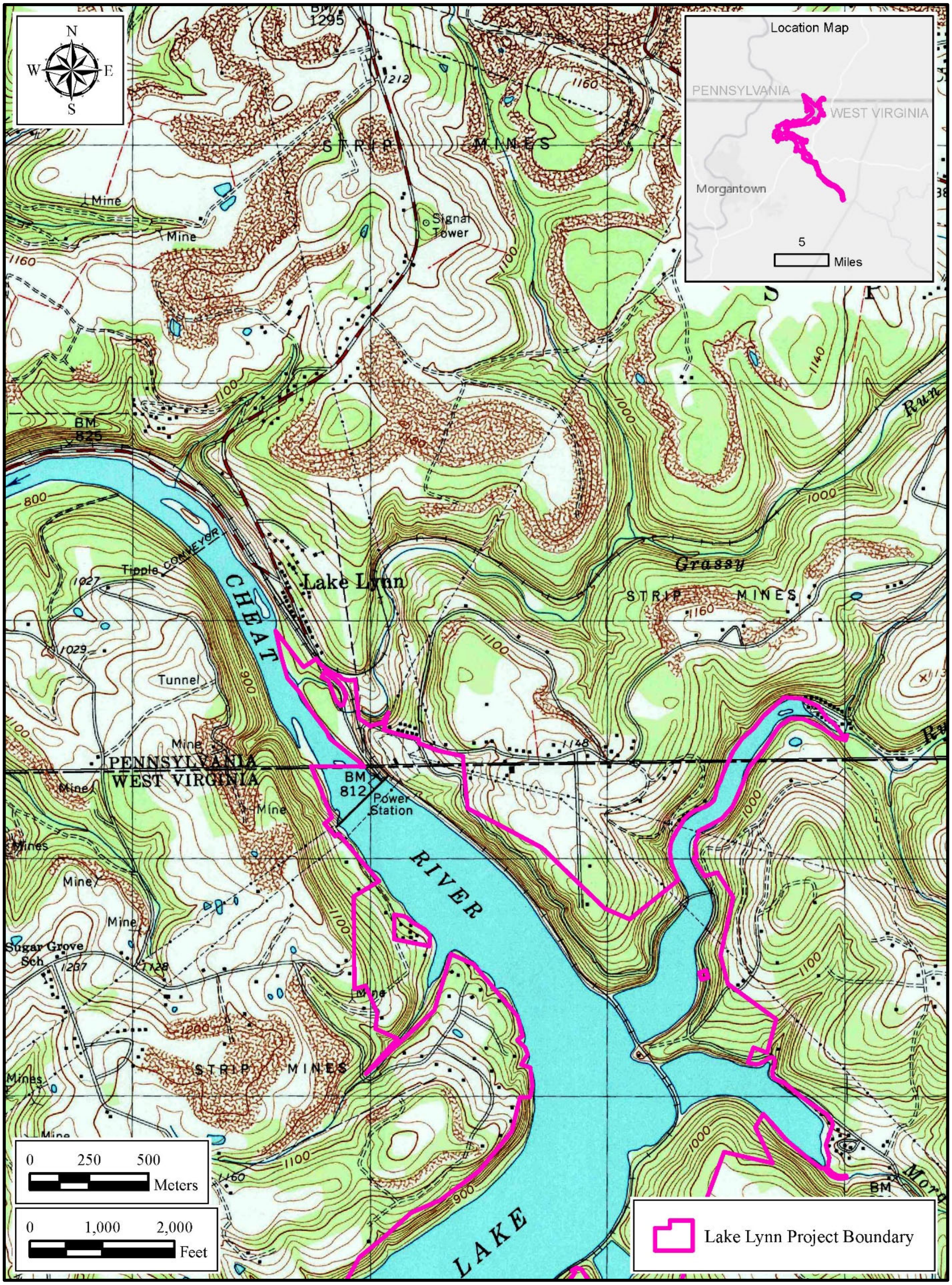


Figure 1. Location of Lake Lynn Hydroelectric Project in Pennsylvania.

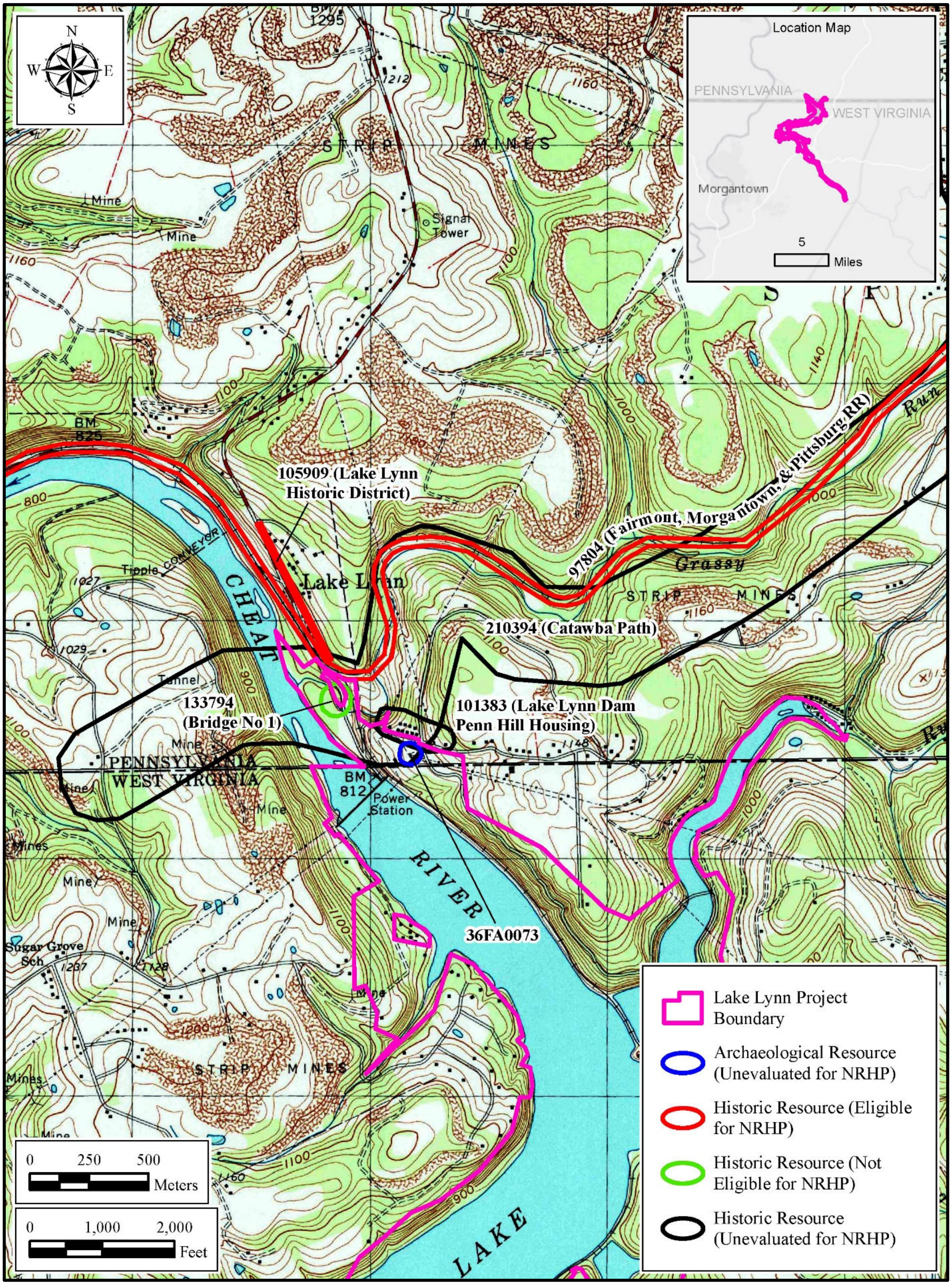


Figure 2. Location of Lake Lynn Hydroelectric Project in Pennsylvania Showing Nearby Cultural Resources.

## Joyce Foster

**From:** Joyce Foster
**Sent:** Friday, January 29, 2021 4:32 PM
**To:** janet_norman@fws.gov; Megan.K.Gottlieb@usace.army.mil; sean.mcdermott@noaa.gov; Kevin_Mendik@nps.gov; clschref@usgs.gov; smwickle@usgs.gov; Jacob.D.Harrell@wv.gov; Danny.A.Bennett@wv.gov; coopersrocksf@wv.gov; Brian.L.Bridgewater@wv.gov; susan.m.pierce@wv.gov; dadrake@pa.gov; peiswerth@pa.gov; hsmiles@pa.gov; olbraun@pa.gov; chnagle@pa.gov; agastbray@moncommission.com; dr.hawk@comcast.net; rmcclure@moncommission.com; vvicites@fayettepa.org; harold.peterson@bia.gov; clint.halftown@gmail.com; ec@delawarenation.com; cbrooks@delawaretribe.org; info@oneida-nation.org; admin@onondaganation.org; wfisher@sctribe.com; cassie@shawnee-tribe.com; tonseneca@aol.com; 106NAGPRA@astribe.com; ethompson@delawarenation-nsn.gov; dkelly@delawarenation.com; sbachor@delawaretribe.org; bbarnes@estoo.net; jbergevin@oneida-nation.org; lmisita@oneida-nation.org; jay.toth@sni.org; wtarrant@sctribe.com; tonya@shawnee-tribe.com; darren.bonaparte@srmt-nsn.gov; bprintup@hetf.org; duane330@aol.com; mstrager@gmail.com; ella@montrails.org; amanda@cheat.org; owen@cheat.org; betty.w304@gmail.com; fjernejcic@comcast.net; greystone.poa@hotmail.com; dgriff66@aol.com; seangoodwin@yahoo.com; graceandparke@yahoo.com; kevin@americanwhitewater.org; birvin@americanrivers.org; smoyer@tu.org; colleen@hydroreform.org; grichardson@cheat.org; DMiller@potesta.com; info@sunsetbeach-marina.com; swelsh@wvu.edu; edgewater@cheatlakedocks.com; stratdouglas@gmail.com; KCampitell@oxforddevelopment.com; shall@jccpgh.org; awagner1595 @gmail.com; chestermcgraw@gmail.com; donnaweems@rocketmail.com; davecyndy@frontier.com; szybarnes@yahoo.com; mlutman@comcast.net; Reecejames98@gmail.com; qtrking86@yahoo.com; rogerdalephillips@gmail.com; scalvert@greenrivergroupllc.com; whm0005@mix.wvu.edu; jkotcon@gmail.com
**Cc:** Jody Smet
**Subject:** Lake Lynn Hydro Project (FERC No. 2459) - Draft Study Report for Review
**Attachments:** Lake Lynn_P-2459_Draft Entrainment Report.pdf

Dear Stakeholder:

Lake Lynn Generation, LLC (Lake Lynn), a subsidiary of Eagle Creek Renewable Energy, is the owner and operator of the Lake Lynn Hydroelectric Project (FERC No. 2459) located on the Cheat River in Monongalia County , WV and Fayette County, PA. The existing Federal Energy Regulatory Commission (FERC) license for the Project expires November 30, 2024. Lake Lynn is providing a draft fish entrainment report for review and comment that was developed kin accordance with the final Study Plan that was provided to you in July of last year.

Please provide any written comments within 30 days. If you have any questions, please contact me at 804-338-5110 or joyce.foster@eaglecreekre.com.

___

**Joyce A. Foster | Director, Licensing and Compliance**
**Eagle Creek Renewable Energy**
Mobile: 804 338 5110
Email: joyce.foster@eaglecreekre.com

EAGLE CREEK
— RENEWABLE ENERGY —

**Joyce Foster**

---

**From:** Joyce Foster
**Sent:** Friday, January 29, 2021 5:02 PM
**To:** janet_norman@fws.gov; Megan.K.Gottlieb@usace.army.mil; sean.mcdermott@noaa.gov; Kevin_Mendik@nps.gov; clschref@usgs.gov; smwickle@usgs.gov; Jacob.D.Harrell@wv.gov; Danny.A.Bennett@wv.gov; coopersrocksf@wv.gov; Brian.L.Bridgewater@wv.gov; susan.m.pierce@wv.gov; dadrake@pa.gov; peiswerth@pa.gov; hsmiles@pa.gov; olbraun@pa.gov; chnagle@pa.gov; agastbray@moncommission.com; dr.hawk@comcast.net; rmcclure@moncommission.com; vvicites@fayettepa.org; harold.peterson@bia.gov; clint.halftown@gmail.com; ec@delawarenation.com; cbrooks@delawaretribe.org; info@oneida-nation.org; admin@onondaganation.org; wfisher@sctribe.com; cassie@shawnee-tribe.com; tonseneca@aol.com; 106NAGPRA@astribe.com; ethompson@delawarenation-nsn.gov; dkelly@delawarenation.com; sbachor@delawaretribe.org; bbarnes@estoo.net; jbergevin@oneida-nation.org; lmisita@oneida-nation.org; jay.toth@sni.org; wtarrant@sctribe.com; tonya@shawnee-tribe.com; darren.bonaparte@srmt-nsn.gov; bprintup@hetf.org; duane330@aol.com; mstrager@gmail.com; ella@montrails.org; amanda@cheat.org; owen@cheat.org; betty.w304@gmail.com; fjernejcic@comcast.net; greystone.poa@hotmail.com; dgriff66@aol.com; seangoodwin@yahoo.com; graceandparke@yahoo.com; kevin@americanwhitewater.org; birvin@americanrivers.org; smoyer@tu.org; colleen@hydroreform.org; grichardson@cheat.org; DMiller@potesta.com; info@sunsetbeach-marina.com; swelsh@wvu.edu; edgewater@cheatlakedocks.com; stratdouglas@gmail.com; KCampitell@oxforddevelopment.com; shall@jccpgh.org; awagner1595@gmail.com; chestermcgraw@gmail.com; donnaweems@rocketmail.com; davecyndy@frontier.com; szybarnes@yahoo.com; mlutman@comcast.net; Reecejames98@gmail.com; qtrking86@yahoo.com; rogerdalephillips@gmail.com; scalvert@greenrivergroupllc.com; whm0005@mix.wvu.edu; jkotcon@gmail.com
**Cc:** Jody Smet
**Subject:** Lake Lynn Hydro Project (FERC No. 2459) - Draft Study Report for Review
**Attachments:** Lake Lynn_P-2459_Draft Mussel Survey Report.pdf

Dear Stakeholder:

Lake Lynn Generation, LLC (Lake Lynn), a subsidiary of Eagle Creek Renewable Energy, is the owner and operator of the Lake Lynn Hydroelectric Project (FERC No. 2459) located on the Cheat River in Monongalia County , WV and Fayette County, PA. The existing Federal Energy Regulatory Commission (FERC) license for the Project expires November 30, 2024. Lake Lynn is providing a draft mussel survey report for review and comment that was developed in accordance with the final Study Plan that was provided to you in July of last year.

Please provide any written comments within 30 days. If you have any questions, please contact me at 804-338-5110 or joyce.foster@eaglecreekre.com.

---

**Joyce A. Foster | Director, Licensing and Compliance**
**Eagle Creek Renewable Energy**
Mobile: 804 338 5110
Email: joyce.foster@eaglecreekre.com

EAGLE CREEK
— RENEWABLE ENERGY —

# Joyce Foster

**From:** Joyce Foster
**Sent:** Friday, July 30, 2021 3:58 PM
**To:** janet_norman@fws.gov; Megan.K.Gottlieb@usace.army.mil; sean.mcdermott@noaa.gov; Kevin_Mendik@nps.gov; clschref@usgs.gov; smwickle@usgs.gov; Jacob.D.Harrell@wv.gov; Danny.A.Bennett@wv.gov; coopersrocksf@wv.gov; Brian.L.Bridgewater@wv.gov; susan.m.pierce@wv.gov; dadrake@pa.gov; peiswerth@pa.gov; hsmiles@pa.gov; olbraun@pa.gov; chnagle@pa.gov; agastbray@moncommission.com; dr.hawk@comcast.net; rmcclure@moncommission.com; vvicites@fayettepa.org; harold.peterson@bia.gov; clint.halftown@gmail.com; ec@delawarenation.com; cbrooks@delawaretribe.org; info@oneida-nation.org; admin@onondaganation.org; wfisher@sctribe.com; cassie@shawnee-tribe.com; tonseneca@aol.com; 106NAGPRA@astribe.com; ethompson@delawarenation-nsn.gov; dkelly@delawarenation.com; sbachor@delawaretribe.org; bbarnes@estoo.net; jbergevin@oneida-nation.org; lmisita@oneida-nation.org; jay.toth@sni.org; wtarrant@sctribe.com; tonya@shawnee-tribe.com; darren.bonaparte@srmt-nsn.gov; bprintup@hetf.org; duane330@aol.com; mstrager@gmail.com; ella@montrails.org; amanda@cheat.org; owen@cheat.org; betty.w304@gmail.com; fjernejcic@comcast.net; greystone.poa@hotmail.com; dgriff66@aol.com; seangoodwin@yahoo.com; graceandparke@yahoo.com; kevin@americanwhitewater.org; birvin@americanrivers.org; smoyer@tu.org; colleen@hydroreform.org; grichardson@cheat.org; DMiller@potesta.com; info@sunsetbeach-marina.com; swelsh@wvu.edu; edgewater@cheatlakedocks.com; stratdouglas@gmail.com; KCampitell@oxforddevelopment.com; shall@jccpgh.org; awagner1595 @gmail.com; chestermcgraw@gmail.com; donnaweems@rocketmail.com; davecyndy@frontier.com; szybarnes@yahoo.com; mlutman@comcast.net; Reecejames98@gmail.com; qtrking86@yahoo.com; rogerdalephillips@gmail.com; scalvert@greenrivergroupllc.com; whm0005@mix.wvu.edu; jkotcon@gmail.com
**Cc:** Jody Smet
**Subject:** Lake Lynn Hydro Project (FERC No. 2459) - Draft Study Report for Review
**Attachments:** Lake Lynn_P-2459_Draft Recreation Assessment Report.pdf

Dear Stakeholder:

Lake Lynn Generation, LLC (Lake Lynn), an affiliate subsidiary of Eagle Creek Renewable Energy, is the owner and operator of the Lake Lynn Hydroelectric Project (FERC No. 2459) located on the Cheat River in Monongalia County , WV and Fayette County, PA. The existing Federal Energy Regulatory Commission (FERC) license for the Project expires November 30, 2024. Lake Lynn is providing a draft ǈŜŎǈŜl·ŰƛƨƴǇ l·ăăŜăăƳŜƴŰ report for review and comment that was developed in accordance with the final Study Plan that was provided to you in July of last year. !ă l· ǈŜƳƛƴŘŜǈΣ ǿŜ ǇǈƨǿƛŘŜŘ Űǿƨ ƨŰKŜǈ Řǈl·ŦŰ ăŰdzŘè ǈŜǇƨǈŰă Ŧƨǈ ǈŜǿƛŜǿ l·ƴŘ ŎƨƳƳŜƴŰ ƨƴ Wl·ƴdzl·ǈè нфΣ нлнмΦ

Please provide any written comments within 30 days. If you have any questions, please contact me at 804-338-5110 or joyce.foster@eaglecreekre.com.

______________________________________________________________________

**Joyce A. Foster | Director, Licensing and Compliance**
**Eagle Creek Renewable Energy**
Mobile: 804 338 5110
Email: joyce.foster@eaglecreekre.com

EAGLE CREEK
— RENEWABLE ENERGY —

**Lake Lynn Generation, LLC**
c/o Eagle Creek Renewable Energy, LLC
7315 Wisconsin Avenue, Suite 1100W
Bethesda, Maryland 20814
240.482.2700

August 5, 2022

VIA E-FILING

Honorable Kimberly D. Bose, Secretary
Federal Energy Regulatory Commission
888 First Street, N.E.
Washington, D.C. 20426

Subject: Lake Lynn Hydroelectric Project (FERC No. P-2459)
Draft License Application

Dear Secretary Bose:

Lake Lynn Generation, LLC (Lake Lynn or Licensee), a subsidiary of Eagle Creek Renewable Energy, LLC (Eagle Creek), is the licensee and operator of the Lake Lynn Hydroelectric Project (Lake Lynn Project). The Lake Lynn Project is on the Cheat River, in Monongalia County, West Virginia, near the city of Morgantown, and in Fayette County, Pennsylvania, near the borough of Point Marion. The existing FERC license for the Lake Lynn Project expires on November 30, 2024. Lake Lynn intends to file an application for a new license with FERC on or before November 30, 2022. Lake Lynn filed a Notice of Intent to File a License Application (NOI), the Pre-Application Document (PAD), and a request to use the Traditional Licensing Process (TLP) for the Lake Lynn Project on August 29, 2019. FERC approved the Licensee's request to use the TLP on October 17, 2019.

In accordance with 18 CFR § §16.8(c)(4), Lake Lynn respectfully submits the Draft License Application (DLA) for filing with FERC. The DLA consists of the following draft technical exhibits and environmental report:

- Initial Statement;
- Exhibit A - Project Description;
- Exhibit B - Project Operation and Resource Utilization;
- Exhibit C - Construction History;
- Exhibit D - Statement of Cost and Financing;
- Exhibit E - Environmental Report;
- Exhibit F - General Design Drawings (Exhibit F to be filed with the FLA with FERC only as CEII under a separate cover);
- Exhibit G - Project Maps; and

- Exhibit H - Description of Project Management and Need for Project Power (Single Line Diagram filed as CEII).

Lake Lynn is providing electronic copies of the DLA to relevant resource agencies, tribes, non-governmental organizations, and other potential interested parties included on the attached distribution list. An electronic copy of the DLA can be downloaded from FERC's eLibrary system (https://elibrary.ferc.gov/eLibrary/search) by searching under docket number P-2459. The primary relicensing documents can also be downloaded from the Lake Lynn Project Relicensing website at: https://cheatlake.today/relicensing/.

Exhibit E discusses the results of the studies conducted in support of the relicensing and considers how the information and data collected during the studies address the issues that were raised by agencies and other relicensing participants, and how that data addresses the Licensee's proposal. In support of the proposed relicensing, Exhibit E evaluates the potential effects on environmental, recreational, and cultural resources that may occur as a result of continued Lake Lynn Project operation under a new license. As appropriate, Exhibit E includes the Licensee's preliminary proposals for the protection and mitigation of effects on, or enhancements to, resources that are associated with the continued operation of the Lake Lynn Project.

Certain information within the DLA, such as portions of Exhibit D and Exhibit H and Exhibit F, are still under development and will be filed with the Final License Application (FLA); the FLA filing date is November 30, 2022. In accordance with FERC regulations 18 CFR§16.8 (c)(4)(5), participants and Commission staff may submit comments to the Licensee regarding the DLA within 90 days following this filing, i.e., by November 3, 2022.

If you have any questions or require any additional information, please contact me at (804) 338-5110 or via e-mail at joyce.foster@eaglecreekre.com.

Sincerely,

Joyce Foster

Joyce Foster
Director, Licensing and Compliance

Attachment: Draft License Application for the Lake Lynn Hydroelectric Project

cc: Distribution List

**Lake Lynn Generation, LLC**
**Lake Lynn Project (P-2459)**
**Distribution List (updated June 2022)**

## ELECTED OFFICIALS

Governor Jim Justice
West Virginia Office of the Governor
State Capitol
1900 Kanawha Blvd. E
Charleston, WV 25305

Patrick Morrisey
West Virginia Office of the Attorney General
State Capitol Complex, Bldg. 1, Room E-26
Charleston, WV 25305

The Honorable Joe Manchin III
United States Senate
306 Hart Senate Office Building
Washington D.C. 20510

The Honorable Shelley Capito
United States Senate
172 Russell Senate Office Building
Washington, DC 20510

The Honorable David McKinley
United States House of Representatives
2239 Rayburn HOB
Washington, DC 20515

Governor Tom Wolf
Commonwealth of Pennsylvania
Office of the Governor
508 Main Capitol Building
Harrisburg, PA 17120

Josh Shapiro
Pennsylvania Office of the Attorney General
16th Floor, Strawberry Square
Harrisburg, PA 17120

The Honorable Pat Toomey
United States Senate
248 Russell Senate Office Building
Washington, DC 20510

The Honorable Bob Casey
United States Senate
393 Russell Senate Office Building
Washington, DC 20510

The Honorable Guy Reschenthaler
United States House of Representatives
531 Cannon House Office Building
Washington, DC 20515

## FEDERAL AGENCIES

Richard McCorkle
U.S. Fish and Wildlife Service
Pennsylvania Field Office
110 Radnor Road, Ste 101
State College, PA 16801
richard_mccorkle@fws.gov

Megan Gottlieb, P.E.
Water Management Unit
U.S. Army Corps of Engineers
Pittsburgh District
2200 William S. Moorhead Federal Building
1000 Liberty Avenue
Pittsburgh, PA 15222-4186
Megan.K.Gottlieb@usace.army.mil

Sean McDermott
Regional Hydropower Coordinator
National Marine Fisheries Service
Northeast Regional Office
1 Blackburn Dr.
Gloucester, MA 01930-2298
sean.mcdermott@noaa.gov

Kevin Mendik
Hydropower Program Coordinator
National Park Service
15 State St, Floor 10
Boston, MA 02109-3502
Kevin_Mendik@nps.gov

Cosmo Servidio
Region 3 Administrator
US Environmental Protection Agency
1650 Arch Street
Philadelphia, PA 19103-2029

Curtis Schreffler
Associate Director, Northeast Region
US Geological Survey
Pennsylvania Water Science Center
215 Limekiln Road
New Cumberland, PA 17070
clschref@usgs.gov

Shaun Wicklein
Virginia and West Virginia Water Science Center
US Geological Survey
1730 East Parham Road
Richmond, VA 23228
smwickle@usgs.gov

Director
Federal Emergency Management Agency
500 C Street, SW
Washington, DC 20472

**STATE**

Jacob Harrell
Wildlife Resources Section Coordination Unit
West Virginia Division of Natural Resources
Elkins Operations Center
PO Box 67
Elkins, WV 26241
Jacob.D.Harrell@wv.gov

Danny Bennett
West Virginia Division of Natural Resources
Elkins Operations Center
PO Box 67
Elkins, WV 26241
Danny.A.Bennett@wv.gov

David Wellman
Fisheries Management
West Virginia Division of Natural Resources
James Plaza 1110 Railroad St.
Farmington, WV 26571-0099
David.I.Wellman@wv.gov

Coopers Rock State Forest
61 County Line Dr.
Bruceton Mills, WV, 26525
coopersrocksf@wv.gov

Brian Bridgewater
West Virginia Department of Environmental Protection
Division of Water and Waste Management
601 57th Street, SE
Charleston, WV 25304
Brian.L.Bridgewater@wv.gov

Susan Pierce
Director and_Deputy State Historic Preservation Officer
West Virginia Division of Culture and History
1900 Kanawha Boulevard East
Charleston, WV 25305
susan.m.pierce@wv.gov

Ronald Schwartz
Regional Director, Southwest Regional Office
Pennsylvania Department of Environmental Protection
400 Waterfront Drive
Pittsburgh, PA 15222-4745

Dana Drake, P.E.
Program Manager, Waterways and Wetlands Program
PA Dept. of Environmental Protection
Southwest Regional Office
400 Waterfront Drive
Pittsburgh, PA 15222
dadrake@pa.gov

Paul Eiswerth
PA Dept. of Environmental Protection
peiswerth@pa.gov

Secretary Cindy Adams Dunn
Pennsylvania Department of Conservation and Natural Resources
Rachel Carson State Office Building
400 Market Street
Harrisburg, PA 17105

Heather Smiles
Chief, Division of Environmental Services
Pennsylvania Fish and Boat Commission
595 East Rolling Ridge Drive,
Bellefonte, PA 16823
hsmiles@pa.gov

Olivia Braun
Pennsylvania Game Commission
2001 Elmerton Avenue
Harrisburg, PA 17110
olbraun@pa.gov

Cheryl Nagle
PA Historical and Museum Commission
State Historic Preservation Office
Commonwealth Keystone Building, Second Floor
400 North Street
Harrisburg, PA 17120-0093
chnagle@pa.gov

**MUNICIPAL**

Andrew Gast-Bray, Ph.D, AICP, CNU-A
Director of Planning
Monongalia County Planning Commission
243 High Street, Courthouse Rm. 110
Morgantown, WV 26505
agastbray@moncommission.com

Edward Alan Hawkins
Monongalia County Planning Commission
dr.hawk@comcast.net

Rennetta McClure
County Administrator
Monongalia County Commission
243 High Street, Room 202
Morgantown, WV 26505
rmcclure@moncommission.com

Vincent Vicites
Chairman, County Commissioner
Fayette County, PA
61 East Main Street
Uniontown, PA 15401
vvicites@fayettepa.org

Albert Gallatin Municipal Authority
PO Box 211
Point Marion, PA 15474-0211

Borough of Point Marion, PA
426 Morgantown Street
Point Marion, PA 15474

Springhill Township
198 Lake Lynn Rd.
Lake Lynn, PA 15451

**TRIBAL**

Harold Peterson
US Bureau of Indian Affairs
Eastern Regional Office
545 Marriott Drive, Suite 700
Nashville, TN 37214
harold.peterson@bia.gov

Absentee-Shawnee Tribe of Oklahoma
Edwina Butler-Wolfe, Governor
2025 S. Gordon Cooper Drive
Shawnee, OK 74801

Cayuga Nation
Clint Halftown
P.O. Box 803
Seneca Falls, NY 13148
clint.halftown@gmail.com

Delaware Nation, Oklahoma
Deborah Dotson, President
PO Box 825
Anadarko, OK 73005
ec@delawarenation.com

Delaware Tribe of Indians
Chester "Chet" Brooks, Chief
5100 Tuxedo Blvd.
Bartletsville, OK 74006
cbrooks@delawaretribe.org

Eastern Shawnee Tribe of Oklahoma
Glenna Wallace, Chief
PO Box 350
Seneca, MO 64865

Oneida Indian Nation
Raymond Halbritter, Nation Representative
2037 Dream Catcher Plaza
Oneida, NY 13421
info@oneida-nation.org

Oneida Indian Nation of Wisconsin
Tehassi Hill, Chair
P. O. Box 365
N7210 Seminary Rd
Oneida, WI 54155-0365

Onondaga Nation
Sidney Hill, Chief
4040 Route 11
Nedrow, NY 13120
admin@onondaganation.org

Osage Nation
Geoffrey Standing Bear, Principal Chief
627 Grandview Avenue
PO Box 779
Pawhuska, OK 74056

Seneca Nation of Indians
Rickey Amstrong, Sr., President
90 O:hi'yoh Way
Salamanca, NY 14779

Seneca-Cayuga Tribe of Oklahoma
William L. Fisher, Chief
P.O. Box 453220
23701 S. 655 Rd.
Grove, OK 74344
wfisher@sctribe.com

Shawnee Tribe
Cassie Harper, Tribal Administrator
P.O. Box 189
29 South Highway 69a
Miami OK 74355
cassie@shawnee-tribe.com

St. Regis Mohawk Tribe
Chief Beverly Kiohawiton Cook
71 Margaret Terrance Memorial Way
Akwesasne, NY 13655

Tonawanda Band of Seneca
Roger Hill, Chief
P.O. Box 795
7027 Meadville Road
Basom, NY 14013
tonseneca@aol.com

Tuscarora Nation
Leo Henry, Chief
2006 Mt. Hope Road
Lewiston, NY 14092

Eastern Band of Cherokee Indians
Richard Sneed, Principal Chief
P.O. Box 1927
Cherokee, NC 28719

United Keetoowah Band of Cherokee Indians in Oklahoma
Chief Joe Bunch
P.O Box 746
Tahlequah, OK 74465

Absentee-Shawnee Tribe of Oklahoma
Devon Frazier, THPO
2025 S. Gordon Cooper Drive
Shawnee, OK 74801
106NAGPRA@astribe.com

Delaware Nation, Oklahoma
Erin Thompson, Director
Cultural Resources/106 Department
31064 State Highway 281
Anadarko, OK 73005
ethompson@delawarenation-nsn.gov
cc: dkelly@delawarenation.com

Susan Bachor
Delaware Tribe of Indians
P.O. Box 64
Pocono Lake, PA 18347
sbachor@delawaretribe.org

Brett Barnes, THPO
Eastern Shawnee Tribe of Oklahoma
PO Box 350
Seneca, MO 64865
bbarnes@estoo.net

Roxanne Weldon
Eastern Shawnee Tribe of Oklahoma
PO Box 350
Seneca, MO 64865

Oneida Indian Nation
Jesse Bergevin, Historic Preservation Specialist
2037 Dream Catcher Plaza
Oneida, NY 13421
jbergevin@oneida-nation.org

Oneida Indian Nation
Laura Misita, Land Administrator
Oneida Indian Nation Legal Dept.
5218 Patrick Road
Verona, New York 13478
lmisita@oneida-nation.org

Oneida Indian Nation of Wisconsin
Corina Williams, THPO
P. O. Box 365
N7210 Seminary Rd
Oneida, WI 54155-0365

Onondaga Nation
Tony Gonyea, Faithkeeper 4040
Route 11
Administrative Building
Nedrow, NY 13120

Osage Nation
Dr. Andrea Hunter, THPO
627 Grandview Avenue
Pawhuska, OK 74056

Seneca Nation of Indians
Jay Toth, THPO 90 O:hi'yoh Way
Salamanca, NY 14779
jay.toth@sni.org

Seneca-Cayuga Tribe of Oklahoma
William Tarrant, Cultural Director
P.O. Box 453220
23701 S. 655 Rd.
Grove, OK 74344
wtarrant@sctribe.com

Shawnee Tribe
Tonya Tipton, THPO
P.O. Box 189
29 South Highway 69a
Miami OK 74355
tonya@shawnee-tribe.com

St. Regis Mohawk Tribe
Darren Bonaparte, THPO
71 Margaret Terrance Memorial Way
Community Building
Akwesansne, NY 13655
darren.bonaparte@srmt-nsn.gov

Tuscarora Nation
Bryan Printup
5226 Walmore Road
Lewiston, NY 14092
bprintup@hetf.org

**NGOs**

Duane Nichols, President
Cheat Lake Environment & Recreation Association
330 Dream Catcher Circle
Morgantown, WV 26508
duane330@aol.com

Mike Strager, Ph.D., Vice President
Cheat Lake Environment & Recreation Association
102 Lake Pointe
Morgantown, WV 26508
mstrager@gmail.com

Ella Belling
Executive Director
Mon River Trails Conservancy
P.O. Box 282
Morgantown, WV 26507
ella@montrails.org

Amanda J. Pitzer
Friends of the Cheat
1343 North Preston Highway
Kingwood, WV 26537
amanda@cheat.org

Owen Mulkeen
Associate Director
Friends of the Cheat
1343 North Preston Highway
Kingwood, WV 26537
owen@cheat.org

Betty L. Wiley
Upper Monongahela River Association
373 Dunkard Avenue
Westover, WV 26501
betty.w304@gmail.com

Frank Jernejcic
Upper Monongahela River Association
501 Lakeview Estates Townhouses
Morgantown, WV 26508
fjernejcic@comcast.net

Anita Carter, Property Manager
Greystone-On-The-Cheat Property Owners Association, Inc.
706 Sunset Beach Road
Morgantown, WV 26508
greystone.poa@hotmail.com

Dan Griffin
Greystone Property Owners Association
3203 Deerfield Court
Morgantown, WV 26508
dgriff66@aol.com

Sean Goodwin
Greystone President
4685 Shadyside Lane
Morgantown, WV 26508
seangoodwin@yahoo.com

Parke Johnson
Greystone Estates
3956 Eastlake Drive
Morgantown, WV 26508
graceandparke@yahoo.com

Adam Polinski
The Coopers Rock Foundation
P.O. Box 505
Morgantown, WV 26507

Kevin R Colburn
American Whitewater
20 Battery Park Ave Suite 302
Asheville, NC 28801-2879
kevin@americanwhitewater.org

Bob Irvin
President
American Rivers
1101 14th Street NW, Suite 1400
Washington, DC 20005
birvin@americanrivers.org

Steve Moyer
Trout Unlimited
1777 N. Kent Street, Suite 100
Arlington, VA 22209
smoyer@tu.org

Colleen McNally-Murphy
National Coordinator
Hydropower Reform Coalition
1101 14th St. NW, Suite 1400
Washington, DC 20005
colleen@hydroreform.org

Angie Rosser
Executive Director
West Virginia Rivers Coalition
3501 MacCorkle Ave. SE #129
Charleston WV 25304

Garrett Richardson
Friends of the Cheat
1343 North Preston Highway
Kingwood, WV 26537
grichardson@cheat.org

Daniel Miller, Ph.D.
Rotary Club of Cheat Lake
125 Lakeview Drive
Morgantown, WV 26508
DMiller@potesta.com

**OTHER INTERESTED PARTIES**

Sunset Beach Marina
177 Sunset Beach Road
Morgantown, WV 26508
info@sunsetbeach-marina.com

Stuart Welsh
West Virginia Cooperative Fish and Wildlife Research Unit
West Virginia University
322 Percival Hall
Morgantown, WV 26506
swelsh@wvu.edu

The Lakehouse Restaurant and Marina
165 Sunset Beach Road
Cheat Lake, WV 26508

Edgewater Marina
239 Fairchance Road
Morgantown, WV 26508
edgewater@cheatlakedocks.com

Stratford Douglas
1024 Snake Hill Road
Morgantown, WV 26508
stratdouglas@gmail.com

Kelly Campitell, LEED GA, Property Manager
Oxford Development Company
334 Budfield Avenue, Suite 121
Johnstown, Pennsylvania 15904
KCampitell@oxforddevelopment.com

Sherree Hall, Facility Director
Jewish Community Center of Greater Pittsburgh
5738 Forbes Avenue
Pittsburgh, PA 15217
shall@jccpgh.org

Amy Wagner
628 Mariner Village
Morgantown, WV 26508
awagner1595@gmail.com

Ann Chester
CLEAR
chestermcgraw@gmail.com

Donna Weems
CLEAR
320 Dreamcatcher Circle
Morgantown, WV 26508
donnaweems@rocketmail.com

Dave Hough
davecyndy@frontier.com

Lewis and Suzy Barnes
The Lakehouse Restaurant
55 Mont Chateau Road
Morgantown, WV 26508
szybarnes@yahoo.com

Mike Lutman
4131 Cove Point Drive
Morgantown, WV 26508
mlutman@comcast.net

Nathaniel James
WVU Student
277A Spruce Street
Morgantown, WV 26508
Reecejames98@gmail.com

Richard Scott
qtrking86@yahoo.com

Roger Phillips
rogerdalephillips@gmail.com

Steve Calvert
4314 Brettwood Lane
Morgantown, WV 26508
scalvert@greenrivergroupllc.com

Will McNeil
WVU Student
whm0005@mix.wvu.edu

Jim Kotcon
jkotcon@gmail.com

**FERC**

John Spain, P.E.
Regional Engineer
Federal Energy Regulatory Commission
Division of Dam Safety and Inspections – New York Regional Office
19 West 34th Street, Suite 400
New York, NY 10001
john.spain@ferc.gov

Andy Bernick, Ph.D.
Federal Energy Regulatory Commission
888 First St. NE
Washington, DC 20426
andrew.bernick@ferc.gov

## Joyce Foster

**From:** Joyce Foster
**Sent:** Friday, August 5, 2022 7:32 PM
**To:** gkratina@pa.gov; richard_mccorkle@fws.gov; Megan.K.Gottlieb@usace.army.mil; sean.mcdermott@noaa.gov; Kevin_Mendik@nps.gov; clschref@usgs.gov; smwickle@usgs.gov; Jacob.D.Harrell@wv.gov; Danny.A.Bennett@wv.gov; David.I.Wellman@wv.gov; coopersrocksf@wv.gov; Brian.L.Bridgewater@wv.gov; susan.m.pierce@wv.gov; dadrake@pa.gov; peiswerth@pa.gov; hsmiles@pa.gov; olbraun@pa.gov; gkratina@pa.gov; chnagle@pa.gov; agastbray@moncommission.com; dr.hawk@comcast.net; rmcclure@moncommission.com; vvicites@fayettepa.org; harold.peterson@bia.gov; clint.halftown@gmail.com; ec@delawarenation.com; cbrooks@delawaretribe.org; info@oneida-nation.org; admin@onondaganation.org; wfisher@sctribe.com; cassie@shawnee-tribe.com; tonseneca@aol.com; 106NAGPRA@astribe.com; ethompson@delawarenation-nsn.gov; dkelly@delawarenation.com; sbachor@delawaretribe.org; bbarnes@estoo.net; jbergevin@oneida-nation.org; lmisita@oneida-nation.org; jay.toth@sni.org; wtarrant@sctribe.com; tonya@shawnee-tribe.com; darren.bonaparte@srmt-nsn.gov; bprintup@hetf.org; duane330@aol.com; mstrager@gmail.com; ella@montrails.org; amanda@cheat.org; owen@cheat.org; betty.w304@gmail.com; fjernejcic@comcast.net; greystone.poa@hotmail.com; dgriff66@aol.com; seangoodwin@yahoo.com; graceandparke@yahoo.com; kevin@americanwhitewater.org; birvin@americanrivers.org; smoyer@tu.org; colleen@hydroreform.org; grichardson@cheat.org; DMiller@potesta.com; info@sunsetbeach-marina.com; swelsh@wvu.edu; edgewater@cheatlakedocks.com; stratdouglas@gmail.com; KCampitell@oxforddevelopment.com; shall@jccpgh.org; awagner1595@gmail.com; chestermcgraw@gmail.com; donnaweems@rocketmail.com; davecyndy@frontier.com; szybarnes@yahoo.com; mlutman@comcast.net; Reecejames98@gmail.com; qtrking86@yahoo.com; rogerdalephillips@gmail.com; scalvert@greenrivergroupllc.com; whm0005@mix.wvu.edu; jkotcon@gmail.com; john.spain@ferc.gov; andrew.bernick@ferc.gov
**Cc:** Joyce Foster
**Subject:** Lake Lynn Hydro Project (FERC No. 2459) - Draft License Application for review
**Attachments:** Lake Lynn_P-2459_Cover Letter DLA.pdf

Dear Stakeholder:

Lake Lynn Generation, LLC (Lake Lynn), a subsidiary of Eagle Creek Renewable Energy, is the owner and operator of the Lake Lynn Hydroelectric Project (FERC No. 2459) located on the Cheat River in Monongalia County , WV and Fayette County, PA. The existing Federal Energy Regulatory Commission (FERC) license for the Project expires November 30, 2024. Lake Lynn is providing the Draft License Application (DLA) for the Project to FERC and the relevant resource agencies, tribes, non-governmental organizations, and other interested parties included on the relicensing distribution list (see attached letter). The attached transmittal letter and the DLA was filed with FERC today.

An electronic copy of the DLA can be downloaded at: https://www.dropbox.com/s/w8k76py7drpeluh/Lake%20Lynn_P-2459_Draft%20License%20Application.pdf?dl=0 An electronic copy of the DLA can also be downloaded from FERC's elibrary system at https://elibrary.ferc.gov/eLibrary/search by searching under the FERC Project number (P-2459).

Attached to this e-mail you will find a transmittal letter for the DLA providing additional information. Please provide any written comments on the DLA to my attention by **November 3, 2022** to me at Joyce.Foster@eaglecreekre.com. If you have any questions or have any issues downloading the DLA, please contact me at 804-338-5110 or Joyce.Foster@eaglecreekre.com.

**Joyce A. Foster | Director, Licensing and Compliance**
**Eagle Creek Renewable Energy**
Mobile: 804 338 5110
Email: joyce.foster@eaglecreekre.com

EAGLE CREEK
— RENEWABLE ENERGY —

**From:** Jesse Bergevin
**To:** Joyce Foster
**Subject:** RE: Lake Lynn Hydro Project (FERC No. 2459) - Draft License Application for review
**Date:** Friday, August 12, 2022 12:16:30 PM
**Attachments:** image002.png

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**[This email originated OUTSIDE of Eagle Creek. Exercise caution. DO NOT open attachments or click links from unknown senders or unexpected email.]**

Ms. Foster,

The Oneida Indian Nation has no comments at this time regarding this license application.

Please let me know if there are any questions.

Best Regards,

**JESSE BERGEVIN**
Historical Resources Specialist

**ONEIDA INDIAN NATION**

P: 315.829.8463
2037 Dream Catcher Plaza
Oneida, NY 13421
OIN

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**From:** Joyce Foster [mailto:joyce.foster@eaglecreekre.com]
**Sent:** Friday, August 05, 2022 7:32 PM
**To:** gkratina@pa.gov; richard_mccorkle@fws.gov; Megan.K.Gottlieb@usace.army.mil; sean.mcdermott@noaa.gov; Kevin_Mendik@nps.gov; clschref@usgs.gov; smwickle@usgs.gov; Jacob.D.Harrell@wv.gov; Danny.A.Bennett@wv.gov; David.I.Wellman@wv.gov; coopersrocksf@wv.gov; Brian.L.Bridgewater@wv.gov; susan.m.pierce@wv.gov; dadrake@pa.gov; peiswerth@pa.gov; hsmiles@pa.gov; olbraun@pa.gov; gkratina@pa.gov; chnagle@pa.gov; agastbray@moncommission.com; dr.hawk@comcast.net; rmcclure@moncommission.com; vvicites@fayettepa.org; harold.peterson@bia.gov; clint.halftown@gmail.com; ec@delawarenation.com; cbrooks@delawaretribe.org; [Shared] The Oneida <info@oneida-nation.org>; admin@onondaganation.org; wfisher@sctribe.com; cassie@shawnee-tribe.com; tonseneca@aol.com; 106NAGPRA@astribe.com; ethompson@delawarenation-nsn.gov; dkelly@delawarenation.com; sbachor@delawaretribe.org; bbarnes@estoo.net; Jesse Bergevin <jbergevin@oneida-nation.org>; Laura Misita <lmisita@oneida-nation.org>; jay.toth@sni.org; wtarrant@sctribe.com; tonya@shawnee-tribe.com; darren.bonaparte@srmt-nsn.gov; bprintup@hetf.org; duane330@aol.com; mstrager@gmail.com; ella@montrails.org; amanda@cheat.org; owen@cheat.org; betty.w304@gmail.com; fjernejcic@comcast.net; greystone.poa@hotmail.com; dgriff66@aol.com; seangoodwin@yahoo.com; graceandparke@yahoo.com; kevin@americanwhitewater.org; birvin@americanrivers.org;

smoyer@tu.org; colleen@hydroreform.org; grichardson@cheat.org; DMiller@potesta.com; info@sunsetbeach-marina.com; swelsh@wvu.edu; edgewater@cheatlakedocks.com; stratdouglas@gmail.com; KCampitell@oxforddevelopment.com; shall@jccpgh.org; awagner1595@gmail.com; chestermcgraw@gmail.com; donnaweems@rocketmail.com; davecyndy@frontier.com; szybarnes@yahoo.com; mlutman@comcast.net; Reecejames98@gmail.com; qtrking86@yahoo.com; rogerdalephillips@gmail.com; scalvert@greenrivergroupllc.com; whm0005@mix.wvu.edu; jkotcon@gmail.com; john.spain@ferc.gov; andrew.bernick@ferc.gov
**Cc:** Joyce Foster <joyce.foster@eaglecreekre.com>
**Subject:** Lake Lynn Hydro Project (FERC No. 2459) - Draft License Application for review

Dear Stakeholder:

Lake Lynn Generation, LLC (Lake Lynn), a subsidiary of Eagle Creek Renewable Energy, is the owner and operator of the Lake Lynn Hydroelectric Project (FERC No. 2459) located on the Cheat River in Monongalia County , WV and Fayette County, PA. The existing Federal Energy Regulatory Commission (FERC) license for the Project expires November 30, 2024. Lake Lynn is providing the Draft License Application (DLA) for the Project to FERC and the relevant resource agencies, tribes, non-governmental organizations, and other interested parties included on the relicensing distribution list (see attached letter). The attached transmittal letter and the DLA was filed with FERC today.

An electronic copy of the DLA can be downloaded at: https://www.dropbox.com/s/w8k76py7drpeluh/Lake%20Lynn_P-2459_Draft%20License%20Application.pdf?dl=0 An electronic copy of the DLA can also be downloaded from FERC's elibrary system at https://elibrary.ferc.gov/eLibrary/search by searching under the FERC Project number (P-2459).

Attached to this e-mail you will find a transmittal letter for the DLA providing additional information. Please provide any written comments on the DLA to my attention by **November 3, 2022** to me at Joyce.Foster@eaglecreekre.com. If you have any questions or have any issues downloading the DLA, please contact me at 804-338-5110 or Joyce.Foster@eaglecreekre.com.

---

**Joyce A. Foster | Director, Licensing and Compliance**
**Eagle Creek Renewable Energy**
Mobile: 804 338 5110
Email: joyce.foster@eaglecreekre.com

EAGLE CREEK
— RENEWABLE ENERGY —

FEDERAL ENERGY REGULATORY COMMISSION
WASHINGTON, DC 20426
November 3, 2022

OFFICE OF ENERGY PROJECTS

Project No. 2459-263—West Virginia and Pennsylvania
Lake Lynn Hydroelectric Project
Lake Lynn Generation, LLC

**VIA FERC Service**

Ms. Joyce Foster
Director, Licensing and Compliance
Lake Lynn Generation, LLC
7315 Wisconsin Avenue, Suite 1100W
Bethesda, MD 20814

**Reference: Staff Comments on Draft License Application for the Lake Lynn Hydroelectric Project No. 2459**

Dear Ms. Foster:

On August 8, 2022, you filed a draft license application (draft application) with the Federal Energy Regulatory Commission for the Lake Lynn Hydroelectric Project relicensing. We have reviewed the draft application, and provide our comments in the enclosed Schedule A.

If you have any questions concerning this letter, please contact Allan Creamer at (202) 502-8365 or allan.creamer@ferc.gov, or Joshua Dub at (202) 502-8138 or Joshua.dub@ferc.gov.

Sincerely,

Stephen Bowler, Chief
South Branch
Division of Hydropower Licensing

Enclosures: Schedule A
Attachment A- Environmental Justice Table

## Schedule A

### General Comments

1. Section 5.18(b)(5)(ii)(C) of the Commission's regulations requires that all of an applicant's proposed environmental measures must be provided in the final license application (FLA).[1] Section 3.3.2, *Proposed Environmental Measures*, of the draft license application (DLA) states that Lake Lynn is proposing to develop a new Water Quality Plan, a new Recreation Plan, and a Shoreline Management Plan (SMP) for the project. The DLA did not contain copies of these plans, nor did the DLA contain the conceptual elements and costs of the plans. To ensure that the FLA includes all of the proposed protection, mitigation, and enhancement (PM&E) measures for review by Commission staff and stakeholders, and that staff has sufficient information to inform an economic and environmental analysis for each of the plans, please include, with the FLA, draft plans or the conceptual elements of the plans, as well as cost estimates for the plans.

2. Section 3.2.1, *Proposed Project Facilities and Operations*, of Exhibit E of the DLA states that Lake Lynn Generation, LLC (Lake Lynn) proposes to remove approximately 10 acres of land from the project boundary that are not required for project purposes. Please include in the FLA the reason(s) that the land no longer serves a project purpose and would no longer need to be included within the project boundary, noting any structures that may be sited on the land. Also, please provide a map showing the location of the land to be removed in relation to the proposed project boundary.

### Exhibit A – Project Description

3. Section 2.1, *Project Structures,* of Exhibit A of the DLA, provides a description of existing project features. To facilitate Commission staff's review of the project and its features, consistent with section 4.51(b) of the Commission's regulations, please provide the: (a) gross storage capacity (acre-feet) and average depth (feet) of the project impoundment; (b) crest elevation (feet) of the dam; (c) dimensions of the (i) log boom, along with a description of its composition, and (ii) substation; (d) length and width of the project tailrace; (e) sill elevation, status (*i.e.,* operational or not), uses (*e.g.,* high inflow conditions, minimum flow release, *etc.*), mode of operation (*i.e.,* automatic or manual), and frequency and method of repair, of the tainter gates; (f) rated capacity, minimum hydraulic capacity, and maximum hydraulic capacity of each turbine-generator unit; and (g) voltage of each transformer.

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[1] *See* Guidance on Environmental Measures in License Application; available at https://www.ferc.gov/sites/default/files/2020-04/GuidanceonEnvironmentalMeasuresinLicenseApplications.pdf.

4. Section 2.1.2, *Intake and Conveyance System*, of Exhibit A of the DLA, indicates that the intake for the Lake Lynn Project is equipped with trash racks. However, section 2.1.2 does not include a detailed description of the trash racks, including: (a) the dimensions of the trash rack(s); (b) the trash racks' clear bar spacing; (c) the intake approach velocity; and (d) the through-rack velocity. This information, which is required by sections 4.51(b)(1) and 5.18(a)(5)(iii) of the Commission's regulations to be included in the FLA, is necessary to evaluate the potential for fish entrainment at the project.

5. Section 4.51(b)(5) of the Commission's regulations requires that an applicant describe the appurtenant facilities and equipment (electrical, mechanical, *etc.*) associated with the proposed project. Please provide this information in the FLA.

6. Section 2.1.4, *Generating Equipment*, of Exhibit A of the DLA describes a 72-foot-wide by 165-foot-long project powerhouse. However, Table 1, *Project Components List,* of Exhibit A indicates that the powerhouse is 165-feet-wide by 72-feet-long. Also, Table 1 lists an average annual generation of 126,639 megawatt-hours (MWh), over the period of record (2009 to 2018), whereas section 2.2, *Average Annual Energy Generation and Dependable Capacity*, of Exhibit B of the DLA indicates that the project generates an average of 140,352 MWh annually. In the FLA, please clarify the dimensions of the project powerhouse and the project's average annual generation.

7. Section 2.1.4, *Generating Equipment*, of Exhibit A of the DLA states that Lake Lynn completed a turbine replacement and upgrade of unit 2 in 2018. In the FLA, please explain: (a) the reason for replacement of unit 2; (b) the specific upgrade(s) made to the unit; and (c) whether the upgrade(s) resulted in any change in rated capacity.

**Exhibit B – Project Operation and Resource Utilization**

8. Section 1.3.1, *Normal Project Operation,* of Exhibit B of the DLA indicates that Lake Lynn operates the Lake Lynn Project as a dispatchable peaking hydroelectric facility using the impoundment's storage capacity, which varies seasonally. However, the DLA provides no additional details regarding peaking operations at the project. To facilitate Commission staff's review of project operation, and in accordance with section 4.51(c) of the Commission's regulations, please provide, in the FLA, a more detailed description of peaking operations, including: (a) the frequency and timing of peaking operation (*i.e.,* peak hours, number of cycles per day, *etc.*), and whether operations vary seasonally; (b) the sequence of operation of the turbine-generator units; (c) whether the project operates to the full extent of the existing seasonal impoundment fluctuation limits; and (d) the amount of time needed to refill the impoundment to the normal maximum surface water elevation. In addition, please provide historic records from the past 10 years of daily lake level elevations and daily generation at the Lake Lynn Powerhouse.

9. Section 1.3.1, *Normal Operation*, of Exhibit B of the DLA indicates that a continuous minimum flow of 212 cubic feet per second is released through the powerhouse or via tainter gates 12 and 13. In the FLA, please clarify the operating condition(s) that govern use of the powerhouse versus the tainter gate(s) as the mechanism for releasing the minimum flow.

10. In order for Commission staff to complete its economic analysis of each relicensing alternative (*i.e.,* no action, applicant's proposal, staff alternative, staff alternative with mandatory conditions), please provide, in the FLA, the median monthly flow duration at the dam in both graphic and tabular form for an average flow year.

11. Appendix B of the DLA provides the annual and monthly flow duration curves for the Cheat River at the Lake Lynn Project. Please provide the tabular data for these graphs in the FLA.

**Exhibit E – Environmental Resources**

*General Comments*

12. Section 2.5, *Coastal Zone Management Act* (CZMA), of Exhibit E of the DLA states that the Lake Lynn Project is not located within a coastal zone. Because Pennsylvania has a coastal zone management program, in the FLA, please provide the certification of consistency from the Pennsylvania CZMA agency, or a statement from the CZMA agency that the project is not subject CZMA review.

13. The DLA includes maps of the project area showing various geographic information system (GIS) data collected during the prefiling studies conducted by Lake Lynn. To facilitate review of the data collected on environmental resources at the project, please file the GIS shapefiles associated with the studies, if available, with the FLA.

*Water and Aquatic Resources*

14. Tables 7, 8, and 12 in section 4.4.1.1.2, *Water Quality Data*, of Exhibit E of the DLA presents the range in values for water temperature, pH, dissolved oxygen, and specific conductance (or conductivity) for the period from April 1 to October 31 of 2008 through 2018. To assist Commission staff in reviewing the significance to the biological community of the range in values for each water quality constituent, please revise Tables 7, 8, and 12 to show the range (minimum and maximum) in values by year, as well as the average for each constituent by year.

15. Section 4.5.1., *Fish and Aquatic Resources – Affected Environment*, of Exhibit E of the DLA includes citations for several references and reports that will need to be part of the public record for this project. Please include with the FLA copies of the following documents:

(a) Normandeau Associates. 2020. Lake Lynn Hydroelectric Project Desktop Fish Entrainment Assessment. December 2020;
(b) Smith, D., and S. Welsh. 2015. Biological Monitoring of Aquatic Communities of Cheat Lake, and Cheat River Downstream of the Lake Lynn Hydro Station, 2011 – 2015. Division of Forestry and Natural Resources West Virginia University;
(c) Smith, Dustin. 2018. Evaluation of a Re-established Walleye Population within a Hydropower Reservoir Recovering from Acidification. Graduate Theses, Dissertations, and Problem Reports;
(d) TRC. 2020. Freshwater Mussel Reconnaissance Scoping Survey Report;
(e) United States Fish and Wildlife Service (USFWS). 2022. qPCR analysis of eDNA filter samples collected in 2021 at Lake Lynn Dam Target species: American Eel (*Anguilla rostrata*);
(f) Wellman, D., F. Jernejcic, and J. Hedrick. 2008. Biological monitoring of aquatic communities of Cheat Lake, and Cheat River downstream of the Lake Lynn Hydro Station, 2008;
(g) Welsh, S. and K. Matt. 2020. An Evaluation of Artificial Habitat Structures in Cheat Lake with Emphasis on Yellow Perch Spawning and Water Level Fluctuations. West Virginia Cooperative Fish and Wildlife Research Unit; and
(h) West Virginia Division of Natural Resources (WVDNR). 2004. Biological Monitoring of Aquatic Communities of Cheat Lake, and Cheat River downstream of the Lake Lynn Hydro-station, 2005 – 2009.

*Terrestrial Resources*

16. Section 2.1.5, *Transmission Facilities*, of Exhibit A of the DLA includes a brief, general description of the project substation, transformers, and transmission lines. Section 4.6, *Wildlife Resources*, of Exhibit E of the DLA does not include information regarding the effects of operating and maintaining the transmission facilities on terrestrial resources, including birds and other wildlife. To facilitate Commission staff's review of the design, configuration, and maintenance of the project transmission facilities as they relate to avian protection, please provide the following information in the FLA:

(a) a discussion of whether the project transmission line poles and other equipment currently installed are consistent with the Avian Power Line Interaction Committee (APLIC) and U.S. Fish and Wildlife Service (FWS) guidelines to minimize adverse avian interactions (*i.e.,* potential avian electrocutions and collisions) (APLIC, 2006 and 2012; and APLIC and FWS, 2005);

(b) detailed descriptions, figures, and diagrams of the project transmission facilities and any existing avian protection devices currently installed;

(c) the specifications and locations of any proposed avian protection measures that would be consistent with APLIC guidelines, if applicable;

(d) a copy of the Avian Protection Plan for the project, or a general Avian Protection Plan that Lake Lynn implements at all of its hydropower projects that include transmission facilities, if applicable; and

(e) data regarding observed or documented avian interactions with the project's transmission facilities, such as nest building, perching, electrocutions, collisions, and any outages related to such interactions, if available.

17. Exhibit E of the DLA does not include a description of Lake Lynn's vegetation management activities, including tree removal, within the project boundary. To facilitate Commission staff's review of the effects of project operation and maintenance activities on terrestrial resources, including regular vegetation management, please provide the following information in the FLA:

(a) the types of existing and proposed vegetation management activities used at the project (*e.g*., tree trimming and removal, mowing, and herbicide applications);

(b) the locations where each vegetation management technique occurs within the project boundary (*e.g*., transmission facilities; access roads; parking areas; and recreation areas, such as the tailrace fishing area, Cheat Lake Trail, Cheat Lake Park, Sunset Beach Marina Public Boat Launch, nature viewing areas, *etc.*);

(c) the procedures, including any time of year restrictions, for managing vegetation in sensitive habitats such as wetlands, riparian areas, and suitable locations for rare, threatened, or endangered species; and

(d) a schedule for conducting regular vegetation management (*i.e.*, activities performed annually, seasonally, as-needed, *etc.*). If herbicides are used to control vegetation, please include the method/location of application (*e.g.*, foliar, stump, stem, and/or vine).

18. Section 4.7, *Botanical Resources*, of Exhibit E of the DLA provides a general description of the types of upland and wetland habitats that occur in the project vicinity, as well as general statements of project related effects on these habitats. The DLA lists different land cover types in uplands within 1 mile of the project by percentage, but it does not provide any acreage estimates for upland habitat types within the project boundary. It is also unclear where the identified wetlands occur within the project

boundary, which species occur in the "[r]uderal forests[2] [that] are … common riparian habitat…," and whether existing project operation and maintenance activities affect these wetlands and forests.

In addition, Lake Lynn proposes to remove lands from the project boundary. However, the DLA does not include any information on the change in upland and wetland habitat areas between the existing and proposed project boundaries. Section 4.7.2, *Environmental Effects*, of Exhibit E of the DLA concludes that "no effects on botanical resources are expected because Lake Lynn is not proposing any changes to the project operations or to the Lake Lynn project facilities (*e.g.*, dam or powerhouse)…[and]…the proposed action does not include any ground-disturbing activities." To facilitate Commission staff's independent review of ongoing project operation and maintenance activities on botanical resources, please provided the following information in the FLA:

(a) the estimated acreages of each identified upland and wetland habitat type within the existing and proposed project boundary;
(b) a map showing the identified uplands and wetlands relative to the existing and proposed project boundary;
(c) a description of project operation and maintenance activities (*e.g.*, reservoir fluctuations associated with seasonal peaking operation, vegetation management activities, and project-related recreation) in relation to existing upland and wetland habitats; and
(d) detailed descriptions of the potential project-related effects on these botanical resources, including the effects of the proposed removal of land from the project boundary.

19. Section 4.7.1.2, *Wetlands, Riparian, and Littoral Habitat*, of Exhibit E of the DLA indicates that Lake Lynn "…worked cooperatively with West Virginia DNR and West Virginia University to document the distribution and relative abundance of aquatic vegetation and to map aquatic vegetation in Cheat Lake. Twenty-two separate areas of aquatic vegetation were documented [throughout] the impoundment. The most common species found in dense abundance during the surveys included brittle naiad (*Najas minor*), wild celery (*Vallisneria americana*), and curly-leaf pondweed (*Potamogeton crispus*)." These aquatic plants are all non-native, invasive species. The DLA does not include information about the effects of ongoing project operation and maintenance activities on these species within the project boundary. In addition, while Exhibit E of the DLA includes information regarding the aforementioned aquatic, non-native, invasive

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[2] The DLA describes these habitats as "…early succession forests [that] are often found in areas that have been disturbed by human activity, such as the construction or maintenance of roads, trails, and buildings. *See* DLA at E-4-54.

plants, it does not discuss occurrences of terrestrial, non-native, invasive plants. In the FLA, please provide:

(a) the locations of terrestrial non-native invasive plants in the project boundary;
(b) a description of the potential project-related effects on the identified populations of both aquatic and terrestrial, non-native, invasive plants in the project boundary, including: (i) the existing seasonal reservoir fluctuations associated with peaking operations; (ii) project maintenance activities, including vegetation management; and (iii) project-related recreation activities;
(c) the methods being used to monitor and/or manage the identified populations of brittle naiad, wild celery, and curly-leaf pondweed, and any terrestrial non-native invasive plants in the project boundary, if applicable; and
(d) the entity/entities managing these populations, if applicable.

*Threatened and Endangered Species*

20. Section 4.8, *Rare, Threatened, and Endangered Species*, of Exhibit E of the DLA discusses species protected under the Endangered Species Act, including the endangered Indiana bat, the threatened northern long-eared bat (NLEB) and flat-spired three-toothed snail, as well as the monarch butterfly, a candidate for federal listing, among the species that may occur within the project boundary. However, the DLA does not include the FWS's newly proposed species, tricolored bat,[3] which FWS proposed for listing as endangered on September 14, 2022, nor does it recognize the proposed reclassification of the federal status of NLEB.[4] The DLA also does not address potential project effects on these federally listed species, with the exception of a brief/general statement regarding proposed seasonal tree clearing restrictions to protect bats. The DLA does not provide enough detail for Commission staff to assess potential project-related effects on federally listed, proposed, and candidate species. Therefore, in the FLA, please ensure that the *Rare, Threatened, and Endangered Species* section:

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[3] 87 Fed. Reg. 56,381-56,393 (September 14, 2022). Please note that the range of tricolored bats includes all of West Virginia and Pennsylvania, and there may be a delay for this species to appear on species lists generated on FWS's Information for Planning and Consultation (IPaC) system.

[4] FWS proposed to reclassify the NLEB from a threatened to an endangered species under the ESA on March 23, 2022. *See* 87 Fed. Reg. 16,442-16,452 (March 23, 2022). FWS anticipates issuing a decision on this proposed rule by the end of November 2022. *See* FWS's questions and answers on the proposed rule, available at: https://www.fws.gov/sites/default/files/documents/NLEB%20pUplisting%20FAQs%20FINAL%20%281%29.pdf.

(a) provides detailed, species-specific discussions of the potential project-related effects (*i.e.*, operation; maintenance, including seasonal vegetation management; and project-related recreation activities; as well as the proposed removal of land from the project boundary) on federally listed, proposed, and candidate species, and their habitats, that may occur at the project. These species include the Indiana bat, NLEB, tricolored bat, flat-spired three-toothed snail, and monarch butterfly; and

(b) ensures that the description of any existing or proposed tree removal activities (requested in item #17 above), includes cutting down, harvesting, destroying, trimming, or manipulating in any other way the trees, saplings, snags, or any other form of woody vegetation likely to be used by NLEBs or tricolored bats within the project boundary. Please note that suitable NLEB roosts include live or dead trees that are typically greater than, or equal to, 3 inches in diameter at breast height and have cavities, peeling bark, crevices, or hollows. Tricolored bats primarily roost among live and dead leaf clusters of live or recently dead deciduous hardwood trees, but they have also been observed roosting in lichens with pendant growth forms, as well as among pine and eastern red cedar needles.

*Recreation*

21. Section 4.9.2.1, *Recreation and Land Use Resources – Environmental Effects, Affects of the Proposed Action*, of Exhibit E of the DLA states that Lake Lynn is proposing to formally remove the water-accessible nature viewing area across from Cheat Haven from the Lake Lynn Project boundary and no longer designate this area as a nature viewing area. So that Commission staff can analyze the effects of removing the nature viewing area from the project boundary, please provide the following in the FLA: (a) an explanation of why Lake Lynn is requesting to remove the habitat viewing area; (b) the record of consultation with West Virginia DNR on the proposed removal; (c) images taken from the viewing area; (d) visitor usage information or data for the viewing area; (e) information on amy dock, ramp, or bathroom facilities, if any such infrastructure exists for boaters visiting the nature viewing area; (f) whether or not any such infrastructure would be removed; and (g) how the removal of the viewing area would be communicated to Lake Lynn Project visitors.

*Land Use and Aesthetic Resources*

22. Section 4.10.1, *Aesthetic Resources – Affected Environment*, of Exhibit E of the DLA discusses aesthetic resources at the Lake Lynn Project. The only aesthetic resources described are limited viewing opportunities from roadways. The project offers several wildlife viewing opportunities, including views from a tower, that may offer scenic viewing of the project area. So that Commission staff can analyze aesthetic

resources at the project, in the FLA, please clarify if any of the recreation sites add additional aesthetic resources to the project; if so, please include images taken from the observation points.

<u>*Cultural Resources*</u>

23. Section 4.11.1, *Historical and Cultural Resources – Affected Environment*, of Exhibit E of the DLA provides a brief description of the cultural context for the project, but does not provide a discussion of pre-European contact historical background or the archeological context of the region, as required in section 4.51(f)(4) of the Commission's regulations. So that Commission staff can describe the affected environment and analyze potential effects to cultural and Tribal resources, in the FLA, please provide a description of the pre-European contact historical background and archeological resources within the region.

24. In the FLA, please provide a record of consultation with the West Virginia State Historic Preservation Office and Pennsylvania State Historic Preservation Office, including concurrence on the Area of Potential Effects.

<u>*Environmental Justice*</u>

25. Executive Order 14008, *Tackling the Climate Crisis at Home and Abroad,*[5] and Executive Order 12898, *Federal Actions to Address Environmental Justice in Minority Populations and Low Income Populations*,[6] as amended, require federal agencies to consider if impacts on human health or the environment would be disproportionately high and adverse for environmental justice (EJ) communities in the surrounding community resulting from the programs, policies, or activities of federal agencies. To assist Commission staff with its analysis under the National Environmental Policy Act (NEPA), please provide the following in the FLA:

(a) a table of racial, ethnic, and poverty statistics for each state, county, and census block group within the geographic scope of analysis. In this case, the geographic scope of analysis is areas within 1 mile of the existing project boundary. The table should include the following information from the U.S. Census Bureau's most recently available American Community Survey 5-year Estimates for each state, county, and block group (wholly or partially) within the geographic scope of analysis:

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[5] 86 Fed. Reg. 7,619-7,633 (January 27, 2021).

[6] 59 Fed Reg. 7,629-7,633 (February 16, 1994).

i. total population;
ii. total population of each racial and ethnic group (*i.e.*, White Alone Not Hispanic, Black or African American, American Indian and Alaska Native, Asian, Native Hawaiian and Other Pacific Islander, some other race, two or more races, Hispanic or Latino origin [of any race]) (count for each group);
iii. minority population including individuals of Hispanic or Latino origin as a percentage of total population;[7] and
iv. total population below poverty level as a percentage.[8]

The data should be collected from the most recent American Community Survey files available, using table #B03002 for race and ethnicity data and table #B17017 for low-income households. A template table is attached.

(b) identification of environmental justice populations by block group, using the data obtained in response to part a) above, by applying the following methods included in EPA's *Promising Practices for EJ Methodologies in NEPA Reviews* (2016).[9]

i. to identify environmental justice communities based on the presence of minority populations, use the "50 percent" and the "meaningfully greater" analysis methods. To use the "50 percent" analysis method, determine whether the total percent minority population of any block group in the affected area exceeds 50 percent. To use the "meaningfully greater" analysis determine whether any affected block group affected is 10 percent greater than the minority population percent in the county using the following process:

1. calculate the percent minority in the reference population (county).
2. to the reference population's percent minority, add 10 percent (i.e., multiply the percent minority in the reference population by 1.1).

[7] To calculate the percent total minority population, subtract the percentage of "White Alone Not Hispanic" from 100 percent for any given area.

[8] To calculate percentage of total population below poverty level, divide the total households below the poverty level by the total number of households and multiply by 100.

[9] Available online at https://www.epa.gov/sites/default/files/2016-08/documents/nepa_promising_practices_document_2016.pdf.

3. This new percentage is the threshold that a block group's percent minority would need to exceed to qualify as an environmental justice community under the meaningfully greater analysis method.

ii. to identify environmental justice communities based on the presence of low-income populations, use the "low-income threshold criteria" method. To use the "low income threshold criteria," the percent of the population below the poverty level in the identified block group must be equal to, or greater than, that of the reference population (county).

(c) a map showing the project boundary and location(s) of any project-related construction in relation to any identified environmental justice communities within the geographic scope. Denote on the map if the block group is identified as an environmental justice community based on the presence of minority population, low-income population, or both.

(d) a discussion of anticipated project-related impacts on any environmental justice communities for all resources where there is a potential nexus between the effect and the environmental justice community. Examples of resource impacts may include, but are not necessarily limited to, project-related effects on: erosion or sedimentation of private properties; groundwater or other drinking water sources; subsistence fishing, hunting, or plant gathering; access for recreation; housing or industries of importance to environmental justice communities; and construction- or operation-related air quality, noise, and traffic. For any identified effects, please also describe whether or not any of the effects would be disproportionately high and adverse.

(e) if environmental justice communities are present, please provide a description of your public outreach efforts regarding your project, including:

i. a summary of any outreach to environmental justice communities conducted prior to filing the application (include the date, time, and location of any public meetings beyond those required by the regulations);
ii. a summary of comments received from members of environmental justice communities or organizations representing the communities;
iii. a description of information provided to environmental justice communities; and
iv. planned future outreach activities and methods specific to working with the identified communities.

(f) a description of any mitigation measures proposed to avoid and/or minimize project effects on environmental justice communities.

(g) identification of any non-English speaking groups, within the geographic scope of analysis, that would be affected by the project (regardless of whether the group is part of an identified environmental justice community). Please describe your previous or planned efforts to identify and communicate with non-English speaking groups, and identify and describe any measures that you propose to avoid and minimize any project-related effects on these communities.

When you file your response with the Commission, please include documentation of any consultation you conducted with entities that expressed interest in environmental justice, copies of their comments, and an explanation of how you have addressed their comments in your final response.

**Exhibit F – General Design Drawings, Supporting Design Report**

26. An applicant must provide a supporting design report (SDR) that complies with section 4.41(g)(3) of the Commission's regulations, and demonstrates that existing and proposed structures are safe and adequate to fulfill their stated functions. No SDR report was filed with the DLA. Therefore, please provide the SDR in the FLA.

**Exhibit G – Project Boundary Maps**

27. The Exhibit G maps, included with the DLA, show a proposed project boundary, along with the existing project boundary. Please submit, as part of the FLA, GIS data layers for both of the project boundaries.

28. The Exhibit G maps show several inholding areas within the project boundary. In the FLA, please: (a) describe each of these areas; (b) identify ownership; and (c) describe the reason(s) that they are not included within the proposed project boundary.

**Attachment A**

**Table 1: Environmental Justice Data Template**

| | RACE AND ETHNICITY DATA | | | | | | | | | | LOW-INCOME DATA |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **Geography** | **Total Population (count)** | **White Alone Not Hispanic (count)** | **African American (count)** | **Native American/ Alaska Native (count)** | **Asian (count)** | **Native Hawaiian & Other Pacific Islander (count)** | **Some Other Race (count)** | **Two or More Races (count)** | **Hispanic or Latino (count)** | **Total Minority (%)** | **Below Poverty Level (%)** |
| **State** | | | | | | | | | | | |
| **County or Parish** | | | | | | | | | | | |
| **Census Tract X, Block Group X** | | | | | | | | | | | |

## Joyce Foster

**From:** Joyce Foster
**Sent:** Friday, November 4, 2022 3:52 PM
**To:** Jacob Harrell <jacob.d.harrell@wv.gov>
**Subject:** Lake Lynn Hydroelectric Project (FERC Project No. 2459) DLA

Jacob,

I am reaching out to you to as a follow-up to the FERC comments on the Lake Lynn Draft License Application. We are proposing to remove a nature viewing area that is only accessible by boat. I would like to discuss whether WVDNR is supportive of this request.

Thank you,


**Joyce A. Foster | Director, Licensing and Compliance**
**Eagle Creek Renewable Energy**
Mobile: 804 338 5110
Email: joyce.foster@eaglecreekre.com


EAGLE CREEK
— RENEWABLE ENERGY —

November 1, 2002

Electronic File

Kimberly D. Bose, Secretary
Federal Energy Regulatory Commission
888 First Street, N.E.
Washington, DC 20426

**RE: Lake Lynn Hydroelectric Project (FERC no. P-2459); Draft License Application Comments**

Dear Secretary Bose:

Thank you for the opportunity to provide comments on the referenced Draft License Application (DLA) for the Lake Lynn Hydroelectric Project (Lake Lynn, FERC no. P-2459). Lake Lynn Generation, LLC (applicant) submitted the DLA for Lake Lynn on August 5, 2022. The West Virginia Division of Natural Resources, Wildlife Resources Section (WRS) has reviewed the submitted DLA and offers the following comments pursuant to 18 C.F.R. §4.38(c)(5):

**Exhibit E, 2.1.1**

In addition to the US Fish and Wildlife Service and National Marine Fisheries Service, authority to prescribe fishway protections is also afforded to the State of West Virginia through provisions within WV state code § 61-3-47 which requires free and easy passage at any dam constructed on waters within West Virginia and further provides authority to the Division of Natural Resources to prescribe fishway protections at any water concourse obstructions.

**Exhibit E, 3.1**

Results of recent fisheries assessments (Matt et al 2021) of Cheat Lake would indicate the need to provide for a deviation from the No-Action Alternative to better protect the Cheat Lake fishery.

**Exhibit E, 3.2.2**

A new recreation plan for Lake Lynn should additionally address the development of the shoreline. Any changes to the shoreline (i.e., addition of new docks/piers) would have an effect

Data from spot checks conducted by WV Department of Environmental Protection (WVDEP) are not comparable to the data collected by the applicant through the continuous water quality monitoring station (US Geological Survey gage station) at the facility. WVDEP's program collects one shoreline (right descending bank) sample bi-monthly at a location. The location of this sample does not match the location of the gage station. Further, the spot check collection by WVDEP only offers a brief snapshot of water quality conditions and cannot possibly capture the true nature of water quality at the project. The WRS does not agree with including WVDEP spot check data within this report due to the inherent incompatibility between the spot check data collection program and the continuous monitoring data collection program.

**Exhibit E, 4.3.2.1**

Prior to March 2020, sedimentation at the Sunset Beach Marina public boat launch reached levels that hampered and severely restricted recreation activity and the public's ability to use the boat launch. This area was dredged between March 9 and March 13, 2020, to an elevation of 861 feet, allowing for safe passage for boats at a lake elevation of 865 feet. Since that date, sediment has continued to accumulate within the docks and within the dredged channel. There is concern that as these areas continue to accumulate sediment, over time the Sunset Beach Marina public boat launch and associated boat docks may become inoperable once again. Monitoring of sedimentation of Sunset Beach Marina public boat launch should be conducted on, at the very least, a yearly basis to determine conditions of sedimentation and to allow for the ability to timely and effectively address any sedimentation issues as they occur. Additionally, a dredging plan should be developed, in consultation with WRS.

**Exhibit E, 4.4.1.1.2**

The Lake Lynn Project has a history of exhibiting periods of low dissolved oxygen (<5mg/L) in the tailrace. Such periodic events typically occur from August to October when increased water temperatures coupled with low in flow contribute to a depletion of available dissolved oxygen passing downstream. Prolonged period of low dissolved oxygen can have profound effects on ichthyofauna, as well as mussel species and other aquatic organisms. Even short duration periods of low dissolved oxygen can depress activity and increase stress responses in aquatic fauna. Therefore, the WRS requests that further attention be afforded to this matter and that operational changes be made to prevent future deviations from occurring. The procedures to address dissolved oxygen should be described in detail with descriptions of steps taken to avoid low dissolved oxygen situations, water quality thresholds that would act as trigger points for various steps in the process, and mechanisms to increase dissolved oxygen in the tailwaters. Such procedures should be made in consultation with WRS and WVDEP.

**Exhibit E, 4.5.1**

To date, the WRS has not been made aware of results for a desktop fish entrainment analysis by the applicant. Beyond the initial consultation with the applicant requesting a fish entrainment analysis, the WRS has not had any further consultation with Eagle Creek regarding the entrainment analysis, to include study design and species list. The WRS has noted several errors and deficiencies in the fish entrainment analysis presented within the DLA. These issues will be expounded further under comments for Appendix D.

**Exhibit E, 4.5.2.1**

The proposed action has been demonstrated to potentially adversely affect fish species during spawning periods, especially yellow perch, as noted elsewhere within the DLA. The noted improvements made in fish assemblages are not attributable to project operations. Rather, they are most likely the result of improvements made in upstream water quality.

**Exhibit E, 4.9**

The applicant has offered no reason for the proposed removal of the boat accessible Cheat Haven nature viewing area. The WRS is aware of a separate proposal from a third-party developer (Tuscan Ridge) planning to construct a substantial boat dock area (84 slips) in the general vicinity of the boat accessible Cheat Haven nature viewing area. The WRS has expressed its opposition to such development. The WRS is concerned that the removal of the Cheat Haven nature viewing area would lead to further development of the shoreline, which may contribute to increased erosion, increased sedimentation, and loss of valuable aquatic shoreline habitat. The WRS would therefore request that this area remain as a boat accessible nature viewing area.

**Exhibit E, 4.9.1.1.3**

The courtesy dock at the winter boat launch area continues to be unsafe, despite multiple requests to repair. Issues with the courtesy dock have been documented for at least the past 5 years. As the condition of the courtesy dock continues to deteriorate, the likelihood of somebody seriously injuring themselves at the dock increases. The WRS is concerned about public safety at this courtesy dock and will continue to request that these concerns be addressed by the applicant to ensure the safe use of the facilities.

The location of the swimming beach leaves it vulnerable to erosion. It receives little to no protection from heavy flows from Cheat River. The WRS recommends relocating to a more suitable location. As always, the WRS would be available to consult with the applicant in identifying more suitable beach location areas.

**Exhibit E, 4.9.1.1.4**

seven fish species examined. The WRS is having difficulty in understanding how the turbine survival of two fish species can represent five other fish species with different morphologies and behaviors.

The estimated number of fish entrained is lower than expected, particularly for walleye. Movement studies of walleye in Lake Lynn would indicate walleye may have a higher propensity for entrainment due to their migratory behavior and nature of congregating near dam facilities (Smith 2015; Jernejcic 1986). This may be a relic of using the downstream fish community to identify entrainment within the reservoir community.

One of the goals of any entrainment analysis is to identify the dangers in downstream fish passage. Blade-strike mortality is only one component of the challenges imposed on downstream fish passage at the project. Other aspects to consider would be barotrauma and spill over the dam face. This desktop entrainment analysis was restricted to just examining blade-strike mortality. As such, the WRS would request further analysis that could shed light on barotrauma effects and potential spill mortality. Additionally, in-field verification of the desktop analysis may be warranted to offer support for any conclusions presented by this analysis.

Thank you for the opportunity to review the variance request. If you have any questions or comments related to the WRS' position regarding this reservoir elevation variance, please contact me by phone at XXX-XXX-XXXX or through email at XXXX.X.XXXXX@wv.gov.

Sincerely Yours,

*Danny Bennett*

WVDNR – Wildlife Resources Section
Natural Resources Program Manager 1
Coordination

Study References:

Jernejcic, F. 1986. Walleye migration through Tygart Dam and angler utilization of the resulting tailwater and lake fisheries. Reservoir Fisheries Management: Strategies for the 80's. pg 294-300/

**Joyce Foster**

| | |
|---|---|
| **From:** | Duane Nichols <duane330@aol.com> |
| **Sent:** | Tuesday, November 8, 2022 8:34 PM |
| **To:** | Joyce Foster |
| **Cc:** | Mike Strager; ChesterMcGraw; Donna Weems; Duane Nichols |
| **Subject:** | CLEAR Comments on Draft Relicensing Application P-2459 (typos removed) |



# CLEAR Comments on Draft Relicensing Application for Lake Lynn Hydroelectric Project (P-2459), November 8, 2022.

1. THE RELICENSING PROCESS IS CHALLENGING FOR THE PUBLIC. This process seems unnecessarily long and drawn-out, being conducted over multiple years. And, the status of input is not at all clear as to what is "heard" and what is accepted for use. The draft relicensing document being some 480 pages is too large to comprehend or evaluate.

2. CLEAR EXPECTED A COMPREHENSIVE SHORELINE MANAGEMENT PLAN AND RECREATION GUIDELINES TO BE ALREADY IN PLACE BUT APPARENTLY THIS IS BEING DELAYED FOR TWO TO THREE MORE YEARS. A number of topics cry out for attention on Cheat Lake. An up dated dock and boat capacity study is needed. The shoreline camping issues continue. Preparations are needed for possible landslides and washouts that interfere with or close the trail(s). The need for an expanded swimming area plus a dog beach exists as well as regular maintenance of these areas. Rest room facilities and regular trash removal are important.

3. CLEAR RECOMMENDS & REQUESTS NEAR-TERM ATTENTION FOR A NUMBER OF ACTIVITIES:

a. SWIMMING BEACH ~ CLEAR was instrumental in the establishment of a Swimming Beach on Cheat Lake, which exceeds capacity on many week-ends and most holidays. We have worked with Lake Lynn Hydro to extend this beach to the Day Use Boat Docks, but this extension process has slowed. It is our priority that this work continue to completion due to its substantial public need.

b. DOG BEACH ~ In the past, dogs have been swimming at the Swimming Beach and interfering with the activities of small children there. CLEAR has recommended a Dog Beach for exclusive use of dogs at the small beach location in the Morgan Run Backwater, noticeably separate from and well separated from the Swimming Beach. We anticipate that no extra preparations or costs, other than signage, will be involved. (The requirement that dogs must be on a leash will not detract from or preclude this plan.)

c. SHORELINE CAMP SITES ~ CLEAR believes that the granting of shoreline camp sites has been discontinued and that residual sites were to be cleaned up. We support these efforts and encourage attention to these plans.

d. SEA WALLS & BUOYS ~ Inappropriate and illegal sea walls and buoys are sometimes installed in the Lake. Attention to these situations can be included in the Lake monitoring activities that are needed on a continuing periodic basis.

c. CAPACITY STUDIES ~ CLEAR has observed the continuing growth in the number of docks and boats on the Lake, some of excessive horsepower due to the noise created. Another capacity study may well be justified in the near term, rather than wait until relicensing to decide.

d. WILDLIFE VIEWING AREAS ~ CLEAR supports the development of specific plans for the Wildlife Viewing Areas as part of the overall Project planning described as post relicensing. It may be that one or two can be discontinued, or planted for long term monitoring at little or no cost. There is no need to discontinue any of them during relicensing.

e. THE SHEEPSKIN TRAIL WILL DESIRABLY SOMEDAY INTERFACE TO THE CHEAT LAKE TRAIL. This year the Sheepskin Trail has been extended a few miles from the mouth of the Cheat River at Pt. Marion, PA, toward the Lake and Dam. CLEAR recommends that provisions proceed to interface the Sheepskin Trail with the Cheat Lake Trail, at least for limited times of greatest usage. Generally, these trails may well ultimately interconnect Parkersburg, WV, on the Ohio River with Washington, DC, on the Potomac River.

f. BIOMONITORS SHOULD BE PLACED IN AT LEAST FOUR OTHER LOCATION IN ADDITION TO THE DAM AREA. Four recommended important locations for additional biomonitors with easy access are as follows: # Southwest end of the Day Use Boat Docks to monitor the swimming area, # Under the CLEAR dock along the South Trail, near its end, # Off the parking area at the east end of the new Route 857 Bridge across the Lake, aka. the Ices Ferry location, and # Downstream boundary of Mt. Chateau property at the Lake (WV State owned property). The latter will provide a measure of the inflow water conditions.

g. OTHER ACTIVITIES ~ # CLEAR supports continued fishing and boating on the Lake and encourages Lake Lynn Hydro and the WV Division of Natural Resources to continue studies and activities that benefit fish, mussels, turtles, etc. The hellbender should not be neglected, as upstream habitat appears compatible. # The Winter Boat Ramp is an important feature to maintain; and, this location is important as, and should be maintained as, a kayak launch site year round. # A bicycle rental concession at the Morgan Run & Ruble Run trail head would be a useful addition to the overall recreation plan — volunteers may be available for its operation after the initial establishment is achieved.

4. AN ON-SITE RANGER IS NEEDED TO PATROL THE RECREATIONAL AREA. Particularly on Saturdays and Sundays during the recreation & boating season, a trained “steward” is needed to monitor the recreational area, to provide information to visitors, to conduct safety surveys, to provide a liaison with security services, and to respond quickly by requesting assistance for any accident victims. This is necessitated because of the extent of the recreational area, because of the dangers of swimming, jogging and bicycling as well as possible incidents involving dogs, wild animals and steep terrain.

5. REGULAR “LAKE LYNN COMMUNITY MEETINGS” ARE NEEDED TO PROVIDE INTERACTION AMONG LAKE USES, LAKE LYNN HYDRO, MONONGALIA COUNTY OFFICIALS, WV DIVISION OF NATURAL RESOURCES, AND OTHER INTERESTED PARTIES. Quarterly meetings at the Cheat Lake Fire Department would be appropriate for those interested in timely information, timely opportunities to provide input, and generally to ensure that the general public has an obvious channel to the Project. Participation by Lake Lynn Hydro personnel would be essential.

NOTE: CLEAR wishes to express our appreciation to Lake Lynn Hydro, to WV DNR, to FERC, and to all the others interested and concerned about Cheat Lake and this Project. We believe that the potential here is for better and more services to this region. Let’s always remember that the Lake Lynn Dam was dedicated from the very beginning to providing for recreation and a public service. Hopefully, we can continue the quest for more and better communications and understanding among all interested parties.

SUBMITTED BY THE CHEAT LAKE ENVIRONMENT AND RECREATION ASSOCIATION, Duane Nichols (President), Michael Strager (Vice President), Ann Chester (Secretary), Donna Weems (Treasurer). ADDRESS: CLEAR, 330 Dream Catcher Circle, Morgantown, WV 26508.

## Joyce Foster

**From:** Joyce Foster
**Sent:** Friday, November 11, 2022 3:00 PM
**To:** ra-epcoastalzone@epa.gov
**Subject:** Lake Lynn Hydroelectric Project (FERC Project No. 2459) PA Coastal Zone

Lake Lynn Generation, LLC is the owner and operator of the Lake Lynn Hydroelectric Project located on the Cheat River in Monongalia County, WV and Fayette County, PA. Based on a review of the PA Coastal Resources Management Program website, we do not believe this project is located within a Coastal Zone and, therefore, is not subject to the CZMA. The website notes that Pennsylvania has two coastal areas: Lake Erie Coastal Zone located within Erie County and Delaware Estuary Coastal Zone within Bucks, Philadelphia, and Delaware counties. Can you please confirm our understanding at your earliest convenience.

Thank you,

**Joyce A. Foster | Director, Licensing and Compliance**
**Eagle Creek Renewable Energy**
Mobile: 804 338 5110
Email: joyce.foster@eaglecreekre.com

EAGLE CREEK
— RENEWABLE ENERGY —

# APPENDIX B

## RESPONSE TO COMMENTS ON THE DRAFT LICENSE APPLICATION

| Filed Date | Comment Number | Commentor | Section | Comment | Comment Response |
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| 9/8/2022 | | United States Department of the Interior Bureau of Indian Affairs | General Comments | The Catawba Indian Nation is not listed as one of the American Indian tribes contacted in the application. Monongalia County, West Virginia, is within an area of historic interest to the Catawba Indian Nation. | The Catawba Indian Nation has been added to the Lake Lynn Project distribution list as well as included in the list of potentially affected Tribes within the Lake Lynn Project area. |
| 11/3/2022 | 1 | FERC | General Comments | Water Quality Plan<br>Recreation Plan<br>Shoreline Management Plan<br>To ensure that the FLA includes all of the proposed protection, mitigation, and enhancement (PME) measures for review by Commission Staff and stakeholders, and that staff has sufficient information to inform an economic and environmental analysis for each of the plans, please include, with the FLA, draft plans or the conceptual elements of the plans, as well as cost estimates for the plans. | Please see Exhibit E Section 3.2.2, 4.3.2.1,4.4.2.1, and 4.9.2.1 for additional details. |
| 11/3/2022 | 2 | FERC | General Comments | Please include in the FLA the reason(s) that the land (10 acres) no longer serves a project purpose and would no longer need to be included within the project boundary, noting any structures that may be sited on the land. Also, please provide a map showing the location of the land to be removed in relation to the proposed project boundary | Please see Exhibit E Section 3.2.1 for addition details. |
| 11/3/2022 | 3 | FERC | Exhibit A | Please provide (a) gross storage capacity (acre-feet) and average depth (feet) of the project impoundment; (b) crest elevation (feet) of the dam; (c) dimensions of the (i) log boom, along with a description of its composition, and (ii) substation; (d) length and width of the project tailrace; (e) sill elevation, status (i.e. operational or not), uses (e.g. high inflow conditions, minimum flow release, etc.), mode of operation (i.e. automatic or manual); and frequency and method of repair, of the Tainter gates; (f) rated capacity, minimum hydraulic capacity, and maximum hydraulic capacity of each turbine-generator unit; and (g) voltage of each transformer | Additional information is provided in Exhibit A of the Final License Application. |

| **Filed Date** | **Comment Number** | **Commentor** | **Section** | **Comment** | **Comment Response** |
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| 11/3/2022 | 4 | FERC | Exhibit A | Detailed description of trash racks, including: (a) the dimensions of the trash rack(s); (b) the trash racks' clear bar spacing; (c) the intake approach velocity; and (d) the through-rack velocity. | Additional information provided in Exhibit A of the Final License Application. |
| 11/3/2022 | 5 | FERC | Exhibit A | Describe the appurtenant facilities and equipment (electrical, mechanical, etc.) associated with the proposed project | Additional information is provided in Exhibit A of the Final License Application |
| 11/3/2022 | 6 | FERC | Exhibit A | Clarify the dimensions of the project powerhouse and the project's average annual generation | Additional information is provided in Exhibit A of the Final License Application. |
| 11/3/2022 | 7 | FERC | Exhibit A | Please explain: (a) the reason for the replacement of unit 2; (b) the specific upgrade(s) made to the unit; and (c) whether the upgrade(s) resulted in any change in rated capacity | Additional information is provided in Exhibit A of the Final License Application. |

| Filed Date | Comment Number | Commentor | Section | Comment | Comment Response |
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| 11/3/2022 | 8 | FERC | Exhibit B | Please provide a more detailed description of peaking conditions, including: (a) the frequency and timing of peaking operation (i.e. peak hours, number of cycles per day, etc.), and whether operations vary seasonally; (b) the sequence of operation of the turbine-generator units; (c) whether the project operates to the full extent of the existing seasonal impoundment fluctuation limits; and (d) the amount of time needed to refill the impoundment to the normal maximum surface water elevation. In addition, please provide historical records from the past 10 years of daily lake level elevations and daily generation at the Lake Lynn Powerhouse. | Additional information is provided in Exhibit B of the Final License Application<br><br>Historical records from 2012-2021 (9 years) have been provided for both the daily lake level elevations and the daily generation at the Lake Lynn Powerhouse. Data from 2021-2022 will be filed with FERC as a supplemental filing within 30-days of the filing of the FLA. |
| 11/3/2022 | 9 | FERC | Exhibit B | Please clarify the operating condition(s) that govern use of the powerhouse versus the Tainter gate(s) as the mechanism for releasing the minimum flow | Additional information is provided in Exhibit B Section 1.3.1 of the Final License Application |
| 11/3/2022 | 10 | FERC | Exhibit B | Please provide the median monthly flow duration at the dam in both graphic and tabular form for an average flow year | The median monthly flow duration at the dam is shown in the 50% flow duration curve provided in both graphic and tabular form in Appendix B-1 of Exhibit B of the Final License Application. |
| 11/3/2022 | 11 | FERC | Exhibit B | Please provide the tabular data for the annual and monthly flow duration curves provided in appendix B | The tabular data for the annual and monthly flow duration curves is provided in Appendix B -1 of Exhibit B of the Final License Application. |

| Filed Date | **Comment Number** | **Commentor** | **Section** | **Comment** | **Comment Response** |
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| 11/3/2022 | 12 | FERC | Exhibit E: General Comments | Please provide the certification of consistency from the Pennsylvania CZMA agency, or a statement from the CZMA agency that the project is not subject to CZMA review | Lake Lynn has requested concurrence from the Pennsylvania Coastal Resources Management Program that the Project is not subject to CZMA review but no response has been received. However, a review of the West Virginia Department of Environmental Protection Coastal Resources Management Program website indicates that Pennsylvania has two coastal areas: Lake Erie Coastal Zone located within Erie County and Delaware Estuary Coastal Zone within Bucks, Philadelphia, and Delaware counties. Section 2.5 has been revised to provide this information. |
| 11/3/2022 | 13 | FERC | Exhibit E: General Comments | Please file GIS shapefiles associated with the studies, if available, with the FLA. | Shapefiles are provided with the Final License Application |
| 11/3/2022 | 14 | FERC | Exhibit E: Water and Aquatic Resources | Revise tables 7, 8, and 12 to show the range (minimum and maximum) in values by year, as well as the average for each constituent by year. | Tables 7, 8 and 12 were replaced to show minimum, maximum and average parameter by year (when available) and the corresponding text has been altered to match the updated table. |
| 11/3/2022 | 15 | FERC | Exhibit E: Water and Aquatic Resources | Please include copies of reference documents in section 4.5.1 (8 total) | Copies of the eight references documents are included as part of this response to comments matrix. |

| **Filed Date** | **Comment Number** | **Commentor** | **Section** | **Comment** | **Comment Response** |
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| 11/3/2022 | 16 | FERC | Exhibit E: Terrestrial Resources | Please provide the following information in the FLA: (a) a discussion of whether the project transmission line poles and other equipment currently installed are consistent with the Avian Power Line Interaction Committee (APLIC) and USFWS guidelines to minimize adverse avian interactions; (b) detailed descriptions, figures, and diagrams of the project transmission facilities and any existing avian protection devices currently installed: (c) the specifications and locations of any proposed avian protection measures that would be consistent with APLIC guidelines, if applicable; (d) a copy of the Avian Protection Plan for the project or a general Avian Protection Plan that Lake Lynn implements at all of its hydropower projects that include transmission facilities, if applicable; (e) data regarding observed or documented avian interactions with the project's transmission facilities, such as nest building, perching, electrocutions, collisions, and any outages related to such interactions, if available | To Lake Lynn's knowledge, the Lake Lynn Project primary transmission line is not consistent with the Avian Power Line Interaction Committee (APLIC) and USFWS guidelines to minimize adverse avian interactions. The Lake Lynn Project transmission lines are dual 800-foot-long, 138kV lines. Lake Lynn staff have not observed any avian interactions with the Lake Lynn Project transmission facilities. |
| 11/3/2022 | 17 | FERC | Exhibit E: Terrestrial Resources | Please provide the following information in the FLA: (a) the types of existing and proposed vegetation management activities used at the project (e.g. tree trimming and removal, mowing, and herbicide applications); (b) the locations where each vegetation management technique occurs within the project boundary (e.g. transmission facilities; access roads; parking areas; and recreation areas, such as the tailrace fishing area, Cheat lake Trail, Cheat Lake Park, Sunset Beach Marina Public Boat launch, nature viewing areas); (c) the procedures, including any time of year restrictions, for managing vegetation in sensitive habitats such as wetlands, riparian areas, and suitable locations for rare, threatened, or endangered species; and (d) a schedule for conducting regular vegetation management (i.e. activities performed annually, seasonally, as-needed). If herbicides are used to control vegetation, please include the method/location of application (e.g. foliar, stump, stem, and/or vine) | Please see Exhibit E Section 4.7.2.1 |

| Filed Date | Comment Number | Commentor | Section | Comment | Comment Response |
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| 11/3/2022 | 18 | FERC | Exhibit E: Terrestrial Resources | Please provide the following information in the FLA: (a) the estimated acreages of each identified upland and wetland habitat type within the existing and proposed project boundary; (b) a map showing the identified uplands and wetlands relative to the existing and proposed project boundary; (c) a description of project operation and maintenance activities (e.g. reservoir fluctuations associated with seasonal peaking operation, vegetation management activities, and project-related recreation) in relation to existing upland and wetland habitats; and (d) detailed descriptions of the potential project-related effects on these botanical resources, including the effects of the proposed removal of land from the project boundary. | Please see Exhibit E Section 4.7 for additional details |
| 11/3/2022 | 19 | FERC | Exhibit E: Terrestrial Resources | Please provide: (a) the locations of terrestrial non-native invasive plants in the project boundary; (b) a description of the potential project-related effects on the identified populations of both aquatic and terrestrial, non-native, invasive plants in the project boundary, including: (i) the existing seasonal reservoir fluctuations associated with peaking operations; (ii) project maintenance activities, including vegetation management; and (iii) project-related recreation activities; (c) the methods being used to monitor and/or manage the identified populations of brittle naiad, wild celery, and curly-leaf pondweed, and any terrestrial non-native invasive plants in the project boundary if applicable; and (d) the entity/entities managing these populations, if applicable. | Please see Exhibit E Section 4.7 for additional details |
| 11/3/2022 | 20 | FERC | Exhibit E: Threatened and Endangered Species | Please ensure that the Rare, Threatened, and Endangered Species section: (a) provides detailed, species-specific discussions of the potential project-related effects (i.e. operation, maintenance, including seasonal vegetation management; and project-related recreation activities; as well as the proposed removal of land from the project boundary) on federally listed, proposed, and candidate species, and their habitats, that may occur at the Project. These species include the Indiana bat, NLEB, tricolored bat, flat-spired three-toothed snail, and monarch butterfly; and (b) ensures that the description of any existing or proposed tree removal activities, includes cutting down, harvesting, destroying, | Section 4.8 of Exhibit E of the FLA has been revised to include this information. |

| **Filed Date** | **Comment Number** | **Commentor** | **Section** | **Comment** | **Comment Response** |
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| | | | | trimming, or manipulating in any other way the trees, saplings, snags, or any other form of woody vegetation likely to be use by NLEB's or tricolored bats within the project boundary. | |
| 11/3/2022 | 21 | FERC | Exhibit E: Recreation | So that Commission staff can analyze the effects of removing the nature viewing area from the project boundary, please provide the following in the FLA: (a) an explanation of why Lake Lynn is requesting to remove the habitat viewing area; (b) the record of consultation with West Virginia DNR on the proposed removal; (c) images taken from the viewing area; (d) visitor usage information or data for the viewing area; (e) information on any dock, ramp, or bathroom facilities, if any such infrastructure exists for boaters visiting the nature viewing area; (f) whether or not any such infrastructure would be removed; and (g) how the removal of the viewing area would be communicated to Lake Lynn Project visitors. | Please see Exhibit E Section 4.9.2.1 for additional details |
| 11/3/2022 | 22 | FERC | Exhibit E: Land Use and Aesthetic Resources | So that Commission staff can analyze resources at the project, in the FLA, please clarify if any of the recreation sites add additional aesthetic resources to the project; if so, please include images taken from the observation points. The project offers several wildlife viewing opportunities, including views from a tower, that may offer scenic viewing of the project area. | Please see Exhibit E Section 4.9.2.1 for additional details. To clarify, there is no view from a tower that offers scenic views of the project. |
| 11/3/2022 | 23 | FERC | Exhibit E: Cultural Resources | So that Commission staff can describe the affected environment and analyze potential effects to cultural and Tribal resources, in the FLA, please provide a description of the pre-European contact historical background and archeological resources within the region. | Please see Exhibit E Section 4.11 of the FLA for additional information. |

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| 11/3/2022 | 24 | FERC | Exhibit E: Cultural Resources | In the FLA, please provide a record of consultation with the West Virginia State Historic Preservation Office and Pennsylvania State Historic Preservation Office, including concurrence on the Area of Potential Effects | Please see Exhibit E Appendix A of the FLA. To date, Lake Lynn has not received concurrence from either SHPO on the APE. |
| 11/3/2022 | 25 | FERC | Exhibit E: Environmental Justice | To assist Commission staff with its analysis under the National Environmental Policy Act (NEPA), please provide the items outlined in FERC's comments on the DLA in the FLA | Please see Exhibit E Section 4.14 of the FLA for the requested Environmental Justice analysis. |
| 11/3/2022 | 26 | FERC | Exhibit F | An applicant must provide a supporting design report (SDR) that complies with section 4.41(g)(3) of the Commission's regulations, and demonstrates that existing and proposed structures are safe and adequate to fulfill their stated functions. No SDR report was filed with the DLA. Therefore, please provide the SDR in the FLA | Please see Exhibit F Appendix of the Final License Application. |
| 11/3/2022 | 27 | FERC | Exhibit G | The Exhibit G maps, included with the DLA, show a proposed project boundary, along with the existing project boundary. Please submit, as part of the FLA, GIS data layers for both of the project boundaries | Data layers for both Project boundaries are being filed with the Final License Application. |
| 11/3/2022 | 28 | FERC | Exhibit G | The Exhibit G maps show several inholding areas within the project boundary. In the FLA, please: (a) describe each of these areas; (b) identify ownership; and (c) describe the reason(s) that they are not included within the proposed project boundary | Please see Exhibit E Section 3.2.1 |

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| 11/7/2022 | | West Virginia Department of Natural Resources | Exhibit E | In addition to the US Fish and Wildlife and National Marine Fisheries Service, authority to prescribe fishway protections is also afforded to the State of West Virginia through provisions within WV State code SS 61-3-47 which requires free and easy passage at any dam constructed on waters within West Virginia and further provides authority to the Division of Natural Resources to prescribe fishway protections at any water concourse obstructions. | Please see Exhibit E Section 2.1.1 |
| 11/7/2022 | | West Virginia Department of Natural Resources | Exhibit E: 3.1 | Results of recent fisheries assessments (Matt et al 2021) of Cheat Lake would indicate the need to provide for a deviation from the No-Action Alternative to better protect the Cheat Lake fishery. | Comment noted |
| 11/7/2022 | | West Virginia Department of Natural Resources | Exhibit E: 3.2.2 | A new recreation plan for Lake Lynn should additionally address the development of the shoreline. Any changes to the shoreline (i.e., addition of new docks/piers) would have an effect. | Please see Exhibit E Section 4.9.2.1 for additional details |
| 11/7/2022 | | West Virginia Department of Natural Resources | Exhibit E: 3.2.2 | Data from spot checks conducted by WV Department of Environmental Protection (WVDEP) are not comparable to the data collected by the applicant through the continuous water quality monitoring station (US Geological Survey gage station) at the facility. WVDEP-s program collects one shoreline (right descending bank) sample bi-monthly at a location. The location of this sample does not match the location of the gage station. Further, the spot check collection by WVDEP only offers a brief snapshot of water quality conditions and cannot possibly capture the true nature of water quality at the project. The WRS does not agree with including WVDEP spot check data within this report due to the inherent incompatibility between the spot check data collection program and the continuous monitoring data collection program. | Please see revised Exhibit E Section 4.4.1 |

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| 11/7/2022 | | West Virginia Department of Natural Resources | Exhibit E: 4.3.2.1 | Prior to March 2020, sedimentation at the Sunset Beach Marina public boat launch reached levels that hampered and severely restricted recreation activity and the public's ability to use the boat launch. This area was dredged between March 9 and March 13, 2020, to an elevation of 861 feet, allowing for safe passage for boats at a lake elevation of 865 feet. Since that date, sediment has continued to accumulate within the docks and within the dredged channel. There is concern that as these areas continue to accumulate sediment, over time the Sunset Beach Marina public boat launch and associated boat docks may become inoperable once again. Monitoring of sedimentation of Sunset Beach Marina public boat launch should be conducted on, at the very least, a yearly basis to determine conditions of sedimentation and to allow for the ability to timely and effectively address any sedimentation issues as they occur. Additionally, a dredging plan should be developed, in consultation with WRS. | Lake Lynn is proposing measures in the new Recreation Management Plan. Please see Exhibit E Section 3.2.2 and 4.3.2.1 and 4.9.2.1 for additional information |
| 11/7/2022 | | West Virginia Department of Natural Resources | Exhibit E: 4.4.1.1.2 | The Lake Lynn Project has a history of exhibiting periods of low dissolved oxygen (<5mg/L) in the tailrace. Such periodic events typically occur from August to October when increased water temperatures coupled with low in flow contribute to a depletion of available dissolved oxygen passing downstream. Prolonged period of low dissolved oxygen can have profound effects on ichthyofauna, as well as mussel species and other aquatic organisms. Even short duration periods of low dissolved oxygen can depress activity and increase stress responses in aquatic fauna. Therefore, the WRS requests that further attention be afforded to this matter and that operational changes be made to prevent future deviations from occurring. The procedures to address dissolved oxygen should be described in detail with descriptions of steps taken to avoid low dissolved oxygen situations, water quality thresholds that would act as trigger points for various steps in the process, and mechanisms to increase dissolved oxygen in the tailwaters. Such procedures should be made in consultation with WRS and WVDEP. | Please see Exhibit E Section 3.2.2 and 4.4.2.1 for additional information and Lake Lynn's proposed Operation Plan that would include standard operating procedures to be implemented during period of low DO levels in an effort to mitigate low tailrace DO levels. |

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| 11/7/2022 | | West Virginia Department of Natural Resources | Exhibit E: 4.5.1 | To date, the WRS has not been made aware of results for a desktop fish entrainment analysis by the applicant. Beyond the initial consultation with the applicant requesting a fish entrainment analysis, the WRS has not had any further consultation with Eagle Creek regarding the entrainment analysis, to include study design and species list. The WRS has noted several errors and deficiencies in the fish entrainment analysis presented within the DLA. These issues will be expounded further under comments for Appendix D. | The Desktop Fish Entrainment study was completed in January 2021 as outlined in the Study Plan that was developed in consultation with resource agencies. The draft report was shared with the Project stakeholders. The report has been revised and is provided Appendix D of the Draft License Application. A copy of a revised study report is also included in Appendix D of the Final License Application. |
| 11/7/2022 | | West Virginia Department of Natural Resources | Exhibit E: 4.5.2.1 | The proposed action has been demonstrated to potentially adversely affect fish species during spawning periods, especially yellow perch, as noted elsewhere within the DLA. The noted improvements made in fish assemblages are not attributable to project operations. Rather, they are most likely the result of improvements made in upstream water quality. | Comment noted |
| 11/7/2022 | | West Virginia Department of Natural Resources | Exhibit E: 4.9 | The applicant has offered no reason for the proposed removal of the boat accessible Cheat Haven nature viewing area. The WRS is aware of a separate proposal from a third-party developer (Tuscan Ridge) planning to construct a substantial boat dock area (84 slips) in the general vicinity of the boat accessible Cheat Haven nature viewing area. The WRS has expressed its opposition to such development. The WRS is concerned that the removal of the Cheat Haven nature viewing area would lead to further development of the shoreline, which may contribute to increased erosion, increased sedimentation, and loss of valuable aquatic shoreline habitat. The WRS would therefore request that this area remain as a boat accessible nature viewing area. | Please see Exhibit E Section 4.9.2.1 for additional details |

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| 11/7/2022 | | West Virginia Department of Natural Resources | Exhibit E: 4.9.1.1.3 | The courtesy dock at the winter boat launch area continues to be unsafe, despite multiple requests to repair. Issues with the courtesy dock have been documented for at least the past 5 years. As the condition of the courtesy dock continues to deteriorate, the likelihood of somebody seriously injuring themselves at the dock increases. The WRS is concerned about public safety at this courtesy dock and will continue to request that these concerns be addressed by the applicant to ensure the safe use of the facilities. The location of the swimming beach leaves it vulnerable to erosion. It received little to no protection from heavy flows from Cheat River. The WRS recommends relocating to a more suitable location. As always, the WRS would be available to consult with the applicant in identifying more suitable beach location areas. | Lake Lynn has repaired the courtesy dock several times in recent years. Upon receipt of this recent comment, Lake Lynn confirmed that the dock is in working condition and has all of the floats on. Lake Lynn will explore additional measures to improve the dock.<br><br>Lake Lynn will consult with WVDNR and others on the beach and other recreation measures during the development of the recreation management plan. |
| 11/7/2022 | | West Virginia Department of Natural Resources | Exhibit E: 4.9.1.1.4 | Seven fish species examined. The WRS is having difficulty in understanding how the turbine survival of two fish species can represent five other fish species with different morphologies and behaviors.The estimated number of fish entrained is lower than expected, particularly for walleye. Movement studies of walleye in Lake Lynn would indicate walleye may have a higher propensity for entrainment due to their migratory behavior and nature of congregating near dam facilities (Smith 2015; Jernejcic 1986). This may be a relic of using the downstream fish community to identify entrainment within the reservoir community.One of the goals of any entrainment analysis is to identify the dangers in downstream fish passage. Blade-strike mortality is only one component of the challenges imposed on downstream fish passage at the project. Other aspects to consider would be barotrauma and spill over the dam face. This desktop entrainment analysis was restricted to just examining blade-strike mortality. As such, the WRS would request further analysis that could shed light on barotrauma effects and potential spill mortality. Additionally, in-field verification of the desktop analysis may be warranted to offer support for any conclusions presented by this analysis | Table 4-9 of the desktop entrainment report summarize the previously reported turbine survival estimates available for any of the seven target fish species. To better understand turbine survival for all of the target fish species the size-specific blade strike probabilities in Tables 4-6 and 4-7 of the revised are more appropriate as they are estimates based on parameters specific to the Lake Lynn turbine units. Franke et al. (1997) indicates the probability of turbine contact is most dependent on the distance between blades, number of blades, and fish body length. The length of the fish's body is of greater importance than the species. As noted in the report, entrainment densities for each target species were adapted from the information available for comparably sized hydroelectric projects. A major assumption associated with these calculations are that previously observed densities of target fish species entrained at other project locations are representative of the relative abundance and behavior of the target species at the Lake Lynn Project. Franke et al. (1997) defined the three primary risks to outmigrating fish passing through the turbine environment as 1) mechanical mechanisms, 2) fluid mechanisms, and 3) pressure mechanisms. Mechanical mechanisms were primarily defined as forces on fish body resulting from direct contact with turbine structural components. Fluid mechanisms were defined as shear-turbulence (the effect on fish of encountering hydraulic forces |

| Filed Date | Comment Number | Commentor | Section | Comment | Comment Response |
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| | | | | | due to rapidly changing water velocities) and cavitation (injury resulting from forces on fish body due to vapor pockets imploding near fish tissue). Impacts to fish from pressure result from the inability of a fish to adjust from the region of high pressure immediately upstream of turbine blade to the region of low pressure immediately downstream of the turbine blade. Results from most studies indicate that mechanical related injuries are the dominant source of mortality for fish in the turbine environment at low head (<30 m or 100 ft) projects (Franke et al. 1997) and blade strike is considered the primary mechanism of mortality when fish pass through turbines (Eicher Associates Inc. 1987; Cada 2001). Franke et al. (1997) noted that pressure related injuries appear to be of minor secondary importance when working at low head (< 30 m or 100 ft) hydroelectric projects. |
| 11/8/2022 | | CLEAR | General Comments | THE RELICENSING PROCESS IS CHALLENGING FOR THE PUBLIC. This process seems unnecessarily long and drawn-out, being conducted over multiple years. And, the status of input is not at all clear as to what is "heard" and what is accepted for use. The draft relicensing document being some 480 pages is too large to comprehend or evaluate. | Comment noted |
| 11/8/2022 | | CLEAR | General Comments | CLEAR EXPECTED A COMPREHENSIVE SHORELINE MANAGEMENT PLAN AND RECREATION GUIDELINES TO BE ALREADY IN PLACE BUT APPARENTLY THIS IS BEING DELAYED FOR TWO TO THREE MORE YEARS. A number of topics cry out for attention on Cheat Lake. An updated dock and boat capacity study is needed. The shoreline camping issues continue. Preparations are needed for possible landslides and washouts that interfere with or close the trail(s). The need for an expanded swimming area plus a dog beach exists as well as regular maintenance of these areas. Rest room facilities and regular trash removal are important. | Comment noted. Lake Lynn will continue working with stakeholders on implementation of the existing Recreation Plan and to address the suggested new recreation enhancements during the development of a Recreation Management Plan. Lake Lynn cannot control land uses upland of the Cheat Lake Trail but will continue to address trail issues as the arise. Lake Lynn has already completed some preliminary work to inform the development of a Shoreline Management Plan and will continue to abide by the existing standard land use article of the FERC license. |

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| 11/8/2022 | | CLEAR | General Comments | SWIMMING BEACH ~ CLEAR was instrumental in the establishment of a Swimming Beach on Cheat Lake, which exceeds capacity on many week-ends and most holidays. We have worked with Lake Lynn Hydro to extend this beach to the Day Use Boat Docks, but this extension process has slowed. It is our priority that this work continue to completion due to its substantial public need. | Comment noted. Lake Lynn will continue working with stakeholders on implementation of the existing Recreation Plan and to address the suggested new recreation enhancements during the development of a new Recreation Management Plan. |
| 11/8/2022 | | CLEAR | General Comments | DOG BEACH ~ In the past, dogs have been swimming at the Swimming Beach and interfering with the activities of small children there. CLEAR has recommended a Dog Beach for exclusive use of dogs at the small beach location in the Morgan Run Backwater, noticeably separate from and well separated from the Swimming Beach. We anticipate that no extra preparations or costs, other than signage, will be involved. (The requirement that dogs must be on a leash will not detract from or preclude this plan.) | Lake Lynn will continue working with stakeholders on implementation of the existing Recreation Plan and to address the suggested new recreation enhancements during the development of a new Recreation Management Plan. |
| 11/8/2022 | | CLEAR | General Comments | SHORELINE CAMP SITES ~ CLEAR believes that the granting of shoreline camp sites has been discontinued and that residual sites were to be cleaned up. We support these efforts and encourage attention to these plans | Comment noted. |
| 11/8/2022 | | CLEAR | General Comments | SEA WALLS & BUOYS ~ Inappropriate and illegal sea walls and buoys are sometimes installed in the Lake. Attention to these situations can be included in the Lake monitoring activities that are needed on a continuing periodic basis. | Comment noted. Lake Lynn will continue working with stakeholders on implementation of the existing Recreation Plan and to address the suggested new recreation enhancements during the development of a Recreation Management Plan. Lake Lynn cannot control land uses upland of the Cheat Lake Trail but will continue to address trail issues as the arise. Lake Lynn has already completed some preliminary work to inform the development of a Shoreline Management Plan and will continue to abide by the existing standard land use article of the FERC license. |

| **Filed Date** | **Comment Number** | **Commentor** | **Section** | **Comment** | **Comment Response** |
|---|---|---|---|---|---|
| 11/8/2022 | | CLEAR | General Comments | CAPACITY STUDIES ~ CLEAR has observed the continuing growth in the number of docks and boats on the Lake, some of excessive horsepower due to the noise created. Another capacity study may well be justified in the near term, rather than wait until relicensing to decide | Comment noted. |
| 11/8/2022 | | CLEAR | General Comments | WILDLIFE VIEWING AREAS ~ CLEAR supports the development of specific plans for the Wildlife Viewing Areas as part of the overall Project planning described as post relicensing. It may be that one or two can be discontinued, or planted for long term monitoring at little or no cost. There is no need to discontinue any of them during relicensing. | Comment noted |
| 11/8/2022 | | CLEAR | General Comments | THE SHEEPSKIN TRAIL WILL DESIRABLY SOMEDAY INTERFACE TO THE CHEAT LAKE TRAIL. This year the Sheepskin Trail has been extended a few miles from the mouth of the Cheat River at Pt. Marion, PA, toward the Lake and Dam. CLEAR recommends that provisions proceed to interface the Sheepskin Trail with the Cheat Lake Trail, at least for limited times of greatest usage. Generally, these trails may well ultimately interconnect Parkersburg, WV, on the Ohio River with Washington, DC, on the Potomac River. | Lake Lynn will continue to cooperate with developers of the Sheepskin Trail as an off-license measure since the Sheepskin Trail does not serve a Project purpose. |
| 11/8/2022 | | CLEAR | General Comments | BIOMONITORS SHOULD BE PLACED IN AT LEAST FOUR OTHER LOCATION IN ADDITION TO THE DAM AREA. Four recommended important locations for additional biomonitors with easy access are as follows: # Southwest end of the Day Use Boat Docks to monitor the swimming area, # Under the CLEAR dock along the South Trail, near its end, # Off the parking area at the east end of the new Route 857 Bridge across the Lake, aka. the Ices Ferry location, and # Downstream boundary of Mt. Chateau property at the Lake (WV State owned property). The latter will provide a measure of the inflow water conditions. | Comment noted |

| **Filed Date** | **Comment Number** | **Commentor** | **Section** | **Comment** | **Comment Response** |
|---|---|---|---|---|---|
| 11/8/2022 | | CLEAR | General Comments | CLEAR supports continued fishing and boating on the Lake and encourages Lake Lynn Hydro and the WV Division of Natural Resources to continue studies and activities that benefit fish, mussels, turtles, etc. The hellbender should not be neglected, as upstream habitat appears compatible. The Winter Boat Ramp is an important feature to maintain; and, this location is important as, and should be maintained as, a kayak launch site year round. A bicycle rental concession at the Morgan Run & Ruble Run trail head would be a useful addition to the overall recreation plan — volunteers may be available for its operation after the initial establishment is achieved. | Comment noted. Lake Lynn will continue working with stakeholders on implementation of the existing Recreation Plan and to address the suggested new recreation enhancements during the development of a Recreation Management Plan. |
| 11/8/2022 | | CLEAR | General Comments | An on-site ranger is needed to patrol the recreational area. Particularly on Saturdays and Sundays during the recreation & boating season, a trained “steward” is needed to monitor the recreational area, to provide information to visitors, to conduct safety surveys, to provide a liaison with security services, and to respond quickly by requesting assistance for any accident victims. This is necessitated because of the extent of the recreational area, because of the dangers of swimming, jogging and bicycling as well as possible incidents involving dogs, wild animals and steep terrain. | Lake Lynn currently provides security at Cheat Lake Park in accordance with the current Recreation Plan during the recreation season. The security personnel serve as a "ranger" patrolling the recreation area and providing information and assistance to visitors. |
| 11/8/2022 | | CLEAR | General Comments | Regular “Lake Lynn community meetings” are needed to provide interaction among lake uses, Lake Lynn hydro, Monongalia County officials, WV Division of Natural Resources, and other interested parties. Quarterly meetings at the Cheat Lake Fire Department would be appropriate for those interested in timely information, timely opportunities to provide input, and generally to ensure that the general public has an obvious channel to the Project. Participation by Lake Lynn Hydro personnel would be essential. | Comment noted |
| 11/8/2022 | | CLEAR | General Comments | CLEAR wishes to express our appreciation to Lake Lynn Hydro, to WV DNR, to FERC, and to all the others interested and concerned about Cheat Lake and this Project. We believe that the potential here is for better and more services to this region. Let’s always remember that the Lake Lynn Dam was dedicated from the very beginning to providing for recreation and a public service. | Comment noted |

| Filed Date | Comment Number | Commentor | Section | Comment | Comment Response |
| --- | --- | --- | --- | --- | --- |
| | | | | Hopefully, we can continue the quest for more and better communications and understanding among all interested parties | |

(a) Normandeau Associates. 2020. Lake Lynn Hydroelectric Project Desktop Fish Entrainment Assessment. December 2020;

# Lake Lynn Hydroelectric Project (FERC No. 2459)

Desktop Fish Entrainment Assessment

**Prepared For**
Lake Lynn Generation, LLC
2 Bethesda Metro Center, Suite 1330
Bethesda, MD 20814

**Prepared By**
Normandeau Associates, Inc.
25 Nashua Rd
Bedford, NH, 03110
(603) 472-5191
www.normandeau.com

**December 2020**

# Table of Contents

## List of Tables

## List of Figures

# 1 Introduction

Lake Lynn Hydro, LLC (Lake Lynn or Licensee) is in the process of relicensing the 51.2-megawatt (MW) Lake Lynn Hydroelectric Project (Project) (FERC No. 2459) with the Federal Energy Regulatory Commission (FERC or Commission). The Project is located on the Cheat River in Monongalia County, West Virginia and Fayette County, Pennsylvania. The current license for the Project expires November 30, 2024.

In an August 29, 2019 filing, the licensee submitted their Pre-Application Document (PAD), and their Notice of Intent (NOI) to seek a new license for the Project. In the same filing, the licensee also requested to use FERC's Traditional Licensing Process (TLP). The Licensee distributed the PAD and NOI simultaneously to Federal and state resource agencies, local governments, Native American tribes, members of the public, and others thought to be interested in the relicensing proceeding. In October 2019, FERC approved the use of the TLP. Following approval, Lake Lynn held a Joint Agency Meeting and site visit in December 2019. Following the Joint Meeting and Site Visit, resource agencies and other stakeholders were afforded the opportunity to comment on the PAD and to request resource studies that they deemed were needed to evaluate Project impacts on natural, cultural and recreational resources.

In response to the NOI/PAD filing and the Joint Meeting and Site Visit, Lake Lynn received written comments and study requests from the U.S. Fish and Wildlife Service (USFWS), West Virginia Division of Natural Resources (WVDNR), Cheat Lake Environment and Recreation Association (CLEAR), Friends of the Cheat (FOC), Monongahela River Trails Conservancy (MRTC), and individual residents in the local community.

Based on the comments received, Lake Lynn developed and distributed a draft Study Plan to the resource agencies and stakeholders on April 15, 2020 for review. Lake Lynn held a conference call/meeting on April 24, 2020 to review and discuss the draft Study Plan. The draft Study Plan has been revised based on the discussions and a Revised Study Plan (RSP) was issued in May 2020. As Lake Lynn is utilizing the TLP, there is no requirement to prepare a formal study plan document as is required in the Integrated Licensing Protocol (ILP), and therefore, there is no subsequent study plan determination by FERC. Nonetheless, Lake Lynn prepared the RSP distributed in May 2020 to document and share with resource agencies and stakeholders its plans for conducting resource studies and ongoing monitoring efforts in 2020 to inform the relicensing process.

This report was prepared on behalf of Lake Lynn to address the Desktop Fish Entrainment Assessment detailed in Section 3.1 of the RSP. The Desktop Fish Entrainment Assessment was requested by the USFWS and WVDNR to estimate the number of fish that are either entrained or impinged by Project operation and the associated rate of injury and mortality for fish that pass through the turbines during Project operation.

# 2 Study Goals and Scope

## 2.1 Goals

The goals of this study were to:

1) Conduct a desktop assessment of the potential for impingement/entrainment of selected target fish species at Lake Lynn, and
2) Prepare a quantitative desktop estimate of the numbers of fish entrained at the Project.

## 2.2 Scope

This Desktop Fish Entrainment Assessment provides the following:

- A description of the Project reservoir, intake structure, turbine units, and seasonal operational regime;
- A summary of available fisheries information historically collected in the Cheat River upstream of the Project;
- An overview of the life history and habitat requirements for target fish species;
- An assessment of impingement and entrainment potential as a function of (1) the existing rack spacing, (2) calculated approach velocities, (3) the physical dimensions of target fish species, and (4) the swim capabilities (i.e., burst speed) of target fish species;
- A review of information contained in the 1997 Electric Power Research Institute (EPRI) database to provide a summary of (1) the size class composition of target fish species, (2) entrainment densities of target fish species, and (3) calculated survival rates of target species for the subset of hydroelectric projects comparable to the Project;
- The calculation of site-specific turbine passage survival rates for target fish species using the USFWS Turbine Blade Strike Analysis Tool (TBSA); and
- The use of seasonal species/size class-specific entrainment densities from comparable projects and project-specific discharge volumes to generate estimates of numbers of fish entrained at the Project.

# 3 Methods

This study addresses the qualitative classification of impingement, entrainment, and the probability of turbine passage survival at the Project using a review of relevant biological criteria and physical Project characteristics for seven fish species of interest. Factors that can influence the potential for impingement or entrainment at a hydropower project include structural characteristics such as the size and depth of the intake structure, the velocity of water as it enters the intake structure, the location of the intake structure relative to fish habitat, and the biological and behavioral characteristics (e.g., size, movement or migration patterns, and habitat preferences) of the specific life stages of fish species of interest. The likelihood of impingement is also highly dependent on the physical features and water velocities found at or near the trash racks along with species-specific physiological capabilities (i.e., swim speed). Turbine survival rates are primarily affected by engineering factors such as the amount of head differential of a turbine, its number of blades, rotational speed, hydraulic capacity, and the length of an entrained fish.

In addition to the previously described qualitative entrainment assessment for the Project, a quantitative estimate of entrainment during generation at the Project was performed. The resulting entrainment estimates were then be combined with modeled and empirical based survival rates for fish passing through the Project turbine units. In the absence of site-specific entrainment data during generation at the Lake Lynn Project, the quantitative estimate developed as part of this desktop assessment relied on a combination of site-specific operations data and fish entrainment rates available from similar hydropower dams. Quantitative estimates of entrainment at the Project were calculated for all target fish species for which density data could be obtained from, the EPRI entrainment database. As a result, quantitative estimates of the entrainment totals for six of the target species and one surrogate species at the Lake Lynn Project are presented in this report.

## 3.1 Project Impoundment, Intake, and Turbine Description

The first step in the evaluation of the potential for fish impingement and entrainment was to describe the physical features of the impoundment, intake structure, and turbine units that will affect entrainment, impingement and turbine passage survival. Where possible, Project features and dimensions were obtained from available engineering drawings and written descriptions of the Project.

## 3.2 Life History and Habitat Requirements of Target Fish Species

A description of the life history, habitat requirements, and behavior of fish species was compiled to determine the likelihood of presence near the Project intakes and to evaluate entrainment potential. The “Traits Based Assessment” of Čada and Schweizer (2012) was used to qualitatively assess the potential entrainment risk for fish species, which considers each species’ primary location within the Project, preferred habitat, local movements and reproductive strategy. Species-specific behavioral requirements determine if and when a given life stage interacts with intake operation. The potential for each species to be susceptible to entrainment can be determined based on their life history characteristics in relation to the location of the Project’s intake structure.

Categories of entrainment potential based on the likelihood that a fish species/life stage will be located near the intake structures are described as:

- None - species/life stage (e.g., adult, spawning, or juvenile) are not known to prefer the habitat near the intake structures
- Minimal - species may only occasionally be found occupying the habitat near the intake structures

- Moderate - species routinely or seasonally found occupying the habitat near the intake structures
- High - species likely to be found occupying the habitat near the intake structures

## 3.3 Entrainment Potential of Target Fish Species

The distance between bars on a trash rack (i.e., clear spacing) can affect the likelihood of an individual fish being excluded from moving through the trash rack and entering the turbine intakes. Fish species and life stages with a body width greater than the clear spacing are physically excluded from passing through a trash rack and becoming entrained. Proportional estimates of body width to total length (scaling factor) were compiled by Smith (1985) for the identified target species. This scaling factor was then used to determine the minimum length of each species excluded from the intake by the trash racks at each of the Project intakes (Table 3-1). The clear spacing values were divided by the scaling factors to calculate the minimum length for each target species that would be excluded at the Project.

## 3.4 Electric Power Research Institute (EPRI) Database Review

The Electric Power Research Institute (EPRI) 1997 entrainment database provides results from entrainment field studies conducted at 43 hydroelectric facilities east of the Mississippi River using full-flow tailrace netting. The database contains site characteristics of each of these facilities, as well as the total number of individuals of each species collected at each of the sites. The species counts are separated into variable size classes ranging from 2 to 30 inches.

A comparison of the EPRI entrainment database was made to provide a literature based assessment to compare with potential entrainment at the Project. To do so, the EPRI database was filtered for characteristics that match or are within a comparable range to those found at the Project which included the following:

- Trash rack clear spacing between 1.75 and 5.5 inches;
- Total powerhouse hydraulic capacities between 1300 and 6600 cfs;
- Plants operated in run-of-river mode or peaking facilities; and
- Target or surrogate fish species.

Collection totals from the set of comparable projects were summarized by the size classes provided in the database for the target species (or a closely related surrogate). In addition, the size class composition of the total number collected was summarized for each target species.

## 3.5 Impingement Potential of Target Fish Species

The ability for an individual fish to avoid being impinged or entrained at a powerhouse intake often depends on its swimming performance (Castro-Santos and Haro 2005). The swimming performance is directly related to the size of an individual fish; however, the swimming capability also varies among species based on morphological differences. Although there is no standard method that defines how swimming performance is measured, three commonly used definitions or types of swim speed are described in the scientific body of literature for fish

(Katopodis and Gervais 2016). The three swim speed types, cruising, prolonged, and burst, are described as the following:

- Cruising or sustained swim speeds can be maintained indefinitely (Bain and Stevenson 1999);
- Prolonged swim speeds can be maintained between 5 and 8 minutes (Bain and Stevenson 1999); and
- Burst (also called startle, darting or sprint) swim speeds can be maintained for less than 20 seconds (Beamish 1978).

Burst swim speeds were used to assess if a fish can adequately escape involuntary impingement or entrainment. If a fish has a greater burst swim speed than the turbine intake approach velocity, it is capable of moving away from the intake flow field to avoid interaction. To assess swimming capabilities for the target fish species of interest, burst swim speeds were compiled from the available scientific literature.

To ascertain whether or not a certain size fish of a particular species is likely to be impinged or entrained, the burst swim speeds were compared to the calculated approach velocity of the intake trash racks at the maximum hydraulic capacity of the Project. The approach velocity at the Project intake was calculated using the velocity equation:

$$Q = V * A$$

Where:

$\mathrm{Q} = \text{flow rate (cfs)}$

$\mathrm{V} = \text{approach velocity (fps); and}$

$\mathrm{A} = \text{area (square feet)}$

Fish species and sizes whose burst swim speeds are less than the approach velocity at the Project intake are likely to be impinged at the trash racks if their body widths are greater than the trash rack spacing. If the body width of a fish is less than the trash rack spacing and its burst swim speed is less than the approach velocity, it is likely to be entrained.

## 3.6 Turbine Survival Evaluation

To estimate survival of fish that entrain and pass through turbines at the Project, theoretical predictions were used to estimate a survival rate using a blade-strike model developed by the Department of Energy (Franke et al. 1997) that uses various turbine, fish and operations characteristics of a hydroelectric project to calculate a turbine blade strike and survival probability. This model was further modified by the United States Fish and Wildlife Service which produced the Turbine Blade Strike Analysis (TBSA) model that determines the fraction of a population of fish that are killed by blade strike passing through a hydroelectric project (Towler and Pica 2018). TBSA creates a normally distributed population of fish described by its number, mean length, and standard deviation of length that are routed through hazards at a hydroelectric project, e. g., a turbine. Monte Carlo simulations are performed to determine the percentage of individuals subjected to turbine blade strike. The blade strike probabilities are based on the Project turbine specifications and calculated using methods outlined in Franke et al. (1997). The probability of blade strike in the model is based on several factors, including the number of runner blades, fish length, runner blade speed, turbine type, runner diameter, turbine efficiency, and total discharge. These factors are inputs into the model which predicts survival for a fish of any species at a designated length. Table 3-2 lists the turbine specifications used as input into the TBSA model which was used to predict turbine passage survival estimates up to the maximum lengths (rounded to whole inch) of each target fish species that could entrain through the existing trash rack spacing at the Project. Lastly, the TBSA model simulations were run using a correlation factor of 0.2 which is the recommended conservative value (Towler and Pica 2018).

## 3.7 Electric Power Research Institute (EPRI) Turbine Survival Database Review

Similar to the comparison of the EPRI entrainment database review, the EPRI 1997 turbine survival database was reviewed to provide an equitable literature-based comparison of the turbine survival estimates calculated for the Project. To do so, the EPRI database was filtered for characteristics that match or are similar to those found at Lake Lynn. The following are the characteristics selected from the database for comparison to the Project:

- Francis turbines;
- Head rating similar to 81.5 ft;
- Hydraulic capacity rating equal to or less than 10,143 cfs; and
- Target or surrogate fish species.

The immediate, 24-hour, and 48-hour, and control survival estimates were selected, if available, as they provided the greatest range of time difference post-turbine passage for each species.

## 3.8 Qualitative Assessment of Entrainment and Turbine Survival Potential

Data collected during the literature review and site-specific evaluation process (i.e., habitat and life history, swim speeds, and turbine survival model estimates) were used to compile a qualitative assessment of the potential entrainment of target fishes. The qualitative assessment used a multi-step rank of:

- High (H)
- Moderate (M)
- Low (L)

Desktop impingement and entrainment assessments assigned an overall entrainment potential rank to each member of the suite of target species considered based on consideration of habitat and life history, swim speed relative to intake velocity, and minimum exclusion lengths relative to trash rack spacing. In general, fish with life history attributes that include obligatory downstream migration are given a rating of ‘High’, while those with juvenile life history stages placing them in the vicinity of the intakes or as adults with swim speeds not necessarily greater than the approach velocity are labeled as ‘Moderate’ risk. Species with life history attributes that generally keep them away from the intakes or fish that had a burst swim speed greater than the intake velocity are listed as a ‘Low’ risk for entrainment. In relation to swim speed, regardless of life stage, fish are considered ‘High’ risk if the maximum burst speed does not exceed the intake velocity, ‘Moderate’ risk if the intake velocity falls within the range of burst swim speed, and ‘Low’ risk if the burst swim speed completely exceeded the intake velocity.

The entrainment potential classification for trash rack spacing depended on the minimum body length exclusion results. If the minimum exclusion length for the existing trash rack spacing was longer than the standard length for a juvenile or adult (i.e., many individuals of that species and life stage are likely to be shorter than the minimum exclusion length) it received a “High” entrainment risk potential. A “Moderate” entrainment risk potential was applied when the minimum exclusion length overlapped with a portion of the individuals that would be expected to achieve that length by the life stage indicated. A “Low” entrainment risk potential was applied when the minimum exclusion length of a trash rack was less than the standard length of the life stage being considered.

The risk categories for the turbine survival potential were based on the TBSA model estimates. TBSA results were converted to a qualitative ranking system similar to Winchell et al. (2000) for standard lengths of the juvenile and adult life stages. “High” survival potential was applied to estimates greater than 85%, “Moderate” for estimates between 70-85%, and “Low” for estimates less than 70%.

## 3.9 Quantitative Assessment of Entrainment and Turbine Survival Potential

In addition to the previously described qualitative entrainment assessment for the Project, a quantitative estimate of entrainment during generation at the Project was calculated. The resulting entrainment estimate could then be combined with modeled and empirical based survival rates for fish passing through the Project turbine units.

In the absence of site-specific entrainment data during generation at the Project, the quantitative estimate presented relied on a combination of site-specific discharge data and surrogate fish entrainment rates available from a comparable projects found in the EPRI database. Quantitative estimates of entrainment at the Project were calculated for all target and surrogate fish species selected for this study. As a result, quantitative estimates of the entrainment totals are presented for six the target species and one surrogate species.

### Table 3-1: Lake Lynn Project impoundment and intake characteristics

| Site Characteristic | Lake Lynn Project | | | |
|---|---|---|---|---|
| Normal Full Pond Elevation (ft) | 870 | | | |
| Operating Mode | dispatchable peaking hydroelectric facility with storage capability | | | |
| Surface Area at Normal Full Pond (acres) | 1729 | | | |
| Total Storage Volume (acre-feet) | 72,000 | | | |
| Impoundment Length (miles) | 13 | | | |
| Total Hydraulic Capacity (cfs) | 10,143 | | | |
| | **Unit 1** | **Unit 2** | **Unit 3** | **Unit 4** |
| Upper Rack Elevation (ft) | 874 | 874 | 874 | 874 |
| Bottom Rack Elevation (ft) | 828 | 828 | 828 | 828 |
| Trash Rack Spacing (in) | 4 | 4 | 4 | 4 |
| Trash Rack Height (ft) | 42 | 42 | 42 | 42 |
| Trash Rack Width (ft) | 25.7 | 25.7 | 25.7 | 25.7 |
| Trash Rack Surface Area (sq. ft) | 1,078 | 1,078 | 1,078 | 1,078 |
| Maximum Turbine Discharge (cfs) | 2425 | 2868 | 2425 | 2425 |
| Intake velocity (fps) | 2.3 | 2.7 | 2.3 | 2.3 |

**Table 3-2: Lake Lynn Project turbine characteristics**

| Project | Lake Lynn | | | |
|---|---|---|---|---|
| Turbine ID | 1 | 2 | 3 | 4 |
| Turbine Type | Francis | Francis | Francis | Francis |
| Number of Blades | 16 | 17 | 16 | 16 |
| Runner Diameter (ft) | 10.8 | 10.8 | 10.8 | 10.8 |
| Runner Diameter at Inlet (ft) | 7.1 | 7.3 | 7.1 | 7.1 |
| Runner Diameter at Discharge (ft) | 10.1 | 10.2 | 10.1 | 10.1 |
| Runner Height (ft) | 3.8 | 3.9 | 3.8 | 3.8 |
| Head (ft) | 81.5 | 81.5 | 81.5 | 81.5 |
| Rotational Speed (rpm) | 133.3 | 133.3 | 133.3 | 133.3 |
| Max Discharge (cfs) | 2425 | 2868 | 2425 | 2425 |
| Peak Efficiency (%) | 94.0% | 94.0% | 94.0% | 94.0% |

# 4 Results

## 4.1 Description of Project's Fish Protection Features

### *4.1.1 Project Reservoir and Features*

The Lake Lynn Project is located on the Cheat River in Monongalia County, West Virginia and Fayette County, Pennsylvania, approximately 10 miles northeast of Morgantown, West Virginia. The Project has a drainage area of 1,411 square miles and is located about 3.7 miles upstream of the confluence with the Monongahela River. The surface area of the Project impoundment is 1,729 acres with a gross storage of 72,000 acre-ft (Table 3-1). The impoundment stretches approximately 13 miles upstream and has a normal full pond elevation of 870 ft NGVD. The Project reservoir can be used for storage as the Project is operated as a dispatchable peaking hydroelectric facility with storage capability.

### *4.1.2 Powerhouse, Intake Structure, and Trash Racks*

The Lake Lynn Project powerhouse was built in 1926 and houses four horizontal Francis turbines, each connected to a generator. The unit intakes are screened by four separate racks that span a horizontal distance of 103 feet and a vertical distance of 42 feet resulting in an intake area of 4,311 $ft^2$. The intake rack structure is comprised of eight separate racks, two for each unit. Intake racks at Lake Lynn are 4-inch clear spacing.

### *4.1.3 Downstream Bypass*

There is currently no downstream bypass facility at the Lake Lynn Project.

#### *4.1.4 Turbines*

The Lake Lynn Project includes four horizontal Francis turbines with a combined generating capacity of 51.2 MW. Units 1, 3, and 4 have a maximum hydraulic capacity of 2,425 cfs, whereas Unit 2 has a hydraulic capacity of 2,868 cfs. At the time of initial construction all four units were identical. During 2018 PE Hydro completed a turbine replacement and upgrade on Unit 2. As a result, the specific physical characteristics for Unit 2 differ slightly from those for Units 1, 3, and 4 and result in an increased hydraulic capacity (see Table 3-2 for unit specifics).

#### *4.1.5 Project Operations*

The Project is operated as a dispatchable peaking hydroelectric facility with storage capability. The facility's ponding capability varies by season and allows for peaking. The Project produces a long-term average generation of 140,352 MWh of clean electricity annually, which is enough to power 13,495 homes (Cube Hydro Partners, 2019). The current FERC License requires that the Licensee operate the Project to maintain Cheat Lake between 868 and 870 ft NGVD from May 1 through October 31, between 857 and 870 ft from November 1 through March 31, and between 863 ft and 870 ft from April 1 through April 30, each year. The current FERC License requires the Licensee release a minimum flow of 212 cfs from the dam with an absolute minimum flow of 100 cfs regardless of inflow.

Although the above mentioned operational parameters do allow for some peaking and storage, during the six month period between May 1 and October 31, the Project operates most like a run-of-river station with a maximum fluctuation in headpond level of 2 feet (between 868 and 870 ft NGVD). For the rest of the year, more fluctuation is permitted. Due to the seasonal shifts in operations, we have incorporated dams in our comparisons that include facilities operated as either run-of-river or peaking.

### 4.2 Life History and Habitat Requirements of Target Fish Species

The fish assemblage of the Cheat River is generally indicative of a moderately sized, low-gradient, mid-Atlantic river. Target species for this analysis were selected in a manner which captured a variety in life history strategies exhibited by fishes in the area. Target species were included because they are either native or naturally occurring fish species within the Project areas, actively managed, or valued as a game species.

The target species selected for inclusion in the Desktop Fish Entrainment Assessment were:

- Bluegill;
- Channel catfish;
- Smallmouth bass;
- Walleye;
- Golden redhorse;
- Emerald shiner; and
- Gizzard shad.

A brief description of the life history characteristics for each target fish species is provided below. A summary of their habitat preferences and behaviors that influence the likelihood of entrainment is provided in Table 4-1.

### 4.2.1 *Cheat Lake Community Sampling*

Biological monitoring was conducted in Cheat Lake and Cheat Lake Embayment from 2005 to 2009 in accordance with the current FERC license for the Project. Surveys conducted include night boat electrofishing and gill netting during May and October, when water levels were low. From 2011 to 2015, fish were also sampled from eight sites in Cheat Lake, consistent with previous surveys. A total of 8,338 fishes from 35 species were collected from 2011 to 2015. Species richness was found to have substantially increase in the riverine zone, increasing from 8 species in 1990 to an average of 23 species captured from 2011 to 2015. An increase in sportfish and non-game fish species was also found when compared to previous studies. Specifically, sportfish in highest abundance included bluegill, smallmouth bass, largemouth bass, yellow perch, and channel catfish. Non-game species included emerald shiner, mimic shiner, logperch, brook silverside, and gizzard shad (Smith and Welsh 2015). Table 4-2 presents a summary of the temporal trends in fish species CPUE from 1990 to 2014.

### 4.2.2 *Bluegill (Lepomis macrochirus)*

Bluegill are relatively sedentary and are commonly found in the littoral zone of lakes, ponds, and reservoirs, as well as quiet, slow flowing waters of streams and rivers. Adults and juveniles seek cover in the form of submerged structure like woody debris intermixed with submerged aquatic vegetation (Stuber et al. 1982a; Stuber et al. 1982b; Aho et al. 1986; Werner 2004). Sunfish species spawn in shallow littoral areas in the spring and summer when water temperatures are above 18°C. They are known to be prolific breeders. Their nests are constructed in sand and gravel near woody debris and aquatic vegetation in water depths less than five feet. They reach sexual maturity at one year of age, with an average length is 4 to 6 inches (Smith 1985). Generally, juvenile bluegill remain in shallow, protected habitats such as coves and flooded tributary mouths following cessation of parental care. Flooding, which can result in a rapid drop in water temperature and excessive siltation, and excessive lowering of the water level during spawning are the two most common habitat-related reasons for reproductive failure (Becker 1983). Strong orientation to cover and preference for shallower, off-channel habitats generally limits this family of fishes to exposure to impingement and entrainment through hydroelectric projects.

### 4.2.3 *Channel catfish (Ictalurus punctatus)*

Channel catfish inhabit large, warm lakes, rivers, ponds and reservoirs, as well as both clear, rapidly flowing channels to turbid, mud-bottomed ones. They occupy a variety of substrate types and can be found in moving or still water (Jenkins and Burkhead 1993). Adults are usually found in pools, or under log jams during the day and riffles at night. They are also known to be tolerant of water with low oxygen and light levels. Channel catfish reach maturity between ages 4-6, with relatively slow growth. They reach an average length of 12-24 inches (Jenkins and Burkhead 1994). Spawning begins in late May and continues through early July when water temperatures range from 21-30°C. Males will build a nest and guard eggs until hatched. Fry begin to school in compact balls, which are guarded by adults until young reach about one inch long and disperse (Becker 1983). Juveniles feed primarily on plankton and insect larvae, but feed on any available invertebrate, fishes, and some plants as they mature (Jenkins and Burkhead 1994).

### *4.2.4 Smallmouth bass (Micropterus dolomieu)*

Smallmouth bass inhabit a range of aquatic habitats, but adults prefer flowing reaches downstream of riffles or bedrock outcrops. These areas provide cover and flows that convey food items. Habitat depth preferences tend to vary seasonally with fish inhabiting shallow littoral zones in the spring and early summer, moving deeper as waters become warmer. Smallmouth bass generally move into deep water and become inactive during winter. Smallmouth bass typically reach maturity at 3-4 years of age, and reach an average length between 12-16 inches (Jenkins and Burkhead 1994). Spawning occurs in early May when water temperatures range from 16-22°C, with males constructing gravel and rock lined nests that are 2-ft to 3-ft in diameter (Jenkins and Burkhead 1994). Nests are often located downstream of large objects such as boulders, ledges, or fallen trees. The coarse substrate and ledge of the main stem provides spawning habitat for smallmouth. Rooted aquatic vegetation provides rearing and cover habitat for young of year (YOY) and juveniles in shallow, slower moving reaches. The diet of the smallmouth bass ranges from a variety of aquatic invertebrates for younger bass to fish, frogs and small mammals as larger adults (Smith 1985). They are known as ambush predators, using vegetation or structure (i.e., rocks, stumps) as cover to prey on smaller fish and invertebrates.

### *4.2.5 Walleye (Sander vitreus)*

Walleye inhabit medium to large, clear lakes, rivers, and impoundments with loose, shifting sediment such as detritus, sand, gravel rubble, and boulders (Jenkins and Burkhead 1994). They are generally found in deeper waters during the day and tend to move into shallower areas during heavy cloud cover and at night for feeding. Walleye are also known to have excellent visual acuity in low light levels. On average, walleye reach a length between 12-14 inches, with some individuals reaching over 30 inches of length. Male walleye reach maturity at 2 to 4 years, whereas females mature at 3 to 6 years. They spawn in the early spring following ice out when water temperatures reach 2.2°C to 15.6 °C. Walleye congregate before spawning and spawn over gravel or rocky substrates in water generally 2 to 4 feet deep (Smith 1985; Jenkins and Burkhead 1993). Females can deposit more than 100,000 eggs, which hatch in two weeks. The eggs are slightly adhesive and settle between rocks, and hatch after 15-30 days. After their small yolk has been fully absorbed into their digestive system, juvenile walleye will feed on zooplankton and fly larvae. As they approach adulthood, their diet consists primarily of fish, crayfish and leeches (Smith 1985), feeding opportunistically.

### *4.2.6 Golden Redhorse (Moxostoma erythrurum)*

The golden redhorse occupies a broad spectrum of warm water habitats, including large creeks and rivers, natural lakes and impoundments (Jenkins and Burkhead 1993), but are known to prefer moderate to large streams with some current. It can tolerate a moderate amount of silting, but is most abundant in clear, unpolluted streams with large pools and well-defined riffles. Juveniles tend to inhabit shallow areas. They reach an average length of around 12-18 inches, and reach sexual maturity at 3-5 years of age. Spawning occurs in mid to late spring, with ideal temperatures ranging from 10-22.5 °C. Spawning is known to take place in late spring in moderate sized streams over gravel riffles, but may also occur in small tributaries. The golden redhorse forages on the bottom of pools for food, preying on aquatic insects, invertebrates, and detritus (Jenkins and Burkhead 1993).

The golden redhorse was not identified in any of the seven comparable hydroelectric projects within the EPRI entrainment database. As such, the shorthead redhorse (*Moxostoma macrolepidotum*) was chosen as a surrogate. This species share a genus with the golden redhorse, and are documented to have closely related life histories, as well as similar morphologies (Smith 1985).

#### *4.2.7 Emerald Shiner (Notropis atherinoides)*

The emerald shiner inhabits large, open rivers, lakes and reservoirs, as well as runs of rivers with low or moderate gradient. They prefer clear water over sand or gravel, and often aggregate in large schools in mid-water or near surface (Page and Burr 1991). They form large schools that move into deeper water for overwintering. This species spawns in the late spring or early summer. Spawning may occur over various substrates, but primarily over gravel (Smith 1983). Females lay up to 2,000 to 3,000 eggs, which hatch 24-36 hours after fertilization. After hatching, fry remain on the substrate for 2-4 days before forming schools. The emerald shiner feeds primarily zooplankton, as well as green algae and diatoms, while juveniles feed almost solely on protozoans (Smith 1983). They reach an average size of 2.5-3.5 inches long (Jenkins and Burkhead 1993).

#### *4.2.8 Gizzard Shad (Dorosoma cepedianum)*

The gizzard shad is a pelagic, schooling fish with a variety of habitats. It prefers pools and runs in medium streams, or rivers with low to moderate gradient. This species is also found in reservoirs, lakes, swamps, floodwater pools, estuaries, brackish bays and marine waters. While many populations are diadromous (residing in coastal waters and returning to freshwater environments to spawn), the Cheat River population is known to be landlocked and does not participate in annual migration. They reach maturity by age 2 or 3, and typically spawn between April and June in temperate latitudes (Jenkins and Burkhead 1993). Spawning takes place in freshwater sloughs, ponds, and lakes at near-surface depths, occasionally over vegetation and debris. Eggs are demersal and attach to algae or rocks. This species is known to have a very high spawning potential, with fecundity ranging from 22,400- 543,910 eggs per female (Jenkins and Burkhead 1993). Gizzard shad are filter feeders, feeding almost solely on plankton from the water column (Jenkins and Burkhead 1993). Gizzard shad are also known to be extremely sensitive to changes in temperature and dissolved oxygen, becoming moribund as water temperatures decrease below 56°F and die at about 38°F (Williamson and Nelson 1985). Die-offs are frequent in fall and late summer when water temperature drops. Juvenile gizzard shad typically pass downstream out of reservoirs during fall and early winter, and their tendency to become moribund as their lower temperature threshold is approached may make this species susceptible to entrainment. This species reaches an average length of 9-14 inches (Jenkins and Burkhead 1993).

## 4.3 Entrainment Potential of Target Fish Species

The calculated minimum exclusion lengths for each of the seven target fish species relative to the existing 4-inch clear spacing at Lake Lynn intake structure are presented in (Table 4-3). As described in Section 3.3, a scaling factor derived from the proportional estimates of body width to total length were used to determine the minimum length of each target species that would be excluded from entraining through the existing intake rack spacing at the Project (i.e., minimum exclusion size = rack clear spacing/scaling ratio).

The majority of the calculated estimates yielded lengths for target species that are unlikely to be present in the Project (i.e., a length outside of the range expected for the species in the vicinity of the Lake Lynn Project). For example, the minimum size of gizzard shad predicted to be excluded by a 4-inch intake rack is 38.1 inches—a length not attained by this species. In cases where the maximum size of the species did not exceed the minimum exclusion size, a designation of 'none' was applied (Table 4-3). Only channel catfish and walleye had a calculated minimum exclusion length (25.5 and 31.0 inches, respectively) lower than the upper end of the expected range of body lengths for those species in the Project area. The existing four inch intake rack spacing alone is not expected to eliminate the potential for entrainment of bluegill, smallmouth bass, shorthead redhorse, emerald shiner or gizzard shad at Lake Lynn.

## 4.4 Electric Power Research Institute (EPRI) Entrainment Database Review

A total of ten hydroelectric projects in the EPRI 1997 database met the selection criteria for similarity to Lake Lynn (Table 4-4) and six of the seven target species were represented in the collective subset of data from the ten identified facilities. Due to limited information on entrainment of the golden redhorse, the shorthead redhorse was utilized as a surrogate for this database review. As mentioned in section 4.2.6, the golden redhorse and shorthead redhorse share similar life histories, as well as occupy similar habitats (moderately sized streams with some current and well-defined riffles) (Jenkins and Burkhead 1993).

The length frequency distribution for the entrainment of target fish species at the ten representative hydroelectric projects from the EPRI data base are presented in Figures 4-1 (by species) and 4-2 (cumulative). The majority of individuals representing target fish species entrainment at the ten representative projects were less than or equal to four inches in length (85% of reported individuals). Individuals greater than 10 inches were limited to a minor percentage of four target species (channel catfish, shorthead redhorse, smallmouth bass and walleye, representing 4%, 13%, 11%, and 9% of all individuals entrained, respectively).

## 4.5 Impingement Potential of Target Fish Species

A summary of burst swim speeds determined for each of the seven target fish species is presented in Table 4-5. These data were obtained using the Swim Speed & Swim Time Tool[1] (Katopodis and Gervais 2016; Di Rocco and Gervais 2020). The expected size range for each of the seven target fish species was evaluated relative to the data available in the Swim Speed & Swim Time Tool and five representative lengths were chosen for burst speed estimation from the database. For each target fish species, the five representative lengths included the upper and lower bounds of the anticipated size range for the Project area as well as the 25$^{th}$, 50$^{th}$, and 75$^{th}$ percentile lengths within that range. Each unique species-length combination was input into the Swim Speed & Swim Time Tool and produced a relationship for swim speed and swim time for a particular body length. For each body length selected to be assessed for each species, the following estimates were recorded:

1. Speed (ft/s) achieved by 97.5% of individuals of species X at body length Y for 3 seconds;
2. Speed (ft/s) achieved by 87.5% of individuals of species X at body length Y for 3 seconds;
3. Speed (ft/s) achieved by 50% of individuals of species X at body length Y for 3 seconds;
4. Speed (ft/s) achieved by 12.5% of individuals of species X at body length Y for 3 seconds; and
5. Speed (ft/s) achieved by 2.5% of individuals of species X at body length Y for 3 seconds.

It is understood that burst swim speeds may vary greatly among different fish species as well as among sizes of the same species. However, variation exists within individuals of the same species and size class. Katopodis and Gervais (2016) demonstrate ascending physical capabilities as a smaller portion of the test fish are represented by each speed rating. For example, 97.5% of bluegill in the 6 inch size class are expected to be capable of achieving a speed of 2.98 fps for a period of 3 seconds, while only 2.5% of bluegill of the same size are expected to be able to achieve a speed of 6.96 fps for 3 seconds. For the purposes of this desktop evaluation values representing the 50$^{th}$ percentile of swim speed over a three second period were selected as representative of a fishes burst swim capability. The 50$^{th}$ percentile speed rating for the minimum, median, and maximum size of each of the seven target fish species is provided in Table 4-5. The full range of swim speed estimates for target fish species generated using the Swim Speed & Swim Time Tool are provided in Appendix A.

Figure 4-3 provides a visual representation of the reported burst speeds for the target species and size classes relative to the calculated intake velocities at the Project turbine units. The species and sizes of target fish likely to become impinged are those whose burst swim speeds are less than the approach velocity at the Project intake. The calculated intake velocity for the

[1] Available online at: http://www.fishprotectiontools.ca/speedtime.html

three original Francis turbines (i.e., Units 1, 3, and 4) is 2.3 fps whereas the calculated intake velocity for the recently upgraded Unit 2 is 2.7 fps.

Four species-length class combinations have burst speeds less than the calculated intake velocities under maximum discharge conditions at Lake Lynn (Table 4-5). These species-length classes are the minimum sizes considered for bluegill (1.6 fps), channel catfish (2.4 fps), smallmouth bass (2.4 fps), and emerald shiner (2.3 fps). All other species-length class combinations were deemed capable of achieving a burst speed in excess of the project intake velocity—thus reducing the likelihood of impingement or entrainment at the Lake Lynn Project. It should be noted that of the four species-size class combinations with burst speeds lower than the calculated approach velocities, all would have a higher probability of being entrained than impinged as they will fit through the existing rack spacing at the Project.

Although the full range of body lengths assessed for gizzard shad as part of this evaluation are capable of a burst speed in excess of the calculated Project intake velocities, they will be a primary focus within the quantitative entrainment assessment due to the propensity for this species to experience extreme lethargy in cold temperatures (see Section 4.2.8). During periods of low water temperature gizzard shad tend to be less capable of escaping entrainment due to their tendency to become moribund.

## 4.6 Turbine Survival Evaluation

Tables 4-6 and 4-7 provide a summary of the calculated TBSA turbine survival estimates for fish entrained at Francis Units 1, 3, and 4 and Francis Unit 2, respectively. Survival values were estimated for the range of body lengths anticipated to be prone to entrainment based upon the minimum exclusion sizes presented in Table 4-3. As would be expected, estimates of turbine passage were inversely related to body length with highest survival estimated for fish at 2 inches of length (~95%) and the lowest for fish at 30 inches of length (21-24%).

## 4.7 Electric Power Research Institute (EPRI) Turbine Survival Database Review

Upon review of the EPRI (1997) survival database, two hydroelectric facilities had comparable characteristics for a direct comparison with Lake Lynn (Table 4-8). However, previously quantified survival rates were available in the EPRI survival database for only two of the target species evaluated as part of this assessment (bluegill and walleye; Table 4-9). When examined across comparable site locations, estimates of 48-hour latent survival based on recovered 4-inch bluegill ranged from 66% to 100%. Latent 48-hour survival based on recovered walleye was 77% for individuals ranging between 6-25 inches.

In general, survival through turbines is related to fish size, with the smaller fish entrained typically having higher survival rates than larger fish. Winchell et al. (2000) provides a review of the EPRI (1997) database and a generalized summary of survival based on turbine type, runner speed, and fish size (Table 4-10). Winchell et al. (2000) reports mean survival rates (all fish species combined) for low speed Francis units to range from 93.9% for fish ≤ 4 inches to 73.2% for fish ≥ 12 inches.

## 4.8 Qualitative Assessment of Entrainment and Turbine Survival Potential

Evaluating entrainment potential of the seven target fish species at the Project required combining and synthesizing the species-specific behavioral traits, life stages, and swimming capabilities and comparing them to the Project's unique intake, water conveyance and infrastructure characteristics. The blending of these factors yielded a qualitative assessment of whether or not an individual of the target fish species will potentially entrain through the Project's intakes or not. If a fish becomes entrained, a secondary evaluation of the potential of that individual surviving passage through the Project's turbines depended primarily on its length and the physical dimensions as well as operating conditions of the turbines at the time of passage. The final qualitative assessment of the potential for surviving downstream passage at the Project took into consideration and summarized all of the factors that influenced entrainment and turbine passage. The results of this qualitative assessment are presented in Table 4-11.

Entrainment potential as a function of behavior, habitat use and life history was ranked as 'low' for nearly all of the target fish species considered in this evaluation with the exception of gizzard shad. The lack of high quality aquatic habitat in the immediate vicinity of the intake structure coupled with the fact that none of those fish species are considered an obligatory migrant contributed to the low entrainment potential. With regards to gizzard shad, their susceptibility to colder water temperatures and downstream movement of juvenile individuals during the fall season resulted in a qualitative entrainment rank of 'high' for the species. When considered on its own, the existing 4-inch intake rack spacing at the Project resulted in an entrainment potential rank of 'high" for nearly all species and life stages. Only adult channel catfish and walleye are expected to achieve a minimum exclusion length suitable to physically avoid entrainment at the Project with the existing 4-inch intake rack spacing. Conversely, the calculated approach velocities for the turbine units at Lake Lynn under maximum generation conditions resulted in an entrainment potential rank of 'low' for adults of nearly all seven of the target fish species. The juvenile life stage for several of the target fish species (bluegill, channel catfish, smallmouth bass, and emerald shiner) received an entrainment potential rank of moderate to high due to their reported burst swim capabilities relative to approach velocities at the Project intake. Gizzard shad are capable of reaching a burst swim speed in excess of calculated approach velocities at Lake Lynn. However to account for their reaction to lowered thermal conditions they were assigned a more conservative rank of 'moderate' relative to swim capabilities at the intake.

When the four factors summarized in Table 4-11 are considered it is likely that gizzard shad will have the highest susceptibility to entrainment at the Project. Their seasonal behavior and response to cold temperatures may make them more vulnerable than the other species considered in this evaluation. The other six target fish species are not anticipated to be present in the immediate vicinity of the intake under most conditions. In the event that they are it is expected that the adult life stage for those six target species have the ability to exceed approach velocities at the intake area or in the case of two species may be effectively screened by the intake rack. If present in the immediate intake area the juvenile life stages of those six species will have a higher likelihood of entrainment due to their slower burst speeds and small body size. However, as noted in Tables 4-6 and 4-7 fish under six inches in length are expected to have a high rate of survival following downstream passage via the Lake Lynn turbine units. These size classes are representative of juvenile fish species (Table 4-11).

**Table 4-1: General habitat use and behavior of target fish species**

| Common Name | Life Stage | Habitat Requirement | Behavioral Movements | Likelihood of Proximity to Intakes |
|---|---|---|---|---|
| **Bluegill** | Adult Spawning | Shallow water over fine gravel | None | Low |
| | Adult | Shallow water with vegetation and structure, or high in water column over deep water | Local migration to deeper water in winter and summer for thermal refuge | |
| | Juvenile | Shallow water with vegetation and structure | None | |
| **Channel catfish** | Adult Spawning | Warm, slow or stagnant water over soft sediments in open water or areas with vegetation | Will form aggregations and build nests in areas of soft sediments | Low |
| | Adult | | None | |
| | Juvenile | | | |
| **Smallmouth bass** | Adult Spawning | Gravel with shallow water | May travel to smaller streams to spawn | Low |
| | Adult | Clear water with boulders, rocky shoals, riffles, or structural cover | Occasionally moves to deep water during the day, forms aggregation in deep water in winter | Low |
| | Juvenile | | None | Low |
| **Walleye** | Adult Spawning | Shallow shoreline areas, shoals, riffles | Moves to near-shore areas or tributaries to spawn | Low |
| | Adult | Pools moderate turbidity and substantial areas of rocky substrate | Moves to near-shore areas at night to feed | Low |
| | Juvenile | | | |
| **Shorthead redhorse** | Adult Spawning | Gravelly runs and riffles | May migrate out of large rivers to smaller streams to spawn | Low |
| | Adult | Rocky pools, runs, and riffles in moderate to large streams | None | Low |
| | Juvenile | | | Low |
| **Emerald shiner** | Adult Spawning | Near surface in open water over gravel shoals | None | Low |
| | Adult | Large, open areas of variable turbidity | Local migration to deeper water in winter | Low |
| | Juvenile | | None | Low |
| **Gizzard shad** | Adult Spawning | Surface water in low-gradient areas | Migrate in large schools in surface waters | Low |
| | Adult | Non-migratory; found near substrate for filter feeding | May be susceptible to seasonal low water temperatures | High |
| | Juvenile | Shallow, near-shore water | May move downstream out of reservoirs in cooler months; susceptible to "cold shock" | High |

**Table 4-2: Temporal trends in fish CPUE from boat electrofishing in Cheat Lake**

| Species | 1990 | 1997 | 1998 | 2001 | 2005 | 2008 | 2011 | 2014 | Grand Total |
|---|---|---|---|---|---|---|---|---|---|
| Banded Darter | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.50 | 0.00 | 0.50 | 0.11 |
| Black Crappie | 0.22 | 0.00 | 0.11 | 0.00 | 0.00 | 0.50 | 2.50 | 3.75 | 0.81 |
| Bluegill | 8.44 | 15.08 | 11.56 | 30.11 | 12.5 | 186 | 10.5 | 27.25 | 36.59 |
| Bluntnose Minnow | 0.22 | 0.00 | 0.00 | 9.11 | 10.5 | 14.25 | 7.75 | 0.75 | 5.38 |
| Brook Silverside | 4.00 | 5.00 | 4.89 | 11.33 | 6.00 | 37.25 | 11.25 | 5.75 | 10.58 |
| Brown Bullhead | 5.11 | 0.00 | 0.56 | 0.00 | 0.00 | 0.00 | 0.50 | 0.00 | 0.59 |
| Common Carp | 0.89 | 2.67 | 2.56 | 2.33 | 3.50 | 1.25 | 0.25 | 0.75 | 1.88 |
| Emerald Shiner | 7.11 | 21.67 | 20.56 | 25.67 | 5.00 | 7.25 | 125.50 | 22.25 | 29.30 |
| Chain Pickerel | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.25 | 3.00 | 0.37 |
| Channel Catfish | 0.22 | 0.42 | 0.22 | 1.00 | 0.75 | 3.00 | 1.00 | 2.00 | 1.05 |
| Channel Darter | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.50 | 0.06 |
| Gizzard Shad | 0.00 | 0.00 | 0.22 | 2.44 | 1.00 | 0.75 | 5.75 | 0.00 | 1.31 |
| Golden Redhorse | 0.00 | 0.92 | 1.67 | 1.33 | 4.25 | 4.25 | 19.50 | 40.00 | 8.39 |
| Golden Shiner | 0.00 | 0.00 | 0.11 | 0.11 | 0.00 | 0.50 | 0.00 | 0.00 | 0.10 |
| Greenside Darter | 0.00 | 0.00 | 0.00 | 0.33 | 0.00 | 0.00 | 0.00 | 1.25 | 0.20 |
| Green Sunfish | 0.22 | 0.00 | 0.33 | 2.11 | 1.75 | 19.50 | 1.25 | 10.50 | 4.21 |
| Flathead Catfish | 0.00 | 0.25 | 0.33 | 0.00 | 0.25 | 0.00 | 0.00 | 0.25 | 0.14 |
| Freshwater Drum | 0.44 | 0.58 | 0.56 | 0.78 | 0.75 | 1.00 | 0.50 | 3.00 | 0.93 |
| Hybrid Striped Bass | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.25 | 0.00 | 0.03 |
| Hybrid Sunfish | 1.56 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.25 | 0.25 | 0.19 |
| Johnny Darter | 0.00 | 0.00 | 0.11 | 0.44 | 0.00 | 3.25 | 0.00 | 1.75 | 0.67 |
| Largemouth Bass | 2.44 | 2.75 | 3.89 | 3.67 | 8.50 | 4.50 | 9.50 | 17.50 | 6.39 |
| Logperch | 0.00 | 1.42 | 3.33 | 3.11 | 10.75 | 1.50 | 2.25 | 14.00 | 4.52 |
| Longnose Gar | 0.00 | 0.00 | 0.00 | 0.22 | 0.00 | 0.50 | 0.25 | 1.25 | 0.27 |
| Mimic Shiner | 0.89 | 0.00 | 0.00 | 33.78 | 5.50 | 54.50 | 12.75 | 29.50 | 17.55 |
| Northern Hogsucker | 0.00 | 0.00 | 0.33 | 0.00 | 0.50 | 0.25 | 0.00 | 0.25 | 0.17 |
| Northern Pike | 0.22 | 0.08 | 0.22 | 0.11 | 0.75 | 0.00 | 0.00 | 0.00 | 0.17 |
| Popeye Shiner | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.25 | 0.03 |
| Pumpkinseed | 4.67 | 1.75 | 2.33 | 1.22 | 0.50 | 3.75 | 0.50 | 0.50 | 1.81 |
| Quillback | 0.00 | 0.33 | 0.00 | 0.00 | 0.00 | 0.00 | 0.75 | 0.25 | 0.15 |
| Rainbow Darter | 0.00 | 0.00 | 0.22 | 0.00 | 0.00 | 0.00 | 0.00 | 2.50 | 0.32 |
| River Carpsucker | 0.00 | 0.00 | 0.22 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.04 |
| Rock Bass | 0.67 | 0.42 | 3.33 | 2.11 | 0.25 | 6.50 | 2.00 | 11.25 | 3.32 |
| Rosyface Shiner | 0.00 | 0.00 | 0.00 | 0.00 | 30.25 | 3.50 | 0.00 | 0.00 | 3.86 |
| Sauger | 0.00 | 0.67 | 2.44 | 1.78 | 1.50 | 1.50 | 4.25 | 4.50 | 2.17 |
| Smallmouth Redhorse | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.50 | 0.00 | 0.06 |
| Silver Redhorse | 1.56 | 0.25 | 0.78 | 0.00 | 0.00 | 0.25 | 0.00 | 11.25 | 1.61 |
| Silver Shiner | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 5.00 | 0.00 | 6.25 | 1.29 |
| Smallmouth Bass | 0.44 | 6.42 | 5.78 | 4.78 | 5.00 | 18.50 | 27.00 | 35.50 | 12.41 |

| Species | 1990 | 1997 | 1998 | 2001 | 2005 | 2008 | 2011 | 2014 | Grand Total |
|---|---|---|---|---|---|---|---|---|---|
| Spottail Shiner | 0.22 | 1.67 | 1.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.25 | 0.41 |
| Spotted Bass | 0.22 | 0.75 | 0.00 | 1.00 | 2.25 | 4.75 | 3.25 | 8.75 | 2.45 |
| Spotfin Shiner | 0.22 | 0.00 | 0.00 | 0.67 | 7.25 | 9.00 | 0.50 | 0.25 | 2.08 |
| Walleye | 0.00 | 0.00 | 0.00 | 1.00 | 0.00 | 0.50 | 6.25 | 2.00 | 1.17 |
| Warmouth | 0.22 | 0.00 | 0.00 | 0.00 | 0.00 | 0.25 | 0.00 | 0.00 | 0.05 |
| White Bass | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 3.50 | 0.00 | 0.40 |
| White Sucker | 0.00 | 0.00 | 0.00 | 0.00 | 0.25 | 0.00 | 0.00 | 0.00 | 0.03 |
| White Crappie | 0.00 | 0.33 | 0.00 | 0.67 | 0.00 | 0.00 | 0.00 | 0.00 | 0.15 |
| Yellow Bullhead | 0.44 | 0.08 | 0.11 | 0.33 | 0.00 | 0.00 | 0.00 | 0.50 | 0.18 |
| Yellow Perch | 9.56 | 7.92 | 24.22 | 14.00 | 1.75 | 0.25 | 1.25 | 22.75 | 11.25 |

*Reproduced from the Lake Lynn PAD (Table 5.11).

**Table 4-3: Minimum length for target fish to be excluded from entrainment based on existing trash rack spacing**

| Common Name | Scaling Factor for Body Width[1] | Typical Length (inches) for target species juveniles and adults potentially encountered at the Lake Lynn Project | | Calculated Minimum Exclusion Length (inches)* |
|---|---|---|---|---|
| Bluegill | 0.133 | Juvenile | 1.0-3.0[1] | None |
| | | Adult | 4.0-6.0[1] | |
| Channel catfish | 0.157 | Juvenile | 2.0-10.0[1] | 25.5 |
| | | Adult | 10.5-50.0[2] | |
| Smallmouth bass | 0.128 | Juvenile | 2.0-7.0[2] | None |
| | | Adult | 8.0-27.0[2] | |
| Walleye | 0.129 | Juvenile | 2.0-11.0[1] | 31.0 |
| | | Adult | 12.0-36.0[1&3] | |
| Shorthead redhorse | 0.13 | Juvenile | 2.0-10.0[2] | None |
| | | Adult | 14-18[1] | |
| Emerald shiner | 0.108 | Juvenile | 1.0-4[1] | None |
| | | Adult | 5 [1] | |
| Gizzard shad | 0.105 | Juvenile | 2.0-7.0[4] | None |
| | | Adult | 10.0-14.0[1] | |

* "None" indicates that the calculated exclusion length exceeds the maximum length expected for the species at Lake Lynn.
1 Smith, C. L. 1985. The Inland Fishes of New York State. Albany, NY. New York Department of Environmental Conservation.
2 Rohde F. C., Arndt R. G., Foltz, J. W., Quattro, J. M. 2009. Freshwater Fishes of South Carolina. University of South Carolina. University of South Carolina Press.
3 Pennsylvania Fish and Boat Commission. 2020. Gallery of Pennsylvania Fishes. Perches and Darters. Site accessed 12/8/20. https://www.fishandboat.com/Fish/PennsylvaniaFishes/GalleryPennsylvaniaFishes/Pages/PerchesandDarters.aspx
4 Pennsylvania Fish and Boat Commission. 2020. Gallery of Pennsylvania Fishes. Herrings. Site accessed 12/8/20. https://www.fishandboat.com/Fish/PennsylvaniaFishes/GalleryPennsylvaniaFishes/Pages/Herrings.aspx

**Table 4-4: Hydroelectric facility characteristics from the EPRI entrainment database comparable to Lake Lynn**

| Facility Name | Total Plant Capacity (cfs) | Operating Mode | Trash Rack Spacing (in) |
|---|---|---|---|
| Centralia | 3,640 | ROR | 3.5 |
| Crowley | 2,400 | ROR | 2.375 |
| Sandstone Rapids | 1,300 | PK | 1.75 |
| Schaghticoke | 1,640 | ROR | 2.125 |
| Twin Branch | 3,200 | ROR | 3 |
| Sherman Island | 6,600 | PK | 3.125 |
| Herrings | 3,610 | ROR | 4.125 |
| Townsend Dam | 4,400 | ROR | 5.5 |
| E.J. West | 5,400 | NA | 4.5 |
| Caldron Falls | 1,300 | PK | 2 |
| | | | |
| Lake Lynn | 10,143 | PK/ROR | 4 |

ROR = Run-of-river, PK= Peaking

**Table 4-5: Burst swim speed information compiled from scientific literature for target fish species**

| Common Name | Size potentially encountered in WV/PA (in) | Size included in burst speed estimate based on data availability | Burst Speed (fps) at minimum size[5] | Burst Speed (fps) at median size[5] | Burst Speed (fps) at maximum size[5] |
|---|---|---|---|---|---|
| Bluegill | 1.0-6.0[1] | 1.0-6.0 | 1.6* | 3.4 | 4.6 |
| Channel catfish | 2.0-50.0[1&2] | 2.0-21.0 | 2.4* | 6.8 | 9.7 |
| Smallmouth bass | 2.0-27.0[2] | 2.0-15.0 | 2.4* | 5.6 | 8.0 |
| Walleye | 2.0-36.0[1&3] | 2.0-20.0 | 3.6 | 10.6 | 15.4 |
| Shorthead redhorse | 2.0-10.0[1&2] | 2.0-10 | 3.6 | 7.2 | 10.0 |
| Emerald shiner | 1.0-5[1] | 1.0-3.0 | 2.3* | 3.6 | 4.7 |
| Gizzard shad | 2.0-7.0[4] | 2.0-7 | 5.2 | 9.3 | 12.7 |
| | 10.0-14.0[1] | 10.0-14 | 16.2 | 18.4 | 20.4 |

*Highlighted cells denote swim speeds that are slower than the intake velocity of one or more units at the Project

1 Smith, C. L. 1985. The Inland Fishes of New York State. Albany, NY. New York Department of Environmental Conservation.

2 Rohde F. C., Arndt R. G., Foltz, J. W., Quattro, J. M. 2009. Freshwater Fishes of South Carolina. University of South Carolina. University of South Carolina Press.

3 Pennsylvania Fish and Boat Commission. 2020. Gallery of Pennsylvania Fishes. Perches and Darters. Site accessed 12/8/20. https://www.fishandboat.com/Fish/PennsylvaniaFishes/GalleryPennsylvaniaFishes/Pages/PerchesandDarters.aspx

4 Pennsylvania Fish and Boat Commission. 2020. Gallery of Pennsylvania Fishes. Herrings. Site accessed 12/8/20. https://www.fishandboat.com/Fish/PennsylvaniaFishes/GalleryPennsylvaniaFishes/Pages/Herrings.aspx

5 Katopodis, C, and R Gervais. 2016. Fish Swimming Performance Database and Analyses. DFO Can. Sci. Advis. Sec. Res. Doc. 2016/002., 550.

**Table 4-6: TBSA predicted survival estimates for passage through Units 1, 3 or 4 at Lake Lynn for body lengths with a probability of entrainment based on rack spacing and minimum exclusion length**

| Unit | Units 1, 3, and 4 | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Fish Body Length | 2 in | 4 in | 6 in | 8 in | 10 in | 12 in | 14 | 19 | 24 | 30 |
| Survival rate | 95.0% | 89.9% | 84.3% | 79.6% | 78.4% | 69.3% | 64.8% | 52.4% | 38.1% | 24.5% |

Values calculated for Units 1, 3, 4 at maximum rated capacity (2,425 cfs per unit), 80% efficiency, and correlation coefficient = 0.2

**Table 4-7: TBSA predicted survival estimates for passage through Unit 2 at Lake Lynn for body lengths with a probability of entrainment based on rack spacing and minimum exclusion length**

| Unit | Unit 2 | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Fish Body Length | 2 in | 4 in | 6 in | 8 in | 10 in | 12 in | 14 | 19 | 24 | 30 |
| Survival rate | 94.7% | 89.6% | 84.3% | 79.1% | 74.0% | 68.5% | 63.5% | 50.6% | 37.3% | 21.0% |

Values calculated for Unit 2 at maximum rated capacity (2,868 cfs), 80% efficiency, and correlation coefficient = 0.2

**Table 4-8: Hydroelectric facility characteristics from the EPRI turbine survival database comparable to the Lake Lynn Project**

| Facility Name | Turbine Type | Rated Head (ft) | Rated Flow (cfs) Per unit | Speed (rpm) | Runner Diameter (ft) | Runner Blades |
|---|---|---|---|---|---|---|
| E.J. West | Francis (vertical) | 63 | 2,450 | 112.5 | 10.9 | 15 |
| Hardy | Francis (vertical) | 100 | 1,500 | 163.6 | 7 | 16 |
| | | | | | | |
| Lake Lynn unit 1,3 & 4 | Francis | 81.5 | 2425 | 133.3 | 10.8 | 16 |
| Lake Lynn unit 2 | Francis | 81.5 | 2868 | 133.3 | 10.8 | 17 |

**Table 4-9: Turbine survival estimates of target species from the EPRI turbine survival database**

| Project Name | Species | Length (in) | | Based on Number Released | | | Based on number recovered | | | Control | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Min | Max | Immediate Survival (%) | 24-hr. Survival (%) | 48-hr. Survival (%) | Immediate Survival (%) | 24-hr. Survival (%) | 48-hr. Survival (%) | Immediate Survival (%) | 24-hr. Survival (%) | 48-hr. Survival (%) |
| E.J. West | Bluegill | - | 4 | 1.26 | - | 1.71 | 1.11 | - | 1.51 | 0.79 | - | 0.36 |
| | Bluegill | - | 4 | 0.44 | - | 0.41 | 0.7 | - | 0.66 | 0.93 | - | 0.58 |
| | Bluegill | - | 4 | 0.21 | - | 0.24 | 0.59 | - | 0.67 | 0.99 | - | 0.62 |
| Hardy | Bluegill | 4.7 | 7.3 | 0.98 | 0.91 | 0.93 | 0.96 | 0.9 | 0.92 | 1 | 1 | 0.98 |
| | Bluegill | 3.1 | 5.9 | 0.77 | 0.67 | 0.71 | 0.97 | 0.85 | 0.9 | 1 | 0.98 | 0.93 |
| | Walleye | 5.8 | 25 | 0.83 | 0.83 | 0.81 | 0.8 | 0.8 | 0.77 | 0.97 | 0.94 | 0.94 |

**Table 4-10: Fish survival rates for generating units comparable to Project based on EPRI (1997) database and summarized by Winchell (2000)**

| Turbine Type | Runner Speed (rpm) | Hydraulic Capacity (cfs) | Fish Size (mm) | Average immediate survival (all species combined) | | |
|---|---|---|---|---|---|---|
| | | | | Minimum | Maximum | Mean |
| Lake Lynn Units 1, 3, 4 (Francis) | 133.3 | 2,425 each | N/A | | | |
| Lake Lynn Unit 2 (Francis) | 133.3 | 2,868 each | N/A | | | |
| Radial Flow (Francis) Winchell (2000) | <250 | 440-1,600 | <100 | 85.9% | 100% | 93.9% |
| | | 370-1,600 | 100-199 | 74.8% | 100% | 91.6% |
| | | 370, 2,450 | 200-299 | 59.0% | 100% | 86.9% |
| | | 440-1,600 | 300+ | 36.1% | 100% | 73.2% |

**Table 4-11: Qualitative project passage survival potential for target fish species relative to factors influencing entrainment and turbine survival at the Project**

| Species and Life Stage | | Entrainment Potential | | | | Turbine Survival Potential |
|---|---|---|---|---|---|---|
| | | Behavior, Habitat and Life History | Trash Rack Clear Spacing | Swim Speed compared to Unit 1,3,4 Approach Velocity | Swim Speed compared to Unit 2 Approach Velocity | |
| | | | 4 inch | (2.3 fps) | (2.7 fps) | |
| **Bluegill** | Adult | L | H | L | L | H-M |
| | Juvenile | | | H | H | H |
| **Channel Catfish** | Adult | L | M | L | L | M-L |
| | Juvenile | | H | M | H | H |
| **Smallmouth Bass** | Adult | L | H | L | L | M-L |
| | Juvenile | | | M | H | H |
| **Walleye** | Adult | L | M | L | L | M-L |
| | Juvenile | L | H | L | L | H |
| **Shorthead Redhorse** | Adult | L | H | L | L | M-L |
| | Juvenile | | | L | L | H |
| **Emerald Shiner** | Adult | L | H | L | L | H |
| | Juvenile | | | M | H | H |
| **Gizzard Shad** | Adult | L | H | M* | M* | M-L |
| | Juvenile | | | M* | M* | H |

*Likelihood relative to burst speed is low, however, this species is susceptible is to lethargic behavior during the winter months, leading to less responsive burst movements

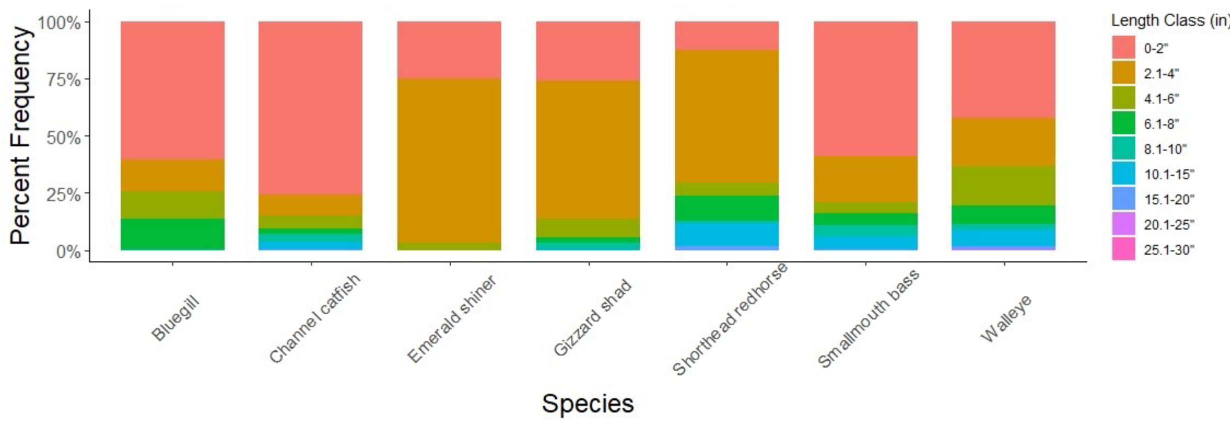


**Figure 4–1. Length class composition by target fish species from the subset of comparable hydroelectric projects within the EPRI 1997 database.**

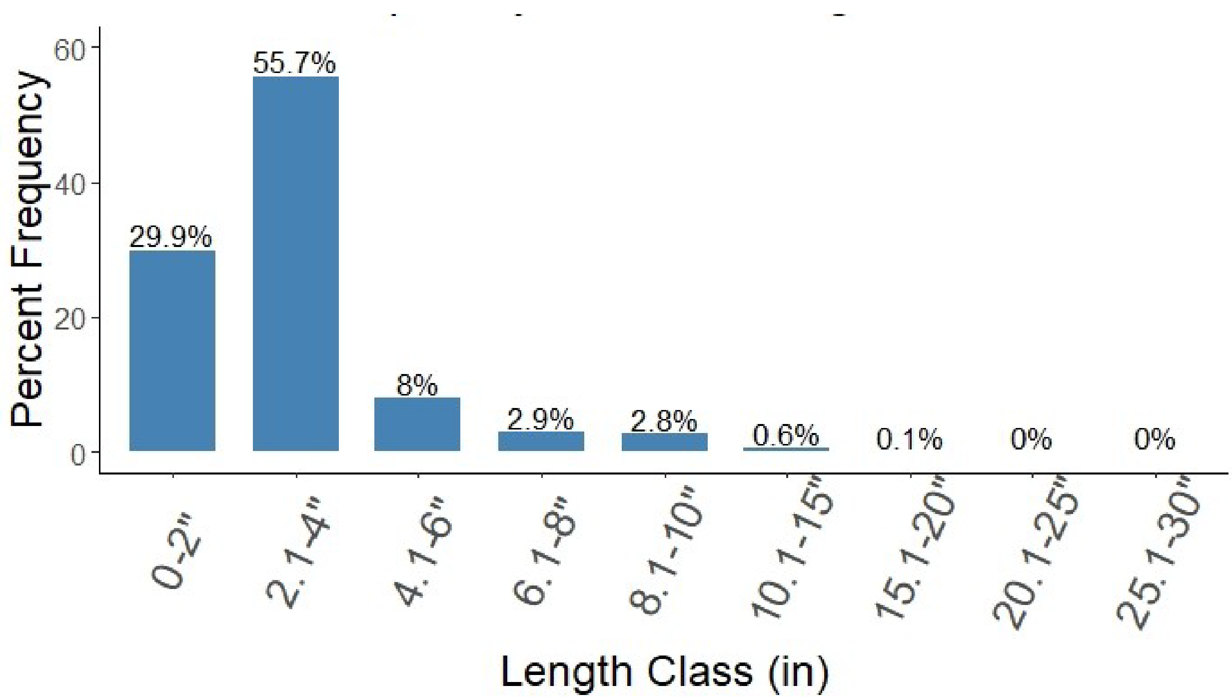


**Figure 4–2. Length class composition for target fish species combined from the subset of comparable hydroelectric projects within the EPRI 1997 database.**

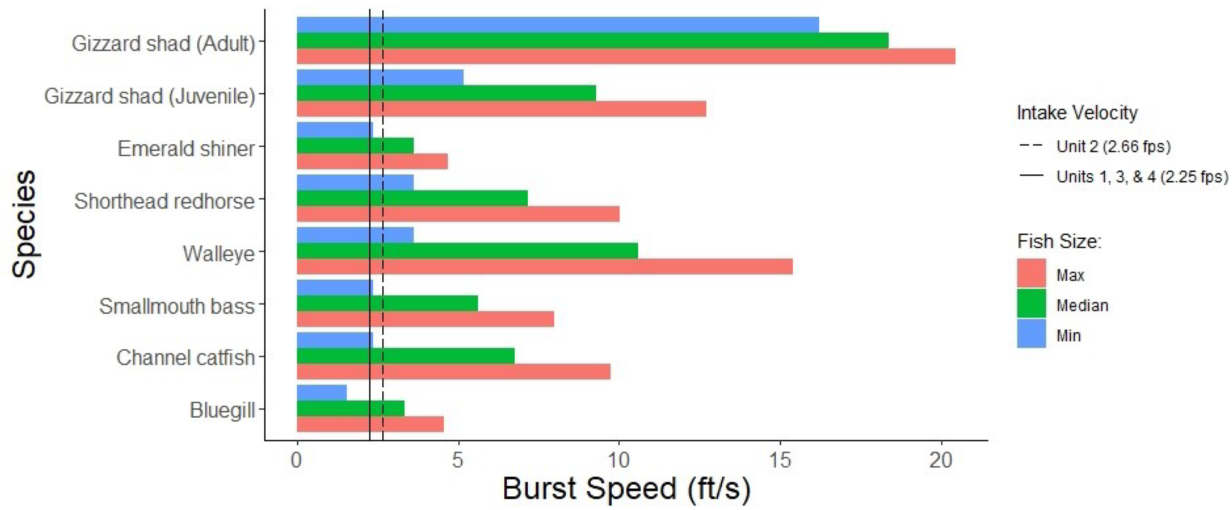


**Figure 4–3. Burst swim speed of target fish species compared to calculated approach velocities at the Lake Lynn intakes.**

# 5 Quantitative Assessment of Entrainment and Turbine Survival Potential

Information contained in the EPRI (1997) data compilation and other sources were used to compile a qualitative assessment of the potential entrainment of target fishes at Lake Lynn (see Section 4.8 of this report). Likewise, a desktop approach, relying on modeled and empirical data, was conducted to provide estimates of fish survival during turbine entrainment (see Section 4.6 of this report). In addition to the previously described qualitative entrainment assessment for the Lake Lynn Project, a quantitative estimate of entrainment during generation at the Project was calculated. The resulting entrainment estimate was then combined with modeled survival rates for fish passing through the Project turbine units.

In the absence of site-specific entrainment data at the Lake Lynn Project, the quantitative estimates presented here relied on a combination of site-specific operations data and surrogate fish entrainment rates available from similar hydroelectric projects. Quantitative estimates of entrainment at Lake Lynn were calculated for each of the target fish species. As noted in Section 4.8, the susceptibility to colder water temperatures and downstream movement of juvenile individuals during the fall season described in the literature for gizzard shad can result in seasonal increases in entrainment for that species.

## 5.1 Site-specific Operations Data

Flow duration curves for the Project were obtained from Appendix E of the PAD and used to develop estimated values of turbine unit discharge for use in the quantitative entrainment analysis. Values for the 10$^{th}$, 25$^{th}$, 50$^{th}$, 75$^{th}$, and 90$^{th}$ exceedance conditions were extracted from the flow duration curves for each calendar month. For each month-exceedance condition combination, values were adjusted for station capacity. For instances where the river flow was in excess of station capacity it was assumed the Project was operating at its capacity of 10,143 cfs and for instances where the river flow was less than station capacity it was assumed the Project was operating at the available inflow less the required 212 cfs minimum flow. The resulting discharge rate (i.e., cubic feet per second) was applied to the full month (i.e., cfs * 86,400 seconds per day * no. days per month) to generate an estimate of the total volume ($ft^3$) of water passing through the Project turbines. The resulting monthly volume estimates for the five exceedance conditions are presented in Table 5-1.

## 5.2 Summary of Fisheries Entrainment Data

Of the 43 projects contained in the EPRI (1997) database, a total of ten (Table 4-4) were identified for comparison to Lake Lynn for evaluation of entrained species and sizes (see Section 4.4) and two projects were identified for evaluation of survival (see Section 4.7). Of the ten comparable projects used for evaluation of entrainment, only one, Townsend Dam, included volume based entrainment density information for all seven of the target fish species included in this evaluation. Townsend Dam is located in New Brighton, PA, so is also a reasonable comparison due to its relative proximity to the Lake Lynn Project. Fisheries entrainment rate data collected during netting studies conducted during the early 1990's at Townsend Dam were selected as the best available surrogate of entrainment rate data for the full set of target species considered at the Lake Lynn Project.

Within any comparison among hydroelectric projects, site-specific differences in facilities and equipment as well as the manner in which they are operated will exist. Townsend Dam has a smaller hydraulic capacity (4400 cfs) in comparison to that at Lake Lynn (10,143 cfs), two turbines versus four, and is operated in a true run-of-river mode. The section of the Beaver River (a tributary within the Ohio River basin) upstream of Townsend Dam is more riverine in nature (0.9 mile impoundment) than the larger Cheat Lake located upstream of Lake Lynn Project (13 mile impoundment). Lastly, the intake rack clear spacing at Townsend dam is 5.5 inches, while the Lake Lynn spacing is 4 inches.

In addition to differences between the stations and their source water bodies, variability in the relative proportions and densities of individual fish species within the community needs to be considered and may be influenced by a variety of factors including water quality, habitat availability, flow, and overall productivity. For example, relative abundance data for gizzard shad collected during eight sampling seasons by boat electrofishing in Cheat Lake suggests the species is the twentieth most frequently sampled species. However, gizzard shad comprised the vast majority of entrainment samples collected at Townsend Dam (88%). As a result, available gizzard shad density data from Minetto Dam in Fulton, NY and the Richard B. Russell pump storage station on the Savannah River, GA/SC were also used to provide a range of estimates of entrainment for the species at Lake Lynn. Based on the identified available entrainment density information, the following estimates were generated for the target species considered in this evaluation:

- Bluegill – based on available monthly entrainment rates from Townsend Dam;
- Channel catfish – based on available monthly entrainment rates from Townsend Dam;
- Smallmouth bass – based on available monthly entrainment rates from Townsend Dam;
- Walleye – based on available monthly entrainment rates from Townsend Dam;
- Emerald shiner – based on available monthly entrainment rates from Townsend Dam;
- Shorthead redhorse – based on available monthly entrainment rates from Townsend Dam; and
- Gizzard shad – based on available monthly entrainment rates from Townsend Dam, Minetto Dam, and Richard B. Russell pump storage.

Entrainment monitoring at Townsend and Minetto Dams was conducted during all months of the year and at the Richard B. Russell Project was conducted during the months of April-November. The quantitative estimates of entrainment at the Lake Lynn Project presented in this report reflect all available data, with some months being blank because individuals of a particular species were not entrained at the comparison projects. The EPRI (1997) data compilation provides the total number of collected fish by species and adjusted for net collection efficiency as well as the total volume of water sampled through the collection nets. Theoretical estimates of entrainment densities for target and surrogate species were calculated on a monthly basis using the equation:

$$D_i = \frac{C_x}{G_x}$$

where:

$D_i$ = density of fish species A per cubic foot of sampling flow;

$C_x$ = count of the number of fish species A during month *x*, and

$G_x$ = sampling volume in cubic feet for month *x*.

Monthly entrainment rates used to calculate estimated entrainment for target fish species at Lake Lynn are provided in Appendix B. Tables in Appendix B provide the reported monthly values for raw number of individuals collected, volume of water sampled ($ft^3$), and the resulting species-specific density ($\#/ft^3$) for each target species at the comparison projects.

## 5.3 Quantitative Estimates of Entrained individuals by Species

Monthly operating volumes for the 50% exceedance condition (Table 5-1) and target species densities obtained from comparative projects were used to calculate estimates of entrainment during generation at Lake Lynn (Table 5-2)[2]. Based on the assumption that entrainment rates observed at Townsend Dam and reported by EPRI (1997) are an accurate representation of entrainment rates for the target fish species at Lake Lynn, an estimated 7,164 channel catfish, 6,110 bluegill, 2,099 walleye, 889 smallmouth bass, 124 emerald shiner, and 115 redhorse are entrained on an annual basis at the Project. Estimates of annual entrainment count for gizzard shad at Lake Lynn vary widely dependent on the comparative project selected. Based on the assumption that the reported entrainment rates for gizzard shad at the Townsend, Minetto, and Richard B. Russell Projects are representative of those for gizzard shad at Lake Lynn, annual entrainment for the species ranges from 265 individuals up to 14 million individuals (Table 5-2). The extreme variation in the predicted entrainment estimates for gizzard shad at Lake Lynn calculated using densities from the three comparative projects suggests that the species can be susceptible to entrainment, particularly during the colder months of the year. However, the assumption that site-specific entrainment rates for this species are readily transferable between sites may not be appropriate.

[2] A full listing of entrainment estimates for target species under the range of exceedance conditions in Table 5-1 can be found in Appendix C.

## 5.4 Predicted Entrainment Survival

The predicted number of entrained individuals for each target fish species (Table 5-2) was combined with the estimated survival rates for turbine units at Lake Lynn obtained using the TBSA to calculate the estimated number of individuals lost during turbine passage. Prior to calculation, the total entrainment estimates for each target species were categorized into length classes based on proportions observed for catch at the project from which the data were reported by EPRI (1997). Estimated numbers of entrained individuals within each length class were then used in combination with modelled survival rates for passage through the Lake Lynn turbines to obtain an estimate of mortality for each species at the Lake Lynn Project. A species specific mortality rate was then calculated as the proportion of the total entrainment estimate for each species represented by individuals predicted to be lost during turbine passage.

Table 5-3 provides a summary of the estimated monthly number of each target fish species entrained at Lake Lynn broken out by length class proportions associated with the site-specific entrainment rates reported for other hydroelectric projects by EPRI (1997). Based on the assumption that entrainment rates observed at Townsend Dam and reported by EPRI (1997) are an accurate representation of entrainment rates for the target fish species at Lake Lynn and incorporation of the size-specific turbine survival rates obtained during the TBSA exercise, an estimated 1,403 channel catfish, 688 bluegill, 557 walleye, 148 smallmouth bass, 16 emerald shiner, and 40 redhorse are lost during turbine passage on an annual basis at the Project. When viewed as a singular percentage of the total number estimated to be entrained on an annual basis at Lake Lynn under a median flow condition, these numbers represented between 11 and 35% of the total number estimated to be entrained.

Similar to the estimates of abundance for entrained gizzard shad (see Section 5.3), the estimated rate of mortality for the species varied widely depending on which of the projects in the EPRI 1997 database was used as a source for “representative” density data. Estimated percent mortality for entrained gizzard shad ranged from a low of 8% using Townsend Dam density data, to a high of 34% using Richard B. Russell density data. This wide range of these estimates further highlights the idea that site-specific entrainment data for gizzard shad may not be transferable between sites.

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**Table 5-1: Monthly generation volume ($ft^3$) at Lake Lynn as estimated from site-specific flow curves provided in Appendix E of PAD**

| % Exceeded | JAN | FEB | MAR | APR | MAY | JUN |
|---|---|---|---|---|---|---|
| 10 | 27,167,011,200 | 24,537,945,600 | 27,167,011,200 | 26,290,656,000 | 27,167,011,200 | 26,290,656,000 |
| 25 | 21,785,182,149 | 24,537,945,600 | 18,298,090,538 | 23,971,506,859 | 27,167,011,200 | 9,205,392,890 |
| 50 | 11,028,256,632 | 24,537,945,600 | 10,046,221,174 | 11,892,949,444 | 14,553,928,174 | 4,400,326,621 |
| 75 | 4,700,119,918 | 7,228,251,369 | 5,673,822,781 | 5,580,539,795 | 6,773,167,404 | 3,108,858,973 |
| 90 | 2,484,667,393 | 3,444,202,756 | 2,507,259,905 | 4,082,485,951 | 3,878,315,710 | 1,732,546,030 |
| **% Exceeded** | **JUL** | **AUG** | **SEP** | **OCT** | **NOV** | **DEC** |
| 10 | 20,660,624,886 | 7,048,884,520 | 26,290,656,000 | 27,167,011,200 | 24,704,352,000 | 27,167,011,200 |
| 25 | 8,259,271,412 | 4,700,119,918 | 5,315,231,421 | 10,283,644,281 | 17,707,829,553 | 21,950,624,391 |
| 50 | 4,011,413,812 | 3,412,745,945 | 1,463,674,242 | 3,129,776,879 | 8,056,068,145 | 10,124,779,340 |
| 75 | 2,288,659,697 | 1,896,973,911 | 927,481,247 | 1,590,595,910 | 3,163,212,976 | 4,979,184,202 |
| 90 | 1,688,238,171 | 1,393,291,498 | 772,821,202 | 1,175,037,405 | 1,601,815,716 | 2,694,124,861 |

**Table 5-2: Estimated entrainment for target fish species at Lake Lynn under a 50% exceedance condition and calculated using entrainment density data reported by EPRI (1997) at the Townsend, Minetto Richard B. Russell Projects. Unless otherwise indicated estimates are based on density data collected at the Townsend Project.**

| Species | JAN | FEB | MAR | APR | MAY | JUN | JUL | AUG | SEP | OCT | NOV | DEC |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Gizzard shad (Townsend Dam) | 143,547 | 12,058 | 144,870 | 2,009 | 1,230 | 58 | 76,477 | 10,083 | 100,225 | 1,907,612 | 795,825 | 11,142,179 |
| Gizzard shad (Minetto) | 7,802 | 3,220 | 3,065 | 507 | 10 | - | 10 | 94,618 | 84 | 173,556 | 384,933 | 390 |
| Gizzard shad (Richard B. Russell) | - | - | - | 73 | - | 12 | 80 | 29 | - | 16 | 55 | - |
| Smallmouth bass | - | - | 35 | 57 | 434 | 202 | 118 | 25 | 18 | - | - | - |
| Bluegill | 199 | 482 | 526 | 344 | 1,013 | 260 | 177 | 89 | 36 | 629 | 1,828 | 527 |
| Walleye | 119 | 289 | 35 | 172 | 217 | - | 89 | 25 | 18 | 22 | 103 | 1,010 |
| Emerald shiner | 80 | - | - | - | - | - | 44 | - | - | - | - | - |
| Channel catfish | - | 289 | 245 | 287 | 4,558 | 665 | 429 | 433 | 171 | 43 | - | 44 |
| Shorthead redhorse | - | - | - | 115 | - | - | - | - | - | - | - | - |

**Table 5-3: Estimated entrainment of target fish species at at Lake Lynn under a 50% exceedance condition adjusted for survival using predicted size-specific rates generated for Units 1, 3, and 4 using the TBSA model**

| Species | | Size Class (Inches) | | | | | | | | | | Estimated Total for Lake Lynn | Percent Total Mortality |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 0-2 | 2-4 | 4-6 | 6-8 | 8-10 | 10-15 | 15-20 | 20-25 | 25-30 | 30+ | | |
| **Gizzard shad (Townsend Dam)** | Proportion of fish entrained | 47.21% | 46.85% | 3.93% | 0.87% | 1.07% | 0.08% | 0.00% | 0.00% | 0.00% | 0.00% | 14,336,172 | 8% |
| | Calculated Mortality | 338409 | 678364 | 88420 | 25436 | 32993 | 3822 | 18 | 0 | 0 | 0 | 1,167,462 | |
| **Gizzard shad (Minetto)** | Proportion of fish entrained | 0.02% | 26.33% | 59.38% | 13.71% | 0.57% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 668,195 | 15% |
| | Calculated Mortality | 6 | 17766 | 62291 | 18687 | 819 | 11 | 0 | 0 | 0 | 0 | 99,580 | |
| **Gizzard shad (Richard B. Russell)** | Proportion of fish entrained | 0.00% | 6.69% | 0.00% | 0.00% | 0.00% | 93.31% | 0.00% | 0.00% | 0.00% | 0.00% | 265 | 34% |
| | Calculated Mortality | 0 | 2 | 0 | 0 | 0 | 87 | 0 | 0 | 0 | 0 | 89 | |
| **Smallmouth bass** | Proportion of fish entrained | 7.41% | 14.81% | 40.74% | 7.41% | 25.93% | 3.70% | 0.00% | 0.00% | 0.00% | 0.00% | 891 | 17% |
| | Calculated Mortality | 3 | 13 | 57 | 13 | 50 | 12 | 0 | 0 | 0 | 0 | 148 | |
| **Bluegill** | Proportion of fish entrained | 19.30% | 50.88% | 19.88% | 9.36% | 0.58% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 6,111 | 11% |
| | Calculated Mortality | 59 | 314 | 191 | 117 | 8 | 0 | 0 | 0 | 0 | 0 | 688 | |

| Species | | Size Class (Inches) | | | | | | | | | | Estimated Total for Lake Lynn | Percent Total Mortality |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 0-2 | 2-4 | 4-6 | 6-8 | 8-10 | 10-15 | 15-20 | 20-25 | 25-30 | 30+ | | |
| **Walleye** | Proportion of fish entrained | 0.00% | 2.00% | 2.00% | 35.18% | 22.72% | 34.09% | 4.00% | 0.00% | 0.00% | 0.00% | 2,100 | 27% |
| | Calculated Mortality | 0 | 4 | 7 | 151 | 103 | 252 | 40 | 0 | 0 | 0 | 557 | |
| **Emerald shiner** | Proportion of fish entrained | 0% | 60% | 40% | 0% | 0% | 0% | 0% | 0% | 0% | 0% | 124 | 13% |
| | Calculated Mortality | 0 | 8 | 8 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 16 | |
| **Channel catfish** | Proportion of fish entrained | 1.08% | 13.98% | 40.32% | 18.28% | 13.98% | 7.53% | 4.30% | 0.54% | 0.00% | 0.00% | 7,165 | 20% |
| | Calculated Mortality | 4 | 101 | 454 | 267 | 216 | 190 | 147 | 24 | 0 | 0 | 1,403 | |
| **Shorthead redhorse** | Proportion of fish entrained | 0% | 0% | 0% | 0% | 0% | 100% | 0% | 0% | 0% | 0% | 115 | 35% |
| | Calculated Mortality | 0 | 0 | 0 | 0 | 0 | 40 | 0 | 0 | 0 | 0 | 40 | |

# 6 Summary

The Cheat River supports both warm water and cool water fish species including popular game species such as largemouth bass, smallmouth bass, trout, crappie, walleye, and channel catfish. Community data for biological sampling conducted upstream of Lake Lynn in Cheat Lake documented 35 fish species between 2011 and 2015. Seven species were identified as representative of that community and were included in this desktop assessment of fish entrainment at the Project (bluegill, channel catfish, smallmouth bass, walleye, emerald shiner, golden redhorse, and gizzard shad). Life history information for the target fish species was reviewed and based on the available habitat requirements and behavioral responses to environmental conditions it was determined that gizzard shad are the target species most susceptible to entrainment at the Project. Gizzard shad are abundant in reservoirs where they are found and tend to school together in the pelagic zone. These fish may be present in the vicinity of the Project intakes and could be entrained. Though they are capable of swimming against intake velocities, they may follow the flow or become entrained while attempting to escape predators. These fishes will succumb or become moribund at prolonged cold water temperatures below about 38°F. Young gizzard shad may move downstream out of reservoirs during fall and early winter and their tendency to become moribund as their lower temperature threshold is approached furthers their susceptibility to entrainment. As a result, entrainment of shad tends to peak in the fall and winter in reservoirs where they are abundant. The entrainment potential for the remaining target fish species is expected to be low given the lack of high quality aquatic habitat in the immediate vicinity of the intake structure coupled with the fact that none of the additional fish species are considered obligatory migrants.

Nearly all of the target fish species are unlikely to attain a minimum body size that would be excluded based solely on the existing 4-inch clear spacing at the Project intakes. Only two species, channel catfish and walleye, are likely to achieve a size too large to fit through the existing intake racks. Intake velocities, a factor impacting involuntary entrainment and impingement, were calculated in the range of 2.3 to 2.7 fps. When these intake velocities are considered, only the smallest size classes (i.e., less than 2 inch) of bluegill, channel catfish, smallmouth bass and emerald shiner are at risk of entrainment due to burst swim capabilities less than the calculated approach velocities. Reported burst swim capabilities for the larger size classes of those species as well as all size classes for the remaining three target species are in excess of the expected intake velocities. This is further supported by a review of the EPRI (1997) database which resulted in ten hydroelectric projects with similar characteristics to Lake Lynn at which entrainment studies were conducted. Six of the target species and one surrogate species were identified in the entrainment data from the ten comparable projects and the majority of fish entrained were less than 4 inches in length.

In general, entrainment for most of the target fish species considered during this evaluation is not anticipated to be high at Lake Lynn. As demonstrated at comparable hydroelectric projects (EPRI 1997), the majority of individuals representing the target fish species were less than four inches in length (i.e., likely representative of primarily juvenile fish). Relative to Lake Lynn, the entrainment of juvenile life stages of target species during generation at the Project is probably incidental as they are likely more abundant in shoreline littoral habitat than the pelagic or deep-water benthic habitat in front of the Lake Lynn intake rack structure. Gizzard shad are the target species most likely to be seasonally entrained during periods of low water temperatures. However, due to their high burst speed swimming capability at all sizes, they are expected to have relatively low entrainment susceptibility during the warmer months of the year.

In the event individuals are entrained, TBSA assessments were conducted for fish lengths representative of the size range of target species with potential to fit through the existing rack spacing at Lake Lynn. The TBSA analysis produced a range of survival estimates for turbine survival through the four Francis units at the Project and were slightly higher for Units 1, 3, and 4 than for the recently modified Unit 2. Within the range of size classes evaluated, survival increased with decreasing body size, a trend also identified in a review of the EPRI (1997) database and consistent with the findings in Winchell et al. (2000). Survival rates calculated for size classes representative of juvenile life stages (i.e., those less than or equal to six inches) ranged from 84-95%.

In addition to the qualitative evaluation for the seven target fish species, quantitative estimates of entrainment and entrainment survival were calculated. Density data available from the EPRI (1997) database was combined with estimated monthly generation volumes to calculate estimates of monthly entrainment for the seven target species. It is important to note that the monthly entrainment estimates are based on the assumption that entrainment rates observed at projects reported by EPRI (1997) are an accurate representation of entrainment rates for the target fish species at Lake Lynn. Assuming this is accurate, annual entrainment estimates for species other than gizzard shad ranged from a low of 115 individuals (redhorse) to a high of 7,165 individuals (channel catfish). Three different sets of monthly entrainment density data were pulled from the EPRI (1997) database to calculate estimates for gizzard shad entrainment at the Project and produced a wide range of estimates with the highest estimate over 14 million individuals entrained annually and a lowest estimate of 265 individuals entrained annually. The wide range of estimated annual entrainment numbers suggest that entrainment rates for gizzard shad may not be readily transferable between sites.

Entrainment estimates for each target species were adjusted to reflect the predicted survival rates generated during the TBSA analysis for the Lake Lynn turbine units. The percentage of the annual entrainment expected to experience mortality was generally low, ranging from 11% of entrained individuals for bluegill to 35% of entrained individuals for redhorse. Similar to the observations for overall abundance, the estimates for the rate of entrainment mortality for gizzard shad varied from a low of 8% of entrained individuals when based on density information available from Townsend Dam to 34% of entrained individuals when based on density information available from Richard B. Russell.

In summary, entrainment potential for most of the target species is anticipated to be low due to a low likelihood of encountering the Project intakes and the lack of obligatory migrants within the system. Of the seven target fish species, gizzard shad are the most likely to be exposed to entrainment at Lake Lynn given their lowered activity and ability to respond during periods of low water temperatures.

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# 8 Appendices

## Appendix A. Supporting tables for burst speed analysis

| Bluegill | | | | | |
|---|---|---|---|---|---|
| % indicates portion of test fish able to achieve speed listed (fps) for 3 seconds | | | | | |
| Size (in) | 97.50% | 87.50% | 50% | 12.50% | 2.50% |
| 1 | 1.01 | 1.21 | **1.55** | 1.99 | 2.37 |
| 2.25 | 1.63 | 1.94 | 2.49 | 3.19 | 3.81 |
| 3.5 | 2.19 | 2.61 | **3.35** | 4.30 | 5.12 |
| 4.75 | 2.60 | 3.10 | 3.97 | 5.09 | 6.07 |
| 6 | 2.98 | 3.54 | **4.56** | 5.84 | 6.96 |

| Channel catfish | | | | | |
|---|---|---|---|---|---|
| % indicates portion of test fish able to achieve speed listed (fps) for 3 seconds | | | | | |
| Size (in) | 97.50% | 87.50% | 50% | 12.50% | 2.50% |
| 2 | 1.54 | 1.83 | **2.35** | 3.02 | 3.58 |
| 6.75 | 3.21 | 3.81 | 4.89 | 6.30 | 7.48 |
| 11.5 | 4.43 | 5.28 | **6.76** | 8.66 | 10.34 |
| 16.25 | 5.48 | 6.53 | 8.40 | 10.76 | 12.83 |
| 21 | 6.37 | 7.58 | **9.74** | 12.50 | 14.90 |

| Smallmouth bass | | | | | |
|---|---|---|---|---|---|
| % indicates portion of test fish able to achieve speed listed (fps) for 3 seconds | | | | | |
| Size (in) | 97.50% | 87.50% | 50% | 12.50% | 2.50% |
| 2 | 1.54 | 1.83 | **2.35** | 3.02 | 3.58 |
| 5.25 | 2.79 | 3.31 | 4.27 | 5.48 | 6.53 |
| 8.5 | 3.71 | 4.40 | **5.64** | 7.25 | 8.63 |
| 11.75 | 4.53 | 5.38 | 6.89 | 8.86 | 10.53 |
| 15 | 5.22 | 6.20 | **7.97** | 10.20 | 12.17 |

| Walleye | | | | | |
|---|---|---|---|---|---|
| % indicates portion of test fish able to achieve speed listed (fps) for 3 seconds | | | | | |
| Size (in) | 97.50% | 87.50% | 50% | 12.50% | 2.50% |
| 2 | 1.87 | 2.45 | **3.61** | 5.32 | 6.99 |
| 6.5 | 3.94 | 5.18 | 7.61 | 11.22 | 14.73 |
| 11 | 5.48 | 7.22 | **10.60** | 15.62 | 20.51 |
| 15.5 | 6.79 | 8.92 | 13.16 | 19.36 | 25.43 |
| 20 | 7.97 | 10.47 | **15.39** | 22.67 | 29.76 |

| Shorthead redhorse | | | | | |
|---|---|---|---|---|---|
| % indicates portion of test fish able to achieve speed listed (fps) for 3 seconds | | | | | |
| Size (in) | 97.50% | 87.50% | 50% | 12.50% | 2.50% |
| 2 | 1.87 | 2.45 | **3.61** | 5.32 | 6.99 |
| 4 | 2.88 | 3.77 | 5.58 | 8.20 | 10.79 |
| 6 | 3.71 | 4.89 | **7.19** | 10.56 | 13.88 |
| 8 | 4.53 | 5.94 | 8.73 | 12.86 | 16.90 |
| 10 | 5.18 | 6.79 | **10.01** | 14.73 | 19.36 |

| Emerald shiner | | | | | |
|---|---|---|---|---|---|
| % indicates portion of test fish able to achieve speed listed (fps) for 3 seconds | | | | | |
| Size (in) | 97.50% | 87.50% | 50% | 12.50% | 2.50% |
| 1 | 1.21 | 1.59 | **2.34** | 3.45 | 4.53 |
| 1.5 | 1.62 | 2.14 | 3.14 | 4.63 | 6.07 |
| 2 | 1.87 | 2.45 | **3.61** | 5.32 | 6.99 |
| 2.5 | 2.20 | 2.89 | 4.27 | 6.27 | 8.24 |
| 3 | 0.24 | 3.19 | **4.69** | 6.92 | 9.09 |

| Gizzard shad (Juvenile) | | | | | |
|---|---|---|---|---|---|
| % indicates portion of test fish able to achieve speed listed (fps) for 3 seconds | | | | | |
| Size (in) | 97.50% | 87.50% | 50% | 12.50% | 2.50% |
| 2 | 4.17 | 4.56 | **5.18** | 5.87 | 6.43 |
| 3.25 | 6.04 | 6.59 | 7.51 | 8.53 | 9.35 |
| 4.5 | 7.45 | 8.17 | **9.29** | 10.56 | 11.55 |
| 5.75 | 8.76 | 9.58 | 10.93 | 12.40 | 13.58 |
| 7 | 10.20 | 11.16 | **12.70** | 14.44 | 15.81 |

| Gizzard shad (Adult) | | | | | |
|---|---|---|---|---|---|
| % indicates portion of test fish able to achieve speed listed (fps) for 3 seconds | | | | | |
| Size (in) | 97.50% | 87.50% | 50% | 12.50% | 2.50% |
| 10 | 13.03 | 14.24 | **16.21** | 18.44 | 20.21 |
| 11 | 13.91 | 15.22 | 17.32 | 19.69 | 21.56 |
| 12 | 14.76 | 16.14 | **18.37** | 20.90 | 22.90 |
| 13 | 15.58 | 17.06 | 19.42 | 22.08 | 24.18 |
| 14 | 16.41 | 17.98 | **20.44** | 23.26 | 25.46 |

# Appendix B: EPRI (1997) reported sample volumes and entrainment densities for the set of Lake Lynn target fish species

| Month | Gizzard Shad - Townsend Dam | | |
|---|---|---|---|
| | Total Catch (#) | Sample Volume ($ft^3$) | Density ($\#/ft^3$) |
| January | 3775 | 290,030,000.00 | 1.30E-05 |
| February | 131 | 266,080,000.00 | 4.91E-07 |
| March | 4323 | 299,800,000.00 | 1.44E-05 |
| April | 37 | 216,770,000.00 | 1.69E-07 |
| May | 18 | 210,410,000.00 | 8.45E-08 |
| June | 2 | 159,160,000.00 | 1.31E-08 |
| July | 5410 | 283,770,000.00 | 1.91E-05 |
| August | 827 | 280,060,000.00 | 2.95E-06 |
| September | 11656 | 170,220,000.00 | 6.85E-05 |
| October | 91950 | 150,860,000.00 | 6.10E-04 |
| November | 24142 | 244,390,000.00 | 9.88E-05 |
| December | 265437 | 241,200,000.00 | 1.10E-03 |

| Month | Gizzard Shad - Minetto | | |
|---|---|---|---|
| | Total Catch (#) | Sample Volume (ft3) | Density (#/ft$^3$) |
| January | 661 | 934,200,000.00 | 7.07E-07 |
| February | 63 | 479,300,000.00 | 1.31E-07 |
| March | 624 | 2,044,600,000.00 | 3.05E-07 |
| April | 43 | 1,012,600,000.00 | 4.27E-08 |
| May | 2 | 2,381,400,000.00 | 6.72E-10 |
| June | - | - | - |
| July | 2 | 640,000,000.00 | 2.50E-09 |
| August | 8672 | 312,800,000.00 | 2.77E-05 |
| September | 16 | 281,800,000.00 | 5.75E-08 |
| October | 62002 | 1,118,100,000.00 | 5.55E-05 |
| November | 56913 | 1,191,100,000.00 | 4.78E-05 |
| December | 23 | 596,700,000.00 | 3.85E-08 |

| Month | Gizzard Shad - Richard B. Russell | | |
|---|---|---|---|
| | Total Catch (#) | Sample Volume (ft3) | Density (#/ft$^3$) |
| January | - | - | - |
| February | - | - | - |
| March | - | - | - |
| April | 4 | 648,000,000.00 | 6.17E-09 |
| May | - | - | - |
| June | 2 | 760,800,000.00 | 2.63E-09 |
| July | 14 | 701,900,000.00 | 1.99E-08 |
| August | 4 | 464,500,000.00 | 8.61E-09 |
| September | - | - | - |
| October | 3 | 596,200,000.00 | 5.03E-09 |
| November | 12 | 1,709,700,000.00 | 6.77E-09 |
| December | - | - | - |

| Month | Smallmouth bass - Townsend Dam | | |
|---|---|---|---|
| | Total Catch (#) | Sample Volume ($ft^3$) | Density ($\#/ft^3$) |
| January | - | - | - |
| February | - | - | - |
| March | 1 | 299,800,000.00 | 3.49E-09 |
| April | 1 | 216,770,000.00 | 4.83E-09 |
| May | 6 | 210,410,000.00 | 2.98E-08 |
| June | 7 | 159,160,000.00 | 4.60E-08 |
| July | 8 | 283,770,000.00 | 2.95E-08 |
| August | 2 | 280,060,000.00 | 7.47E-09 |
| September | 2 | 170,220,000.00 | 1.23E-08 |
| October | - | - | - |
| November | - | - | - |
| December | - | - | - |

| Month | Bluegill - Townsend Dam | | |
|---|---|---|---|
| | Total Catch (#) | Sample Volume ($ft^3$) | Density ($\#/ft^3$) |
| January | 5 | 290,030,000.00 | 1.80E-08 |
| February | 5 | 266,080,000.00 | 1.97E-08 |
| March | 16 | 299,800,000.00 | 5.23E-08 |
| April | 6 | 216,770,000.00 | 2.90E-08 |
| May | 15 | 210,410,000.00 | 6.96E-08 |
| June | 9 | 159,160,000.00 | 5.91E-08 |
| July | 13 | 283,770,000.00 | 4.42E-08 |
| August | 7 | 280,060,000.00 | 2.61E-08 |
| September | 4 | 170,220,000.00 | 2.46E-08 |
| October | 30 | 150,860,000.00 | 2.01E-07 |
| November | 55 | 244,390,000.00 | 2.27E-07 |
| December | 13 | 241,200,000.00 | 5.20E-08 |

| Month | Walleye - Townsend Dam | | |
|---|---|---|---|
| | Total Catch (#) | Sample Volume (ft³) | Density (#/ft³) |
| January | 3 | 290,030,000.00 | 1.08E-08 |
| February | 3 | 266,080,000.00 | 1.18E-08 |
| March | 1 | 299,800,000.00 | 3.49E-09 |
| April | 3 | 216,770,000.00 | 1.45E-08 |
| May | 3 | 210,410,000.00 | 1.49E-08 |
| June | - | - | - |
| July | 6 | 283,770,000.00 | 2.21E-08 |
| August | 2 | 280,060,000.00 | 7.47E-09 |
| September | 2 | 170,220,000.00 | 1.23E-08 |
| October | 1 | 150,860,000.00 | 6.93E-09 |
| November | 3 | 244,390,000.00 | 1.28E-08 |
| December | 24 | 241,200,000.00 | 9.97E-08 |

| Month | Emerald shiner - Townsend Dam | | |
|---|---|---|---|
| | Total Catch (#) | Sample Volume (ft³) | Density (#/ft³) |
| January | 2 | 290,030,000.00 | 7.21E-09 |
| February | - | - | - |
| March | - | - | - |
| April | - | - | - |
| May | - | - | - |
| June | - | - | - |
| July | 3 | 283,770,000.00 | 1.11E-08 |
| August | - | - | - |
| September | - | - | - |
| October | - | - | - |
| November | - | - | - |
| December | - | - | - |

| Month | Channel catfish - Townsend Dam | | |
|---|---|---|---|
| | Total Catch (#) | Sample Volume (ft$^3$) | Density (#/ft$^3$) |
| January | - | - | - |
| February | 3 | 266,080,000.00 | 1.18E-08 |
| March | 7 | 299,800,000.00 | 2.44E-08 |
| April | 5 | 216,770,000.00 | 2.41E-08 |
| May | 66 | 210,410,000.00 | 3.13E-07 |
| June | 24 | 159,160,000.00 | 1.51E-07 |
| July | 30 | 283,770,000.00 | 1.07E-07 |
| August | 36 | 280,060,000.00 | 1.27E-07 |
| September | 20 | 170,220,000.00 | 1.17E-07 |
| October | 2 | 150,860,000.00 | 1.39E-08 |
| November | - | - | - |
| December | 1 | 241,200,000.00 | 4.34E-09 |

| Month | Shorthead redhorse - Townsend Dam | | |
|---|---|---|---|
| | Total Catch (#) | Sample Volume (ft$^3$) | Density (#/ft$^3$) |
| January | - | - | - |
| February | - | - | - |
| March | - | - | - |
| April | 2 | 216,770,000.00 | 9.65E-09 |
| May | - | - | - |
| June | - | - | - |
| July | - | - | - |
| August | - | - | - |
| September | - | - | - |
| October | - | - | - |
| November | - | - | - |
| December | - | - | - |

# Appendix C: Estimated monthly entrainment abundance for Lake Lynn target fish species under five different flow conditions

Calculated estimates of entrained gizzard shad by month under five different flow conditions at the Lake Lynn Project based on density data collected at Townsend Dam

| % Exceeded | JAN | FEB | MAR | APR | MAY | JUN | JUL | AUG | SEP | OCT | NOV | DEC |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **10** | 353,613 | 12,058 | 391,758 | 4,440 | 2,296 | 346 | 393,892 | 20,825 | 1,800,259 | 16,558,405 | 2,440,439 | 29,896,917 |
| **25** | 283,561 | 12,058 | 263,865 | 4,049 | 2,296 | 121 | 157,462 | 13,886 | 363,962 | 6,267,924 | 1,749,282 | 24,156,356 |
| **50** | 143,547 | 12,058 | 144,870 | 2,009 | 1,230 | 58 | 76,477 | 10,083 | 100,225 | 1,907,612 | 795,825 | 11,142,179 |
| **75** | 61,178 | 3,552 | 81,819 | 943 | 572 | 41 | 43,633 | 5,604 | 63,509 | 969,475 | 312,481 | 5,479,523 |
| **90** | 32,341 | 1,692 | 36,156 | 690 | 328 | 23 | 32,186 | 4,116 | 52,919 | 716,190 | 158,237 | 2,964,847 |

Calculated estimates of entrained gizzard shad by month under five different flow conditions at the Lake Lynn Project based on density data collected at Minetto

| % Exceeded | JAN | FEB | MAR | APR | MAY | JUN | JUL | AUG | SEP | OCT | NOV | DEC |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **10** | 19,219 | 3,220 | 8,289 | 1,122 | 18 | - | 52 | 195,429 | 1,511 | 1,506,495 | 1,180,416 | 1,047 |
| **25** | 15,412 | 3,220 | 5,583 | 1,023 | 18 | - | 21 | 130,310 | 306 | 570,260 | 846,110 | 846 |
| **50** | 7,802 | 3,220 | 3,065 | 507 | 10 | - | 10 | 94,618 | 84 | 173,556 | 384,933 | 390 |
| **75** | 3,325 | 949 | 1,731 | 238 | 5 | - | 6 | 52,593 | 53 | 88,203 | 151,144 | 192 |
| **90** | 1,758 | 452 | 765 | 174 | 3 | - | 4 | 38,629 | 44 | 65,159 | 76,538 | 104 |

Calculated estimates of entrained gizzard shad by month under five different flow conditions at the Lake Lynn Project based on density data collected at Richard B. Russell Pump-Storage

| % Exceeded | JAN | FEB | MAR | APR | MAY | JUN | JUL | AUG | SEP | OCT | NOV | DEC |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **10** | - | - | - | 162 | - | 69 | 412 | 61 | - | 137 | 167 | - |
| **25** | - | - | - | 148 | - | 24 | 165 | 40 | - | 52 | 120 | - |
| **50** | - | - | - | 73 | - | 12 | 80 | 29 | - | 16 | 55 | - |
| **75** | - | - | - | 34 | - | 8 | 46 | 16 | - | 8 | 21 | - |
| **90** | - | - | - | 25 | - | 5 | 34 | 12 | - | 6 | 11 | - |

Calculated estimates of entrained smallmouth bass by month under five different flow conditions at the Lake Lynn Project based on density data collected at Townsend Dam

| % Exceeded | JAN | FEB | MAR | APR | MAY | JUN | JUL | AUG | SEP | OCT | NOV | DEC |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **10** | - | - | 95 | 127 | 810 | 1,210 | 609 | 53 | 323 | - | - | - |
| **25** | - | - | 64 | 116 | 810 | 423 | 244 | 35 | 65 | - | - | - |
| **50** | - | - | 35 | 57 | 434 | 202 | 118 | 25 | 18 | - | - | - |
| **75** | - | - | 20 | 27 | 202 | 143 | 67 | 14 | 11 | - | - | - |
| **90** | - | - | 9 | 20 | 116 | 80 | 50 | 10 | 9 | - | - | - |

Calculated estimates of entrained bluegill by month under five different flow conditions at the Lake Lynn Project based on density data collected at Townsend Dam

| % Exceeded | JAN | FEB | MAR | APR | MAY | JUN | JUL | AUG | SEP | OCT | NOV | DEC |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **10** | 490 | 482 | 1,422 | 761 | 1,891 | 1,555 | 914 | 184 | 646 | 5,463 | 5,604 | 1,414 |
| **25** | 393 | 482 | 958 | 694 | 1,891 | 544 | 365 | 123 | 131 | 2,068 | 4,017 | 1,142 |
| **50** | 199 | 482 | 526 | 344 | 1,013 | 260 | 177 | 89 | 36 | 629 | 1,828 | 527 |
| **75** | 85 | 142 | 297 | 162 | 471 | 184 | 101 | 50 | 23 | 320 | 718 | 259 |
| **90** | 45 | 68 | 131 | 118 | 270 | 102 | 75 | 36 | 19 | 236 | 363 | 140 |

Calculated estimates of entrained walleye by month under five different flow conditions at the Lake Lynn Project based on density data collected at Townsend Dam

| % Exceeded | JAN | FEB | MAR | APR | MAY | JUN | JUL | AUG | SEP | OCT | NOV | DEC |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **10** | 294 | 289 | 95 | 381 | 405 | - | 457 | 53 | 323 | 188 | 317 | 2,709 |
| **25** | 236 | 289 | 64 | 347 | 405 | - | 183 | 35 | 65 | 71 | 227 | 2,189 |
| **50** | 119 | 289 | 35 | 172 | 217 | - | 89 | 25 | 18 | 22 | 103 | 1,010 |
| **75** | 51 | 85 | 20 | 81 | 101 | - | 51 | 14 | 11 | 11 | 41 | 497 |
| **90** | 27 | 41 | 9 | 59 | 58 | - | 37 | 10 | 9 | 8 | 21 | 269 |

Calculated estimates of entrained emerald shiner by month under five different flow conditions at the Lake Lynn Project based on density data collected at Townsend Dam

| % Exceeded | JAN | FEB | MAR | APR | MAY | JUN | JUL | AUG | SEP | OCT | NOV | DEC |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **10** | 196 | - | - | - | - | - | 228 | - | - | - | - | - |
| **25** | 157 | - | - | - | - | - | 91 | - | - | - | - | - |
| **50** | 80 | - | - | - | - | - | 44 | - | - | - | - | - |
| **75** | 34 | - | - | - | - | - | 25 | - | - | - | - | - |
| **90** | 18 | - | - | - | - | - | 19 | - | - | - | - | - |

Calculated estimates of entrained channel catfish by month under five different flow conditions at the Lake Lynn Project based on density data collected at Townsend Dam

| % Exceeded | JAN | FEB | MAR | APR | MAY | JUN | JUL | AUG | SEP | OCT | NOV | DEC |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **10** | - | 289 | 664 | 634 | 8,509 | 3,974 | 2,209 | 895 | 3,070 | 377 | - | 118 |
| **25** | - | 289 | 447 | 578 | 8,509 | 1,391 | 883 | 597 | 621 | 143 | - | 95 |
| **50** | - | 289 | 245 | 287 | 4,558 | 665 | 429 | 433 | 171 | 43 | - | 44 |
| **75** | - | 85 | 139 | 135 | 2,121 | 470 | 245 | 241 | 108 | 22 | - | 22 |
| **90** | - | 41 | 61 | 99 | 1,215 | 262 | 180 | 177 | 90 | 16 | - | 12 |

Calculated estimates of entrained shorthead redhorse (surrogate for Golden redhorse) by month under five different flow conditions at the Lake Lynn Project based on density data collected at Townsend Dam

| % Exceeded | JAN | FEB | MAR | APR | MAY | JUN | JUL | AUG | SEP | OCT | NOV | DEC |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **10** | - | - | - | 254 | - | - | - | - | - | - | - | - |
| **25** | - | - | - | 231 | - | - | - | - | - | - | - | - |
| **50** | - | - | - | 115 | - | - | - | - | - | - | - | - |
| **75** | - | - | - | 54 | - | - | - | - | - | - | - | - |
| **90** | - | - | - | 39 | - | - | - | - | - | - | - | - |

(b) Smith, D., and S. Welsh. 2015. Biological Monitoring of Aquatic Communities of Cheat Lake, and Cheat River Downstream of the Lake Lynn Hydro Station, 2011 – 2015. Division of Forestry and Natural Resources West Virginia University;

## Biological Monitoring of Aquatic Communities of Cheat Lake and Cheat River Downstream of the Lake Lynn Hydro Station

**Student Investigator:** Dustin M. Smith
**Principal Investigator:** Stuart A. Welsh
**Cooperators:** Frank Jernejcic and Dave Wellman
**Years Ongoing:** 2011 – 2015
**Degree Program:** PhD
**Expected completion:** Dec 2015
**Funding Source:** West Virginia Division of Natural Resources, FirstEnergy Corp.

**Objectives:**
A five-year biomonitoring project was initiated March 2011 for Cheat Lake and its tailwaters. The project (partitioned into nine tasks) is a continuation of previous work by West Virginia Division of Natural Resources. Three tasks of the proposed work focus on Cheat River and Cheat Lake tailwaters (Tasks 1 – 3), and 6 tasks focus on Cheat Lake (main lake and embayments). Field data collection for all objectives has been completed. Data analysis and final report preparation are currently ongoing. Quarterly progress reports are provided to the funding agencies.

1. Fish biomonitoring downstream of Cheat Lake
2. Benthic macroinvertebrate resource biomonitoring downstream of Cheat Lake
3. Water quality biomonitoring downstream of Cheat Lake
4. Fish biomonitoring of Cheat Lake and embayments
5. Walleye population monitoring and stock assessment
6. Monitoring of adult walleye movement
7. Physical and chemical water quality characteristics of Cheat Lake
8. Aquatic vegetation mapping of Cheat Lake
9. Bathymetric mapping of Cheat Lake

**Progress**:
For this study, Cheat Lake was divided into three major study areas: embayments (Rubles Run – 56 acres, and Morgan Run – 37 acres); lower Cheat Lake, downstream of I-68 bridge to Lake Lynn hydro station; and upper Cheat Lake upstream of the I-68 bridge to the head of the lake. The 3.7-mile section of Cheat River downstream from the hydro station was defined as the Cheat tailwater area located in the first 1.1 miles, and Cheat River between the Cheat tailwater area and the confluence of Cheat River with the Monongahela River (lower 2.6 miles).

The water quality of the Cheat Lake tailwaters and Cheat River has been monitored bi-monthly from 2011-2015 to assess any impacts from hydropower operations and/or existing acid mine drainage inputs on downstream water quality. The Cheat Lake tailwater section has consistently maintained water quality that is supportive of aquatic organisms with an average pH of 6.6, average dissolved oxygen of 8.7 mg/l, and average specific conductivity of 109 µs/cm. In contrast, water quality in Grassy Run, an acidic tributary to the Cheat River, as expected has had poor water quality with an average pH of 3.1 and conductivity of 1422 µs/cm. In general, Cheat River water quality downstream of Grassy Run reflects the impacts of acid mine drainage (AMD) from Grassy Run with an average pH of 5.5 and an average conductivity of 220 µs/cm.

Physical and chemical water quality profiles were conducted monthly (except during periods of ice cover) from 2011-2014. The primary focus of these limnological profiles was to monitor the pH of Cheat Lake which is still impacted by upstream AMD sources, and to monitor the stratification of water temperature and dissolved oxygen within the lake. Depressions in pH (less than 6.0) within the lake occurred occasionally in 2011, primarily in the early spring when the combined effects of AMD and acidic snowmelt impact the lake. This trend of early spring pH depression has occurred since the initiation of lake profiles by WVDNR in 2005. However, in 2012, 2013 and 2014 Cheat Lake did not experience pH depressions below 6.0, possibly due to increases in AMD remediation upstream in the Cheat River watershed. Otherwise, lake pH was satisfactory, remaining above 6.0 the majority of the time. Stratification of water temperature and dissolved oxygen has historically occurred in lower Cheat Lake from approximately June-September. In general, the upper 6-8 meters of the water column is characterized by warmer water with suitable dissolved oxygen levels (above 5.0 mg/L), while the lower portion of the water column is characterized by much colder water with increasingly less dissolved oxygen (less than 5.0 mg/L). This phenomenon occurs primarily in the lower portion of Cheat Lake which is characterized by much greater depths. However, given the increases in precipitation and cooler air temperatures in 2013 and 2014, Cheat Lake did not experience the severity of stratification during these years that normally occurs during summer months.

Night boat electrofishing and gill netting were conducted during May and October 2011-2014 in Cheat Lake. The primary focus of these surveys was to monitor the health of the fish communities of Cheat Lake. In total, 839 fishes were captured with gill nets, while 5,683 were collected using electrofishing. The upper lake, which retains many riverine characteristics, consistently produced a greater abundance of fish compared to both the lower lake and embayment areas. The embayment areas produced the lowest fish abundances. Largemouth bass and spotted bass were the most abundant in embayment areas, while smallmouth bass were more abundant in the upper lake. Green sunfish, bluegill, and pumpkinseed were most abundant in the lower lake. Walleye, yellow perch, white bass, and channel catfish were typically most abundant in the upper lake. Smaller forage species abundance also differed dependent on lake area. Mimic and emerald shiners were very abundant in the upper lake and fairly abundant in the lower lake, but were uncommon in embayments. Conversely, logperch and brook silversides were most abundant in the embayments and lower lake.

***Figure 1.*** *Dustin Smith with a walleye captured during walleye population surveys.*

Night boat electrofishing, tow barge (pram) day electrofishing, and gill netting were conducted during June/July, September (pram only), and October during 2011 and 2014 in the tailwaters and river downstream of Cheat Lake. In total, 1,903 fishes were captured with boat electrofishing, 195 with gill nets, and 1,055 with pram electrofishing. An abundance of small forage fish primarily represented by mimic shiners, emerald shiners, and bluntnose minnows were collected in both the tailwater and river sections. In the tailwaters, mimic shiner was the most abundant forage fish, while in the river emerald shiners were more abundant. Smallmouth bass and channel catfish were the most abundant game fishes collected, although largemouth bass and sauger were quite abundant near the mouth of the Cheat River. In addition, benthic macroinvertebrate sampling was completed in July and November of 2011 and 2014. The tailwater area just below the dam has a relatively low abundance of macroinvertebrates, likely stemming from the variation in outflow from the upstream dam. The family Chironomidae (midges) accounts for most of the invertebrates in the tailwaters just downstream of the dam. Two sites were sampled for macroinvertebrates approximately one mile downstream of the dam, and support a much greater abundance of macroinvertebrates. However, the macroinvertebrate community at these sites has low diversity mainly comprised of tolerant taxa. Macroinvertebrates from the families Chironomidae and Hydropsychidae (net-spinnning caddisflies) account for most of the macroinvertebrates at these downstream stations.

Research on adult walleye movement was started in early December 2011. We implanted 50 adult walleyes (31 males, 17 females, 2 undetermined, 432-708 mm TL) with acoustic transmitters. Data collection on tagged individuals was completed in April 2015 and stationary receivers were removed from the reservoir. Fish locations were determined using both submerged, stationary receivers and active tracking. During winter months, tagged fish normally remained near their original capture locations until late February (2012)/mid-March (2013-2015) when fish usually began upstream movements, likely in order to reach spawning habitat. By early March (2012) to early April (2013-2015), most tagged fish moved to the head of Cheat Lake to spawn. Analysis of the data suggests that upstream spawning movements were primarily driven by elevated water temperatures (Figure 2). Thirteen tagged fish periodically occupied the area upstream of the first riffle of Cheat Lake, possibly to spawn in the river upstream of the lake. Several tagged fish continued to use this area upstream of the first riffle during the spring and summer months. Also, during non-spawning periods (i.e., summer/fall), increases in river discharge and water temperature often triggered upstream movements of many tagged fish. Walleye usage of the upstream riverine reaches increases during summer when main lake water temperature increases and dissolved oxygen decreases. Tagged walleyes can potentially alleviate stressful temperature and oxygen conditions by using the cooler, more oxygenated riverine area.

Walleye population monitoring and stocking assessment surveys were conducted in Cheat Lake during March/April and November of 2012, 2013, and 2014. Gill nets were used to capture walleyes throughout the lake to assess the status of the population and the success of walleye stocking efforts. Catch per unit effort (CPUE) of walleyes was only 0.5-0.6 fish per net night during spring (2012-2014). However, it is most likely that the walleye population was greatly underrepresented during our surveys. Most adult walleye were likely near the head of the lake, thus upstream of our netting areas. Information from our acoustic tagged walleyes indicated that most fish were occupying this upper lake area, presumably in preparation for spring spawning. Supporting this assumption, CPUE during fall 2012, 2013, and 2014 was much higher with 1.3-2.8 fish per net night.

Currently, an aquatic vegetation map of Cheat Lake is being created and is near completion. Areas of Cheat Lake that harbor aquatic vegetation have been visually assessed to determine species composition and relative abundance. This information is currently being incorporated into a lakewide map using GIS, and will depict species presence/abundance information. Areas of highest aquatic vegetation abundance are embayment habitats such as the Morgans Run and Rubles Run embayments. Dominant vegetation taxa found in Cheat Lake include *Potamogeton* spp., *Vallisneria americana*, and *Najas* spp. This information will help determine areas that likely represent import nursery habitat for larval/juvenile fishes of Cheat Lake.

A bathymetric map of Cheat Lake was created in 2011 using sonar, GPS technology, and GIS-based interpolation techniques. Depth data with GPS coordinates were recorded from transects using boat-mounted sonar gear. These data were imported into a GIS, where interpolation and contour line mapping techniques were used to produce a bathymetric map of Cheat Lake. This component of the study was used to help determine habitat preferences of walleye and also areas that are vulnerable to water level fluctuations.

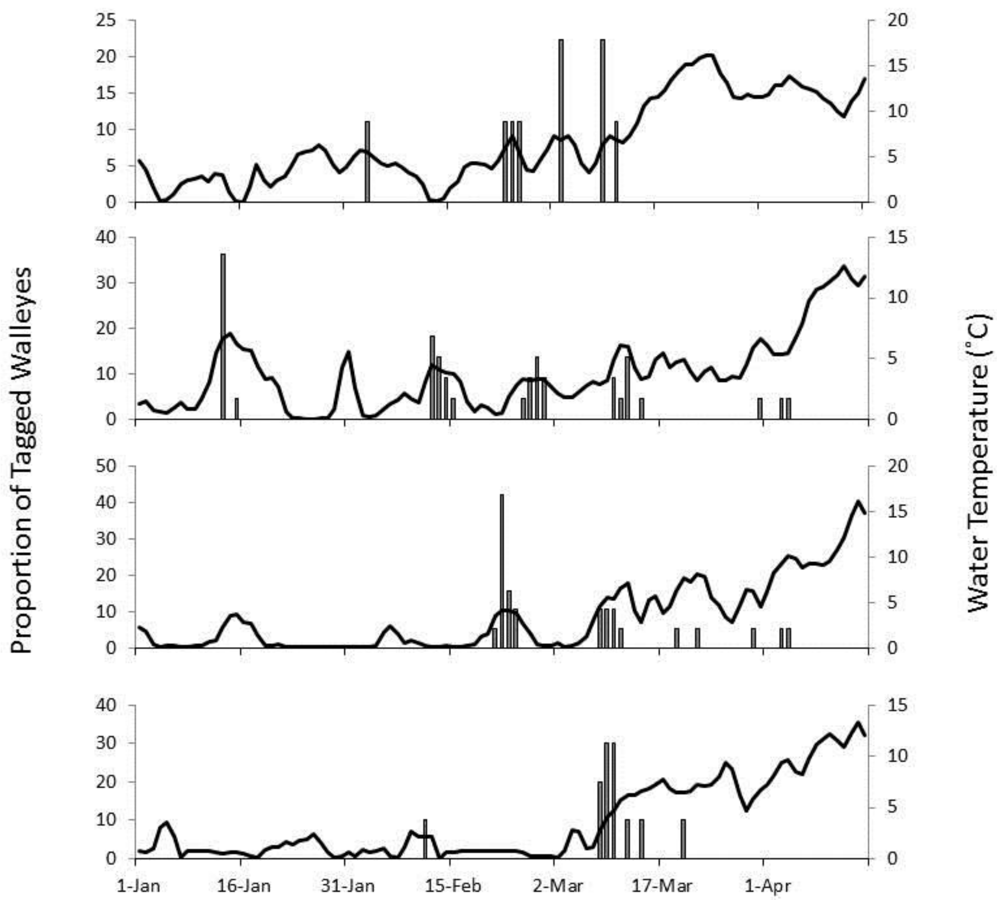


***Figure 2.*** *Daily proportion of tagged walleyes migrating toward spawning areas (gray bars) during the pre-spawn period and associated water temperature (black line) data for 2012-2015.*

2018

# Evaluation of a Re-established Walleye Population within a Hydropower Reservoir Recovering from Acidification

Dustin M Smith

# Evaluation of a Re-established Walleye Population within a Hydropower Reservoir Recovering from Acidification

**Dustin M. Smith**

**Dissertation submitted**
**to the Davis College of Agriculture, Natural Resources, and Design**
**at West Virginia University**

**in partial fulfillment of the requirements for the degree of**

**Doctor of Philosophy in**
**Forest Resource Science**

**Stuart Welsh, Ph.D., Chair**
**Kyle Hartman, Ph.D.**
**Patricia Mazik, Ph.D.**
**David Smith, Ph.D.**
**David Wellman, M.S.**

**Division of Forestry and Natural Resources**

**Morgantown, West Virginia**
**2018**

**Keywords: reservoir, biomonitoring, acidification, hydropower, Walleye, acoustic telemetry, fish community, water quality**

# ABSTRACT

## Evaluation of a Re-established Walleye Population within a Hydropower Reservoir Recovering from Acidification

**Dustin. M. Smith**

Cheat Lake, a hydropower reservoir in northern West Virginia, was impacted for decades by acid mine drainage and acid precipitation. Acidification of Cheat Lake likely reduced fish species richness and fish abundance. From 1952–1977, only 15 fish species were collected, cumulatively. Additionally, the fish community was dominated by acid tolerant species such as Brown Bullhead (*Ameiurus nebulosus*) and White Sucker (*Catostomus commersonii*) (82% of mean annual relative abundance), while acid intolerant species such as Walleye were extirpated. Due to legislative action and subsequent funding of water quality treatment within the watershed (e.g., Surface Mining Control and Reclamation Act of 1977), acidification issues have been mitigated over time. My study aimed to quantify temporal changes in the fish community of Cheat Lake, as they might be related to improvements in water quality. Additionally, from a fishery management perspective, I focused on evaluating population characteristics and spatial ecology of a reestablished Walleye (*Sander vitreus*) population in Cheat Lake.

I examined changes in water quality data (1952–2015) and fish community data (1952–2015) from Cheat Lake. Main lake pH averaged less than 5.0 prior to 1990 and averaged 5.8 in 1990. Since 1997, pH has averaged greater than 6.0 every year indicating reduction in acidification of Cheat Lake. Based on boat electrofishing and gill net surveys, I found that the fish community of Cheat Lake has significantly changed over time, likely owing to improvements in water quality. From 1990–2015, 18,387 fishes were collected using these methods. Additionally, 44 species were collected representing a substantial increase in species richness. The mean annual relative abundance of fishes captured from 2011–2015 was over 4 times greater than that from 1990–2001. Also, fish community composition significantly changed over time from 1990–2015. Changes in fish community composition were largely driven by increases in abundance of acid intolerant fish species such as Smallmouth Bass (*Micropterus dolomieu*).

I also evaluated population characteristics of the Walleye population. As expected, initiation of stocking significantly increased abundance of Walleyes within Cheat Lake as indicated by increases in gill net catch per unit effort (CPUE). Age and growth analysis indicated that the Cheat Lake Walleye population was characterized by fast growing individuals that reach large maximum sizes. Both male and female Cheat Lake Walleyes reach quality size (≥ 380 mm) after two years of growth. Specifically, female Walleyes reached larger maximum sizes (female $L_\infty$ = 754 mm; male $L_\infty$ = 502 mm) and grew faster after age-3 than male Walleyes. Increasing natural reproduction was also evident as indicated by collection of young of year in the fall of non-stocking years and through evaluation of year classes from age and growth data.

Telemetry data provided information on distribution and movement patterns of Cheat Lake Walleyes. Walleyes exhibited seasonal and sex-based differences in distribution and

movement, and large scale movements were correlated with water temperature and river discharge. Male Walleyes were found to use riverine habitats more often than female Walleyes, while females primarily used main lake habitats. All Walleyes showed a tendency for increases in core range shifts and changes in linear range in the spring and fall months. Shifts in core range and increases in linear range during spring were due to spawning movements. Both male and female Walleyes migrated to the headwaters of Cheat Lake prior to spawning, with male Walleyes migrating earlier than female Walleyes. For all Walleyes, upstream spawning migrations were correlated with elevated water temperatures (75% of migrations at water temperatures > 4.1°C). After spawning, female Walleyes typically migrated back to main lake habitats, while the majority of male Walleyes continued to use riverine habitats. During fall, individuals occupying riverine habitats made downstream movements to the main lake where they remained throughout the winter.

Changes in the fish community and the establishment of a quality Walleye fishery were made possible due to water quality treatment within the watershed. Cheat Lake now supports a relatively diverse fish community, including abundant sportfish species. A reestablished Walleye population provides a unique fishery for anglers, where Walleye grow fast and have the potential to reach trophy sizes. Data on the improvements and status of the fish community, as well as movement data on the Walleye population, provide valuable information to managers and anglers alike. This information will be valuable for future management of the Cheat Lake fish community and will help conserve this valuable resource.

## Dedication

I dedicate this dissertation to my wife Ashley, for her never-ending support of my career and academic endeavors, and for sacrificing without question so that I may pursue my dreams. I also dedicate this to my daughter Samara, who is the light of my world and means more to me than any degree ever could.

## Acknowledgements

I have had the support of many while pursuing my degree, and I know undoubtedly that their support was what made my continued pursuit and ultimate completion of this dissertation possible. I must thank my family for supporting me throughout my academic and career endeavors. My Mom and Dad both instilled in me a love of the outdoors, and have supported me every step of the way. My wife Ashley has selflessly followed me wherever my career has taken us, and allowed me to pursue my dreams despite her sometimes putting her dreams on hold…for her I am eternally grateful and I absolutely could not have done this without her. My daughter Samara is the light of my world and always managed to put a smile on my face even in the most difficult times. Everything I do is for her and I hope to one day be able to support her dreams just as others in my life have supported mine.

In addition to family, I have countless friends and colleagues to thank for their support. Nate Taylor and Corbin Hilling were both instrumental in completing the field work and both provided valuable advice in the development of this research. They both gave tirelessly to this project working extremely late hours, weekends, and even holidays to help complete the work. Throughout the project, they were both incredibly hard workers, valuable colleagues, and most importantly, irreplaceable friends. I am grateful to Scott Morrison and Frank Jernejcic for providing me with valuable advice throughout the project both related to this research and to my career. Scott introduced me to the telemetry methods I would end up using throughout the study and provided first hand field work advice that could be obtained nowhere else. Frank provided me with endless information and knowledge about my study area Cheat Lake and the work done in the watershed that he has been a part of for so many years. I thank all those who assisted with field work throughout the project including Missy Braham, Brian Crabill, Wendell Hofer, Amanda Renick, Bri Tierney and Zack Vucurevich. I thank my other fellow Welsh lab grad students Joni Aldinger, Austin Rizzo, and Patricia Thompson who were always willing to lend a hand regardless of conditions and made the work that much more enjoyable. I thank my committee members Kyle Hartman, Pat Mazik, David Smith and Dave Wellman for helping me with the development of this research, for offering sound advice, and for the invaluable knowledge that each of them provided. I thank Becky Nestor, without which all WVU Coop grad students would be lost, for doing so much for me whether it be related to my pursuit of my degree or simply for the pleasant conversations we would have each day. Finally, I thank my advisor Stuart Welsh for giving me the opportunity to pursue this project, for putting in long hours helping with field work, for his unwavering positive attitude, his assistance and advice with all things related to the project, for his endless support and patience, for introducing me to the sport of ice fishing and letting me tag along, and most importantly his understanding of the importance of family.

The funding for this research was provided in part by Cube Hydro Partners, LLC and the West Virginia Division of Natural Resources. I am thankful for their financial support for this project, which has allowed me to further my education and experience. I would also like to thank the West Virginia Division of Forestry and Natural Resources and the USGS Cooperative Fish and Wildlife Research Unit for providing equipment, facilities, and other resources that have made this work possible.

## Table of Contents

## List of Tables

## List of Figures

# Chapter 1 – Ecology of Fish Communities in Altered Reservoir Ecosystems with Special Emphasis on Reservoir Walleye Fisheries

Few large river systems in the present day remain in their free-flowing state. Most have been impounded for one or more reasons related to human needs such as flood control, navigation, water supply, and electric power generation (Baxter 1977; Ney et al. 1990). Consequently, the resulting reservoir ecosystems are subjected to challenges that may deviate from those present in natural systems (Baxter 1977; Ney et al. 1990; Miranda et al. 2010). These unique challenges may include unnatural water level fluctuations, altered temperature and dissolved oxygen profiles, and various other changes to the physical and chemical nature of the water body (Baxter 1977; Ploskey 1986; Ney et al. 1990; Gido et al. 2002; Miranda et al. 2010). Reservoirs, which often have a strong linkage to an extensive watershed, are heavily influenced by any activity or impact within the watershed (Miranda and Bettoli 2010).

Within the Appalachian region, acidification is one of the most significant anthropogenic impacts to watersheds (Herlihy et al. 1990; Herlihy et al. 1993). Acidification via precipitation and mine drainage has impacted many watersheds and likewise some reservoirs in this region, especially in West Virginia (Core 1959; Poe 1971; Herlihy et al. 1990; Herlihy et al. 1993; McClurg et al. 2007). Acidification often leads to extirpation of species, including sportfishes, such as Walleye, that are important top predators and recreationally valuable to anglers. Although substantial research has examined acidification of natural lakes and streams, little research exists on the impacts and recovery processes of fish communities and recreational fisheries in acidified reservoirs. Responses of fish communities and recreational fisheries to reservoir stressors such as acidification and subsequent recovery, are important for researchers to document and utilize for future management actions.

**Reservoir Ecosystems**

Reservoirs are typically constructed to serve the needs of hydroelectric power generation, for flood control purposes, or for water storage (Ney et al. 1990). Despite their intended construction, reservoirs are extremely important to recreationists including fishermen, boaters, swimmers, etc. (Miranda et al. 2010). Estimates from 2016 indicated that over 24 million anglers (83 % of freshwater anglers) in the United States utilized reservoirs, and freshwater anglers spent over $29 billion on fishing (USFWS and USDOC 2018). Reservoirs are comparatively young aquatic ecosystems, with most having been constructed during the twentieth century (Miranda et al. 2010). As such, researchers and managers are continuing to gain knowledge on and improve management of reservoir fisheries.

Reservoirs often differ from natural lakes in at least part of their physical, chemical, and biological properties largely because of the effects of inflowing rivers and anthropogenic manipulation of flows (Kimmel and Groeger 1984). Reservoirs exhibit substantial variation in morphology and characteristics dependent on the topography of the region and purpose of the reservoir (Miranda and Bettoli 2010). For instance, reservoirs built in steep terrain are often longer and narrower in morphology, while those constructed in low-lying terrain often have a dendritic shape due to numerous tributaries (Dodds 2002; Hayes et al. 1999). Given the departure in characteristics and management response from natural systems, and the inherent variation between reservoirs, continued research into ecology of reservoirs and their fisheries are vital for resource managers.

Given their large watersheds, reservoirs are strongly tied to activities within contributing tributaries (Vanni et al. 2005; Miranda and Bettoli 2010). Natural processes and anthropogenic activities within the watershed inevitably impact the downstream reservoir (Kimmel and Groeger 1984; Ney et al. 1990; Vanni et al. 2005; Miranda and Bettoli 2010). Upstream watershed activities influence factors in reservoirs such as nutrients, sediment, and water quality (Kimmel and Groeger 1984; Ney et al. 1990; Vanni et al. 2005; Miranda and Bettoli 2010). For instance, land use development within a watershed can have significant impacts on the downstream reservoir (Vanni et al. 2005). Land use within a watershed significantly effects the resulting water quality and fish community composition of a downstream reservoir (Miranda and Bettoli 2010). Various watershed activities such as deforestation, agriculture, mining, and urban development cause disturbance and may impact the downstream movement of nutrients, sediment, detritus, and potentially pollutants into a reservoir (Vanni et al. 2005; Miranda and Bettoli 2010). The occurrence of these watershed activities can ultimately impact such factors as primary productivity, water quality, habitat, and species composition of reservoirs (Miranda and Bettoli 2010).

Watersheds with high levels of disturbance from practices such as agriculture, timbering, or urbanization will often lead to increased sedimentation and nutrient levels in downstream reservoirs (Beaulac and Reckhow 1982; Field et al. 1996; Arbuckle and Downing 2001; Jones and Knowlton 2005; Knoll et al. 2003; Jones et al. 2004). Excess sedimentation or nutrient levels can negatively impact reservoir habitat or cause water quality issues (Burford et al. 2007; Soares et al. 2008; Juracek 2014). In contrast, forested watersheds and wooded riparian zones contribute more coarse woody debris to reservoirs than do watersheds or riparian zones dominated by agriculture or urban areas (Miranda and Bettoli 2010). Coarse woody habitat provides essential cover to many species and can impact species composition in reservoirs (Sass et al. 2006). Therefore, land use practices that reduce coarse woody habitat can significantly impact reservoir fish communities. Industry operations within watersheds can also impact receiving reservoirs. In West Virginia, heavily mined watersheds resulted in the acidification of major reservoirs downstream (Core 1959; Poe 1971). Acidification from upstream mining practices impaired water quality and significantly reduced species richness and fish abundance in these reservoirs (Core 1959; Poe 1971).

The resulting reservoir characteristics that can be strongly influenced by watershed activities have a major effect on the fish communities that reservoirs support (Miranda and Bettoli 2010). Therefore, reservoir management should be viewed from a watershed based scale rather than a localized scale (Miranda and Bettoli 2010). Without incorporating factors within the entire watershed, important drivers of reservoir dynamics could be missed. Understanding how these watershed activities and associated reservoir characteristics impact fish communities is integral in the management of reservoir fisheries.

*Longitudinal Patterns*

Watershed complexities produce reservoirs that are more spatially heterogenous than natural lakes (Lodge et al. 1988; Irwin and Noble 1996). Specifically, the influence of incoming tributaries in reservoirs usually creates a noticeable longitudinal gradient of abiotic and biotic conditions (Kimmel and Groeger 1984; Thornton et al. 1990; Gido et al. 2002). Reservoirs will typically show an upstream to downstream gradient from lotic conditions to lentic conditions (Kimmel and Groeger 1984; Hayward and Van den Avyle 1986; Thornton et al. 1990; Gido et al. 2002). Consequently, biotic and abiotic characters of reservoirs often vary with some predictability along this gradient (Eggleton et al. 2005). For instance, upstream portions of a reservoir may be more riverine in character, based on the biotic and abiotic conditions compared to downstream areas (Kimmel and Groeger 1984; Thornton et al. 1990; Gido et al. 2002). As such, upstream reaches of reservoirs will often support fish and invertebrate species more indicative of a river ecosystem (Gido et al. 2002). In contrast, fish communities often begin to represent lacustrine conditions in lower reaches of reservoirs (closer to the dam) (Gido et al. 2002).

Longitudinal biological gradients of reservoirs are driven by spatial patterns of abiotic characteristics. In riverine reaches of reservoirs, river flow is typically more influential compared to areas downstream (Gido et al. 2002; Okada et al. 2005; Soares et al. 2008; Miranda and Bettoli 2010). With this increase in river flow influence comes differences in water quality and physical habitat. Whereas downstream reaches of reservoirs often thermally stratify, riverine reaches are typically uniform in temperature and dissolved oxygen due to the continued mixing of water from river current (Miranda and Bettoli 2010). Consequently, dissolved oxygen levels may be higher in riverine areas during summer compared to downstream lacustrine habitats. In terms of physical habitat, there is typically a higher percentage of hard substrate available in riverine reaches (Miranda and Bettoli 2010). As in a riverine environment, current carries fine sediments from these upstream reaches, leaving coarser substrates as benthic habitat (Wood and Armitage 1997). There are also often longitudinal differences in macrohabitats such as aquatic vegetation. Specifically, macrophyte growth is expected to be less in riverine reaches compared to lacustrine reaches (Hayes et al. 1999). Given these variations in water quality and habitat characteristics, fish communities in reservoirs often vary spatially. Fish communities in upstream riverine reaches are typically dominated by species that prefer lotic habitat while downstream lacustrine areas may be dominated by species favoring lentic habitat (Gido et al. 2002; Prchalova 2008; Miranda and Bettoli 2010). Understanding this spatial heterogeneity is vital to effective management of reservoir fish communities.

*Physical Habitat*

Reservoirs are distinct from natural lakes in their physical habitat characteristics and aging patterns (Kimmel and Groeger 1986; Miranda 2017). Reservoirs face unique habitat limitations due to the nature of their creation and subsequent linkage to large watersheds

(Miranda 2017). Habitat limitations in reservoirs are usually the direct result of the unnatural processes stemming from the inundation of formerly terrestrial habitats (Miranda et al. 2010). Specifically, reservoirs often lack habitat structure and diversity due to pre-impoundment timbering, post-impoundment woody decay, sedimentation of hard substrates, and limited aquatic vegetation (Wills et al. 2004; Santos et al. 2008).

Reservoirs are often lacking in submerged, physical habitat, such as coarse woody debris, due to physical removal during reservoir construction, decomposition over time, or limited woody deposits from the riparian zone (Agosthino et al. 1999; Wills et al. 2004; Miranda 2017). Lack of woody cover can impact biological communities. Woody cover provides habitat for forage species (e.g., invertebrates, small fishes, etc.) and predatory fishes alike (Sass et al. 2006). Species that favor physical structure for spawning or foraging could see reductions in abundance due to a lack of structure (Sass et al. 2006). For instance, Yellow Perch (*Perca flavescens*) often drape their eggs over woody debris in littoral areas (Thorpe 1977). Without woody debris or vegetation, eggs are laid on bare substrate and have a reduced survival rate compared to eggs deposited on structure (Nelson 1978). Woody debris also provides cover for juvenile fishes and may provide areas for fish to forage (Wills et al. 2004; Sass et al. 2006). As a result of the lack of woody habitat in reservoirs, many management agencies implement habitat enhancement programs to increase the available physical habitat for fish and anglers alike (Miranda 2017).

Sedimentation is another process that alters and homogenizes habitat within reservoirs (Miranda and Bettoli 2010). Specifically, sedimentation can ultimately convert formerly heterogenous substrate with a variety of hard and soft substrates, into entire benthic areas composed of silt and muck (Miranda and Bettoli 2010; Krogman and Miranda 2016). Reservoirs are subjected to continued depositional filling from both inorganic and organic inputs from feeder tributaries (Miranda et al. 2010). This continuous sedimentation in reservoirs can alter the biota. Specifically, fishes and invertebrates that require hard substrates at some point in their life history (e.g., lithophilic spawners) will likely experience population declines over time (Miranda and Bettoli 2010). For others, sedimentation may limit available spawning sites. For example, Walleyes require hard substrate to successfully spawn and in reservoirs with extensive sedimentation, this may leave only the very upstream reaches of a reservoir with suitable habitat (Bozek et al. 2011). Excessive sedimentation can also alter fish community composition in reservoirs. Sedimentation leads to homogenization of littoral habitats and therefore provides a less diverse array of habitats for species to inhabit (Gido et al. 2000; Miranda and Bettoli 2010; Krogman and Miranda 2016).

Reservoirs also often lack aquatic vegetation due to changes in water quality, lack of an established seed bank, and unnatural water level fluctuations (Smart et al. 1996). Although reservoirs can support excessive levels of aquatic vegetation in certain situations, often reservoir conditions make establishment of sufficient aquatic vegetation difficult (Miranda and Bettoli 2010). In some reservoirs, excessive suspension of sediments and resulting turbidity can reduce vegetation growth (Smart et al. 1996). More commonly, the formerly terrestrial origin of inundated soils and the subsequent lack of an established seed bank inhibit establishment of aquatic vegetation in reservoirs (Smart et al. 1996; Miranda and Bettoli 2010). The development of an established seed bank to support aquatic vegetation communities can naturally take hundreds of years (Doyle and Smart 1993; Smart et al. 1996; Miranda and Bettoli 2010). In contrast, reservoirs are relatively new, with most having been in existence less than 100 years (Smart et al. 1996; Miranda and Bettoli 2010). Additionally, the frequent and large water level fluctuations common to many reservoirs can prevent establishment of vegetation (Smart et al. 1996). An intermediate level of aquatic vegetation is often desired, as it can benefit the biotic community (Wiley et al. 1984; Smart et al. 1996; Miranda 2017). Certainly, an intermediate level of vegetation increases the diversity of available habitats which in turn can increase the diversity of species supported (Dibble et al. 1996; Smart et al. 1996). For fish, aquatic vegetation can represent important spawning habitat, nursery habitat, or foraging habitat (Dibble et al. 1996). Without sufficient vegetation, some species that rely on this habitat for spawning, shelter, or forage may see reductions in abundance (Dibble et al. 1996).

*Water Quality*

Water that is trapped within a reservoir undergoes various physical and chemical changes (Miranda 2017). The extent of these changes can vary substantially dependent on the function of the reservoir and how long water is retained (Miranda 2017). Under some circumstances, these changes can significantly impact reservoir fish communities (Miranda 2017). Specifically, the most important water quality characteristics impacted after impoundment are dissolved oxygen and temperature (Miranda and Bettoli 2010).

Reservoirs often exhibit water quality limitations in the form of dissolved oxygen and temperature stratification, particularly during the warm, summer months. During warm, summer months, water temperature and dissolved oxygen concentrations will often stratify, particularly in the deepest, lacustrine areas of the reservoir (Coutant 1985; Soares et al. 2008). The reservoir will separate into an epilimnion and hypolimnion. The epilimnion is comprised of warm water temperatures and higher dissolved oxygen, while the hypolimnion is composed of cooler water temperatures and lower dissolved oxygen (Dodds 2002). Problems arise for fishes in this situation that require relatively cool water for optimal growth but also require suitable dissolved oxygen levels. For instance, Hale (1999) described growth suppression in crappies in late summer due to unsuitable dissolved oxygen concentrations at depths with optimal water temperatures.  Crappies were forced to inhabit shallower areas with adequate dissolved oxygen but these areas in turn had water temperatures too warm for growth (Hale 1999). This situation has been termed the “temperature-DO” squeeze (Coutant 1985). Traditional “coolwater” species such as Muskellunge, Smallmouth Bass, and Walleye could face similar situations. For instance, Walleyes have been documented as preferring relatively cool water temperatures (22 C; Kitchell et al. 1977). In reservoirs that strongly stratify, dissolved oxygen levels may be limited in depths that sustain these cool temperatures during warmer months (Bozek et al. 2011). In these situations, Walleyes must choose whether to occupy unsuitable water temperatures or dissolved oxygen conditions (Bozek et al. 2011). Fishes could face reductions in growth, condition, and other physiological constraints if forced to occupy either unsuitable water temperatures or dissolved oxygen concentrations (Miranda and Bettoli 2010).

*Water Level Fluctuations*

Reservoir water level fluctuations can influence a variety of physical, chemical, and biological reservoir characteristics (Wetzel 1990; Geraldes and Boavida 2005). Water level fluctuations can significantly impact available habitat for a variety of organisms and life stages (Ploskey 1986). In particular, the littoral zone of reservoirs is often highly affected by water level fluctuations (Furey et al. 2004; Fischer and Ohl 2005; Zohary and Ostrovsky 2011; Miranda 2017). Water level fluctuations often lead to barren littoral areas, with little vegetation growth (Smart et al. 1996; Miranda and Bettoli 2010). Specifically, the frequent and substantial fluctuations in water provide a harsh environment for growth of vegetation (Smart et al. 1996; Miranda 2017). Small decreases in water levels can also decrease cover and change substrate composition (Irwin and Noble 1996). For instance, Beauchamp et al. (1994) found that 20 percent of available rocky substrate was exposed during a 2-meter drawdown event. In another study, Gasith and Gafny (1990) found that substrate available for fishes changed from rocky to sandy during decreased water levels. Similarly, Dibble (1993) found that gravel habitat was exposed during drawdown events. Additionally, beneficial woody cover that may be present in littoral areas may be exposed and unusable during drawdown events (Zohary and Ostrovsky 2011). Often times, the dewatering of these important habitats can be poorly timed and impact life stages dependent on these areas (Hayes et al. 1999).

Dewatering of shoreline areas can disrupt biotic communities normally inhabiting littoral zones (Hayes et al. 1999). Dewatering can be especially impactful on invertebrate communities and early life stages of fishes (Ploskey 1986; Zoharty and Ostrovsky 2011). Invertebrates colonizing littoral areas may not be mobile enough to escape dewatering events or constant fluctuations may simply prevent colonization of these areas by invertebrates (Ploskey 1986; Zoharhy and Ostrovsky 2011). Benthic invertebrates can be impacted by exposure and loss of habitat (Ploskey 1986; Furey et al. 2006). Additionally, for fishes that spawn in shallow littoral areas, such as Walleye and Yellow Perch, dewatering can cause stranding of eggs and larvae, resulting in mortality (Hassler 1970; Heman et al. 1969; Priegel 1970; Krieger et al. 1983; Ploskey 1986). Yellow Perch typically drape eggs over woody debris or vegetation in shallow, littoral areas (Thorpe 1977). Decreased water levels after spawning occurs could lead to dewatering of eggs (Krieger et al. 1983). Similarly, Walleyes typically spawn in shallow water, and if water levels are reduced after spawning, areas where eggs have settled may become exposed (Johnson 1961; Priegel 1970; Chevalier 1977). Therefore, it is evident that poorly time or managed water level fluctuations can have adverse impacts on aquatic communities.

If managed correctly, water level fluctuations can be beneficial to reservoir fish communities (Groen and Schroeder 1978; Ploskey 1986; Willis 1986; Sammons and Bettoli 2000). Well timed fluctuations can inundate additional habitat during critical periods such as during and after spawning. Increased spawning success of some species has been associated with inundation of additional habitat (Groen and Schroeder 1978; Ploskey 1986; Willis 1986; Sammons and Bettoli 2000). Specifically, species that spawn on vegetation are often benefited by springtime water level increases (Groen and Schroeder 1978; Ploskey 1986). Additionally, increased recruitment has been associated with high water levels during extensive periods after spawning (Willis 1986; Sammons and Bettoli 2000). Specifically, refuge provided by flooded vegetation has been correlated with increased survival of young of year of several species (Willis 1986; Sammons and Bettoli 2000). Increases in water levels may also increase available forage for some species, specifically those that feed on invertebrates (Ploskey 1986; Willis 1986). Consequently, well timed water level increases may lead to increased growth rates for some fishes (Ploskey 1986). In some circumstances, water level drawdowns can benefit reservoir fishes (Ploskey 1986; Willis 1986). Large drawdowns in water level may function to concentrate prey for fishes, especially piscivores (Groen and Schroeder 1978; Ploskey 1986). Some studies have suggested that appropriately timed drawdowns could be conducted to improve foraging conditions for piscivores, thereby increasing growth (Ploskey 1986; Willis 1986).

Given the potential for both positive and negative effects of water level fluctuations and the variety of factors they can influence, it is apparent that knowledge of water regime impacts is important for management of reservoir fisheries. Although poorly timed and mismanaged water level fluctuations can be detrimental to reservoir fisheries, well timed and properly managed fluctuations can in some cases be beneficial (Groen and Schroeder 1978; Ploskey 1986; Willis 1986). Resource managers should be cognizant that water level management can be a vital tool for reservoir fisheries management (Jenkins 1970; Willis 1986).

### *Fish Communities*

The reservoir characters previously mentioned can be important in structuring of fish communities. Due to the diversity of habitats and longitudinal gradient of characteristics, reservoirs often support a wide variety of fish species (Gido et al. 2009). However, most species commonly found in reservoirs are also generalists that occupy a wide distribution (Miranda and Bettoli 2010). Specialized species native to the original riverine system are often absent from reservoirs due a lack of suitable habitat (Gido et al. 2009; Clavero and Hermoso 2011). Hildebrand (1979) noted some riverine species disappear or remain at substantially different abundances after the formation of reservoirs. However, reservoirs often support both lotic and lentic species, especially in systems that retain strong longitudinal gradients from riverine to lacustrine habitat (Gido et al. 2009). However, riverine species that persist in reservoirs may be larger species or riverine species with more plastic habitat requirements (Smith and Petrere Jr. 2008; Gido et al. 2009; Clavero and Hermoso 2011). In contrast, lacustrine areas of reservoirs are often dominated by species with a preference for lentic habitats (Gido et al. 2002; Gido et al. 2009).

As a result of the varying fish communities supported in reservoirs, and the potential spatial separation of these assemblages, managers may need to utilize a diversity of actions to manage fisheries. Additionally, although dominant reservoir species are often generalists, possibly not common to the pre-impoundment river system, they may represent important sportfish for recreational anglers. Therefore, effective management of these species is often important to resource agencies. Additionally, some of these sportfish may have been common to the pre-impoundment river, such as Smallmouth Bass or Walleye, and have adapted to reservoir conditions. Some sportfish, such as Walleye and Smallmouth Bass, are also often species that are sensitive to additional environmental perturbations (Magnuson et al. 1984). Therefore, these species not only represent important species to recreational anglers, but also those that are indicators of the health of the aquatic environment.

## Acidification and Recovering Aquatic Ecosystems

Acidification of aquatic ecosystems results from acid precipitation or acid mine drainage (Herlihy et al. 1990; Herlihy et al. 1993). Acidification of freshwater environments has a negative impact on aquatic communities. Notably, stream impairment due to acidification results in loss of species from impacted areas and lower fitness of individuals that remain (Haines 1981; Magnuson et al. 1984; Baker et al. 1990; Tremblay and Richard 1993; Schorr and Backer 1996; McClurg et al. 2007). Acidification chronically impacts fisheries, such as reductions in species richness, fish abundance, reduced reproduction, and reduced growth (Haines 1981; Magnuson et al. 1984; Schofield and Driscoll 1987; Baker et al. 1990; Schorr and Backer 1996; McCormick and Leino 1999; McClurg et al. 2007). Acid-intolerant species may experience decreases in reproductive success, growth, and possibly extirpation (Haines 1981; Magnuson et al. 1984; Baker et al. 1990; Tremblay and Richard 1993; Schorr and Backer 1996; McCormick and Leino 1999; McClurg et al. 2007). Extremely acidic conditions can be lethal to some fishes, especially the early life stages (Haines 1981; Baker et al. 1990; McCormick and Leino 1999; McClurg et al. 2007). Acidification can also impact fish communities by significantly altering productivity and forage availability (Haines 1981; Baker et al. 1990; McClurg et al. 2007).

Several studies have found significant effects of acidification on fish populations (Beamish 1976; Haines 1981; Rahel and Magnuson 1983; Pauwels and Haines 1986; Wales and Beggs 1986; Tremblay and Richard 1993; Baldigo and Lawrence 2000; Schorr and Backer 1996; McClurg et al. 2007; Cravotta et al. 2010; Williams and Turner 2015). Previous studies that examined acidification effects on lentic ecosystems primarily focused on acid precipitation (Beamish 1976; Rahel and Magnuson 1983; Wales and Beggs 1986; Eaton et al. 1992; Tremblay and Richard 1993). Additionally, most of these studies have focused on lentic systems outside of the Appalachian region (Beamish 1976; Rahel and Magnuson 1983; Pauwels and Haines 1986; Wales and Beggs 1986; Eaton et al. 1992; Tremblay and Richard 1993).

Nevertheless, these studies provide information on response of fish communities to acidification. Most of these studies concluded that species such as Smallmouth Bass, Walleyes, along with some darters (Percidae) and shiners (Cyprinidae) were among the first to disappear after acidification (Beamish 1976; Rahel and Magnuson 1983; Tremblay and Richard 1993). In contrast, White Suckers and Brown Bullheads were often tolerant of acidic conditions and the last species to remain in extremely acid lakes (Beamish 1976; Rahel and Magnuson 1983; Tremblay and Richard 1993; Wales and Beggs 1986; Pauwels and Haines 1986).

Most studies examining the effects of acid mine drainage on aquatic organisms have been conducted in lotic habitats (Schorr and Backer 2006; McClurg et al. 2007; Cravotta et al. 2010; Williams and Turner 2015). Similar to the value of the studies of acidification on lakes, these lotic studies provide valuable information on the response of fish species and communities to acid mine drainage pollution. In streams impacted by acid mine drainage, most studies concluded that there were significant decreases in species richness and overall fish abundance (Schorr and Backer 2006; McClurg et al. 2007; Cravotta et al. 2010; Williams and Turner 2015). Streams treated to reduce the impacts of acid mine drainage experienced improvements to fish community health. Although acid intolerant species returned to treated streams in these studies, most were smaller stream species with little parallel to reservoir ecosystems. Most notably in these studies, species richness and fish abundance substantially increased following treatment of acid mine drainage (Schorr and Backer 2006; McClurg et al. 2007; Cravotta et al. 2010; Williams and Turner 2015).

There has been little published research on the impacts and recovery of reservoir fish communities from acidification. Some research was conducted decades ago on reservoir fisheries impacted by acid mine drainage in West Virginia (Core 1959; Poe 1971). Although the response of fish communities to acidification in reservoirs may ultimately be similar to that in streams and natural lakes, it would be beneficial to document instances of acidification and recovery within reservoir ecosystems. Additionally, for resource managers within impacted waterbodies, understanding the magnitude of impact from acidification and the conservation and recreational benefits from recovery provide benchmarks from which to base future management activities and goals.

**Ecology of Walleye in the context of Reservoir Systems**

The Walleye (*Sander vitreus*) is a commercially and recreationally popular North American sportfish (Schmalz et al. 2011). Walleyes are members of the family Percidae, which also includes Sauger, Yellow Perch, and many species of darters (Jenkins and Burkhead 1994). In physical appearance, Walleyes are characterized by completely spinous 1st dorsal fins and partially spinous 2$^{nd}$ dorsal and anal fins, large canine teeth, luminous eyes with a tapetum lucidum, and white tipped caudal fins (Etnier and Starnes 1993). They have a native range encompassing large portions of Canada and the United States from the Rocky Mountains in the west to the Appalachian Mountains in the east (Billington et al. 2011). Walleyes have been extensively introduced due to their popularity (Billington et al. 2011). Areas of introduction include the Pacific drainages, Atlantic slope drainages, and some Gulf of Mexico drainages (Billington et al. 2011). They are typically described as a coolwater species, but have adapted well to a variety of habitats (Kitchell et al. 1977; Bozek et al. 2011). Walleyes inhabit freshwater rivers, streams, lakes, and reservoirs (Bozek et al. 2011). Walleyes exhibit substantial plasticity, persisting in both lotic and lentic environments (Bozek et al. 2011). Kitchell et al. (1977) posited that Walleyes evolved to successfully occupy habitats intermediate of those dominated by warmwater centrarchids and coldwater salmonids. Additionally, Walleyes have scotopic vision allowing them to be successful predators in high turbidity or nocturnal environments, differentiating them from other predatory freshwater fishes (Bozek et al. 2011). Overall, the Walleye is a widely-distributed successful top predator in North America (Bozek et al. 2011).

*Spawning and Early Life Stages*

Across their range, Walleyes spawn in the spring months, the timing of which can vary widely based on latitude (Eschmeyer 1950; Scott and Crossman 1973; Becker 1983; Jenkins and Burkhead 1994; Bozek et al. 2011). Spawning can occur from March–June dependent on latitude, and may begin under the ice in the northern range (Eschmeyer 1950; Scott and Crossman 1973; Becker 1983; Jenkins and Burkhead 1994; Bozek et al. 2011). Spawning will often occur earlier in the southern limits of Walleye's range and later in the northern limits corresponding to differences in monthly water temperatures (Bozek et al. 2011). In West Virginia, Walleye spawning typically occurs from mid-March–early April (WVDNR, unpublished data). Spawning timing is thought to be linked to both water temperature and photoperiod (Eschmeyer 1950; Priegel 1970; Scott and Crossman 1973; Bozek et al. 2011). Photoperiod determines the maturation of egg and sperm while water temperature dictates when spawning activity actually occurs (Bozek et al. 2011). The water temperature at which spawning begins varies, but typically ranges from 5–10 ° C (Bozek et al. 2011). Despite the importance of water temperature, photoperiod ultimately dictates the temporal limits of when spawning takes place (Bozek et al. 2011). For instance, in some waters if unseasonably cold water temperatures linger, Walleyes may eventually spawn at cooler temperatures than usual (Rawson 1957; Hokanson 1977). Additionally, if waters warm rapidly in early spring, Walleyes may end up spawning at warmer than usual temperatures (Rawson 1957; Hokanson 1977). As such, spawning has been documented at temperatures as low as approximately 2 °C (Priegel 1970;

Hokanson 1977) and as warm as approximately 16 °C (Corbett and Powles 1986; Hokanson 1977; Priegel 1970).

Walleyes are considered a simple lithophilic species, given that they broadcast their eggs over hard substrates (e.g., gravel, cobble) and do not build a nest or provide any parental care (McElman 1983). In reservoirs, Walleye populations are typically classified as either river spawners or lake spawners (Colby et al. 1979; Jennings et al. 1996; Bozek et al. 2011). Therefore, Walleye spawning in reservoirs may occur in lentic, main lake areas or within large feeder tributaries to the reservoir (Pflieger 1997; Chalupnicki et al. 2010; Bozek et al. 2011; Martin et al. 2011). In lentic areas, Walleyes typically choose rocky, windswept shorelines to broadcast their eggs, while in rivers they usually deposit eggs in areas of current with hard substrate (Eschemeyer 1950; Palmer et al. 2005; Raabe 2006; Hamilton 2009; Martin et al. 2011). In some reservoirs, both lake spawners and river spawners occur (Jennings et al. 1996; Palmer et al. 2005). Researchers suggest that this variation in spawning strategy could simply be a learned behavior or be a heritable trait (Olson et al. 1978; Jennings et al. 1996; Palmer et al. 2005). Spawning success in main lake areas typically is dependent on suitable habitat in the form of rocky, windswept shorelines (Johnson 1961; Auer and Auer 1990; Martin et al. 2011). Likewise, for successful spawning to occur in feeder tributaries, sufficient rocky substrate and current is optimal (Hanson 2006; Hartman 2009). In some reservoirs, spawning may not occur successfully due to a lack of suitable spawning habitat (Johnson 1961).

Walleyes typically spawn at night, with male Walleyes flanking females, and depositing milt over areas where females deposit eggs (Etnier and Starnes 1993). After fertilization and loss of adhesiveness, eggs eventually settle into the substrate (Scott and Crossman 1973). Likely due in part to the lack of nest preparation or parental care, egg mortality is usually high in Walleyes (Colby et al. 1979). Reported egg survival rates vary widely in the literature, due to numerous factors (e.g., habitat, predation, etc.) that can increase or decrease survival (Colby et al. 1979). Survival rates as low as < 1% and as high as > 60% have been reported in the literature (Eschemeyer 1950; Johnson 1961; Forney 1976; Roseman et al. 1996). Fertilized eggs that survive typically hatch within 10–27 days (Niemuth et al. 1959; Johnson 1961; Priegel 1960; Bozek et al. 2011). Egg hatching times depend greatly on water temperatures during incubation, with warmer water temperatures correlated with shorter incubation periods (Scott and Crossman 1973). Upon hatching, larval Walleyes are quite small, only 6–9 mm in total length (Summerfelt et al. 2011). Larval Walleyes are poor swimmers, and upon hatching are still not capable of swimming, but instead move with water currents (Walburg 1971). Due to their limited swimming ability, larval Walleyes are reliant on currents to carry them to suitable habitat after hatching (Becker 1983; Mion et al. 1998; Jones et al. 2003). Too little water current may strand them in areas without suitable habitat or food, whereas too much current could be fatal due to physical trauma or transport to unsuitable areas (Mion et al. 1998). Newly hatched Walleyes have limited yolk to subsist on and thus rely on feeding shortly after hatching (Bozek et al. 2011). Consequently, hatch timing and juxtaposition near abundant forage is critical for survival at these early life stages (Jones et al. 2003).

*Diet and Foraging*

Walleyes undergo ontogenetic diet shifts, primarily during their first year of life (Chipps and Graeb 2011). Walleyes initially begin feeding on small zooplankton as larvae, with survival highly correlated with larval transportation to areas with available zooplankton (Mion et al. 1998; Jones et al. 2003). Walleyes feed on small zooplankton for the first several weeks of their life before switching to benthic macroinvertebrates (Mathias and Li 1982; Hoxmeier et al. 2004; Galarowicz et al. 2006). Subsistence on benthic invertebrates persists until Walleyes reach a size at which they switch to piscivory, targeting small fishes (Chipps and Graeb 2011). Even after switching to fish, prey size continues to increase with increasing Walleye size (Chipps and Graeb 2011). Walleyes are gape limited and require larger prey for sustenance as their body size increases (Chipps and Graeb 2011). Onset of piscivory in Walleyes can vary considerably, with some studies suggesting it can occur as early as 20 mm, where others suggest 40 mm or larger (Colby et al. 1979; Mathias and Li 1982; Galarowicz et al. 2006; Hartman 2009). Chipps and Graeb (2011) suggest that the onset of piscivory is somewhat determined by both gape limitations and availability of fish that fit within this limitation. In rare instances, Walleyes have been documented to continually subsist on invertebrates as adults where forage fish are unavailable (Colby et al.1979). Walleyes initially forage on small bodied fishes that conform to their gape limit, which is likely to be other age-0 fishes such as shiners (*Notropis* sp.), Yellow Perch, Gizzard Shad, or other available small-sized forage fish (Kocovsky and Carline 2001; Bozek et al. 2011; Chipps and Graeb 2011). Several studies have reported that Walleyes prefer soft-rayed fishes (Forney 1974; Knight et al. 1984; Hartman and Margraf 1992; Bozek et al. 2011), although they also feed heavily on some spiny-rayed fishes, especially Yellow Perch (Forney 1974; Colby et al. 1979; Hartman and Margraf 1992; Hartman and Margraf 1993; Jackson et al 1993; Kocovsky and Carline 2001; Pierce et al. 2006). Species such as Yellow Perch are documented as being especially important when soft-rayed species are not available or are in low abundances (Forney 1974; Hartman and Margraf 1992; Hartman and Margraf 1993; Jackson et al. 1993; Kocovsky and Carline 2001).

Reservoirs often provide Walleyes with a diversity of forage options, although the species and size spectrum of available prey will depend largely on the characteristics of each watershed. For instance, where some reservoirs have abundant soft-rayed prey such as Gizzard Shad, Ciscoes, or Rainbow Smelt, other systems may lack these species and spiny-rayed prey such as Yellow Perch and Centrarchids may be more important (Forney 1974; Hartman and Margraf 1992; Santucci and Wahl 1993; Kocovsky and Carline 2001). Still some reservoirs may lack a diverse size spectrum of prey and force Walleyes to feed on smaller species (Colby et al. 1979; Lyons and Magnuson 1987). Limitations in preferred prey or a diverse size spectrum of prey could negatively impact condition or growth (Henderson et al. 2004; Kaufmann et al. 2009).

*Age and Growth*

Walleye age and growth have been researched extensively. Walleye age and growth are dependent on a variety of factors, including latitude, water temperature, habitat, competition, and forage (Colby et al. 1979; Kocovsky and Carline 2001; Quist et al. 2003; Bednarski et al. 2010; Bozek et al. 2011). Walleyes in the northern portion of their range typically grow slower and live longer, while southern Walleyes grow faster and have shorter lifespans (Carlander 1997; Craig 2000; Quist et al. 2003; Bozek et al. 2011). Latitudinal differences in growth are directly related to growing degree days, or the length of the growing season (Bozek et al. 2011). There are also sex-based differences in Walleye growth (Quist et al. 2003; Bozek et al. 2011). Specifically, female Walleyes grow faster and have larger maximum sizes compared to male Walleyes (Bozek et al. 2011). Additionally, diet has been shown to influence Walleye growth (Colby et al. 1979; Hartman and Margraf 1992; Henderson et al. 2004; Kaufmann et al. 2009). Studies suggest that available prey type and size spectrum of available prey may impact condition and growth in Walleyes (Hartman and Margraf 1992; Santucci and Wahl 1993; Carlander 1997; Henderson et al. 2004; Kaufmann et al. 2009). Specifically, if there is a lack of preferred prey or optimal size prey, condition and growth may be limited (Santucci and Wahl 1993; Carlander 1997; Henderson et al. 2004; Kaufmann et al. 2009).

Growth in reservoirs is typically reported to be similar to growth in natural systems, but certain reservoir characteristics may increase or decrease growth. For instance, reservoirs may support a variety of optimal prey items, such as Gizzard Shad, that allows for faster growth in resident Walleyes (Hartman and Margraf 1992; Santucci and Wahl 1993; Quist et al. 2003). However, other aspects of reservoirs, such as thermal stratification, may cause less than optimal growth conditions (Bozek et al. 2011). Growth in reservoirs will ultimately depend on other factors that are determined by the characteristics of each reservoir.

*Habitat and Water Quality*

The Walleye is typically considered a coolwater species, preferring habitat with lower maximum water temperatures and adequate dissolved oxygen (Hokanson 1977; Kitchell et al. 1977; Colby et al. 1979; Jenkins and Burkhead 1994). In reservoirs, optimal conditions are most often found in mesotrophic waters (Scott and Crossman 1973; Colby et al. 1979; Jenkins and Burkhead 1994). Walleyes have been reported to prefer a water temperature of approximately 22 °C for optimal foraging and growth (Kitchell et al. 1977; Bozek et al. 2011). For spawning activity, lower water temperatures from 5–10 °C are required (Hokanson 1977; Etnier and Starnes 1993; Jenkins and Burkhead 1994; Bozek et al. 2011). If Walleyes are forced to occupy unsuitable water temperatures, there could be impacts to condition, growth rate, and potentially reproduction (Kokovsky and Carline 2001). Walleyes will seek out preferred water temperatures, sometimes despite unsuitability of other water quality parameters (e.g., dissolved oxygen) (Fitz and Holbrook 1978).

Besides water temperature, other water quality parameters are often important to persistence and success of Walleye populations in reservoir ecosystems. Walleyes prefer dissolved oxygen concentrations above 5.0 mg/L, a minimum level for optimal egg incubation (Oseid and Smith Jr. 1971; McMahon et al. 1984). Low dissolved oxygen levels may limit hatching success and survival of larval Walleyes (Colby et al. 1979; Auer and Auer 1990). Given oxygen requirements for Walleye eggs, substrate and water movement that facilitates higher dissolved oxygen is often critical for hatching success (Raabe 2006). Additionally, in reservoirs that experience stratification, Walleyes may be limited in depth of water occupied and perhaps alter their location to areas of higher dissolved oxygen (Colby et al. 1979).

Walleyes are sensitive to pH levels. Specifically, low pH can be detrimental to successful reproduction in Walleyes (Lynch and Corbett 1980; Hulsman et al. 1983; Rahel and Magnuson 1983). Studies have found that pH values lower than 6.0 leads to increased egg and larval mortality (Hulsman et al. 1983). In some acidified lakes, a pH ≤ 5.5 results in Walleye reproductive failure (Rahel and Magnuson 1983). In the Cheat River watershed, WV, Walleyes were initially abundant but continued acidification due to acid mine drainage eventually extirpated the species from the watershed (Core 1959).

Habitat requirements of Walleyes change throughout each life stage associated with different survival needs (Bozek et al. 2011). While adult habitat has been extensively studied, relatively limited research has been conducted on age-0 Walleye habitat use (Bozek et al. 2011). Age-0 Walleye habitat use shifts as young grow larger (Etnier and Starnes 1993; Bozek et al. 2011). Initially, age-0 Walleyes occupy pelagic habitats, but as their first year progresses they become demersal, progressively occupying deeper waters as they become negatively phototactic (Etnier and Starnes 1993; Bozek et al. 2011). However, habitat use of age-0 Walleyes can vary with food and habitat availability (Bozek et al. 2011). Adult Walleyes are usually demersal, but specific habitat use shifts seasonally in concordance with spawning and foraging (Colby et al. 1979).

Walleyes can successfully reproduce in both lentic and lotic environments, provided there is rocky substrate with adequate dissolved oxygen through either wave action or river current (Jenkins and Burkhead 1994; Bozek et al. 2011). Spawning habitat is critical for sustained natural reproduction and recruitment in aquatic systems. Walleyes may either spawn in lentic or lotic habitats, with some habitat similarities and differences (Bozek et a. 2011). In lentic environments, such as main lake areas of reservoirs, Walleyes will spawn on rocky, windswept shorelines (Becker 1983; Bozek et al. 2011; Martin et al. 2011). Rocky substrate is considered critical, as it provides areas for eggs to settle, while being oxygenated as well as protected from predators and abiotic stressors such as wave action or siltation (Bozek et al. 2011; Martin et al. 2011). Walleyes have been documented as spawning on alternative habitats in lentic environments, but the success of reproduction is variable. Walleyes have been documented in other studies as spawning on root wads, vegetation, muck-detritus bottom, and fine sand in some systems (Eschemeyer 1950; Johnson 1961; Priegel 1970; Auer and Auer 1990; Ickes et al. 1999), however, there is some evidence that spawning on rocky substrate increases egg survival (Johnson 1961; Auer and Auer 1990). Depth of spawning activity for Walleyes is in relatively shallow, nearshore areas (Jenkins and Burkhead 1994; Bozek et al. 2011). Studies have documented higher survival of eggs on rocky substrates and lower survival on fine sand or silty substrates (Johnson 1961; Auer and Auer 1990; Hamilton 2009; Bozek et al. 2011). Likewise, while some wave activity is beneficial via oxygenation, excessive wave activity can damage eggs or carry them to unsuitable areas (Eschemeyer 1950; Johnson 1961; Raabe 2006; Bozek et al. 2011). Too little wave activity could lead to a lack of oxygenation (Bozek et al. 2011). When spawning in rivers, such as feeder tributaries of reservoirs, Walleyes similarly spawn on rocky substrates where some current is present (Jenkins and Burkhead 1994; Bozek et al. 2011). They also typically choose relatively shallow water, similar to lentic spawning areas (Jenkins and Burkhead 1994; Bozek et al. 2011). Additionally, like lake spawning areas, rocky substrates offer protection from predation, transport damage, and siltation, while allowing for adequate oxygenation (Dustin and Jacobson 2003; Ivan et al. 2010; Bozek et al. 2011). Similar to wave activity for lake spawners, some river flow is needed for oxygenation of eggs, but excessive flow could be detrimental to eggs (Jones et al. 2003; Bozek et al. 2011).

Foraging habitat varies to some extent seasonally, likely as a function of water temperature and forage fish availability. Overall, adult Walleyes are considered demersal, usually orienting themselves close to the bottom (Bozek et al. 2011). Walleyes are negatively phototactic as adults, which likely influences their affinity for deep water and benthic habitats (Bozek et al. 2011). Walleyes will become more pelagic under certain conditions, typically when stratification occurs and a strong temperature-oxygen thermocline develops (Williams 2001; Clark-Kolaks 2008; Kirby et al. 2017). Physical habitat preferences have been reported to be hard substrates with structure in the form of boulders, submerged vegetation, or large woody debris (Holt et al. 1977; Ryder 1977; Schlagenhaft and Murphy 1985; Paragamian 1989; Kerr et al. 1997; Williams 2001; Clark-Kolaks 2008). However, foraging habitat appears to be somewhat plastic, as Walleyes will follow abundant forage fish into a variety of habitats (Raby et al. 2017).

In reservoirs, Walleye habitat varies widely and is often significantly impacted by water level fluctuations. Specifically, water level fluctuations can significantly impact spawning habitat and have significant consequences on Walleye recruitment (Priegel 1970; Raabe 2006). Optimal spawning habitat can be limited or unavailable, dependent on the timing and magnitude of water level fluctuations during this period (Johnson 1961; Priegel 1970). Dewatering of optimal rocky habitat during reservoir fluctuations can force Walleyes to spawn on less suitable substrates such as sand and muck (Johnson 1961; Priegel 1970). Additionally, if spawning occurs in shallow water habitats and water levels are subsequently reduced, stranding and mortality of eggs could occur (Priegel 1970). In either situation, water level fluctuations and their impact on spawning habitat and success can lead to increases in recruitment failure that can be detrimental to Walleye populations (Priegel 1970; Raabe 2006).

*Migration and Movement*

Walleyes rely on migrations and movements to locate areas necessary for spawning and foraging (Hanson 2006). Walleyes may undertake large scale seasonal migrations, or smaller scale diel movements. Walleyes make diel movements related to habitat shifts between diurnal and nocturnal periods (Colby et al. 1979; Hanson 2006). In lakes and reservoirs, Walleyes have been documented to move from deeper, main lake areas during the day, to shallower, cove areas at night, presumably to forage (Williams 2001; Kirby et al. 2017). Walleyes also are known to make potentially large migrations to spawning grounds in late winter or early spring (Bozek et al 2011). Some of these migrations have been over 200 km in length (Eschmeyer and Crowe 1955; Hanson 2006). After spawning, Walleyes likewise usually make post-spawn migrations to foraging areas (Palmer et al. 2005). Finally, Walleyes may make additionally movements to areas used for overwintering habitat (DePhilip et al. 2005). There have been significant sex-based differences in migrations and movement reported in Walleyes (Wang et al. 2007; Raby et al. 2017). Specifically, females are often more apt to make post-spawn movements away from spawning grounds compared to males (Wang et al. 2007; Raby et al. 2017). Motivations for movement may be to find preferred water quality conditions (e.g., water temperature, dissolved oxygen, etc.), pursue abundant forage resources, or a combination of both (Wang et al. 2007; Raby et al. 2017).

*Walleye in West Virginia Reservoirs*

In recent years, interest in Walleye fisheries has increased among West Virginia anglers. Subsequently, fisheries managers have increased management efforts for these fisheries across West Virginia waters. Walleyes are native to West Virginia, but were historically inhabitants of riverine environments in the state (Zipfel 2006). Damming of river systems and water quality impairment (often acid mine drainage) resulted in the loss or reduction of Walleye fisheries in many areas of West Virginia (WVDNR, unpublished data). Stocking of Walleyes and water quality improvements have resulted in reestablished Walleye populations in many West Virginia reservoirs (WVDNR, unpublished data). Still, many West Virginia reservoirs have limitations that create challenges for management of Walleye fisheries. West Virginia reservoirs often lack adequate spawning habitat, limiting success of natural reproduction. In these waters, continued stocking is necessary to maintain Walleye populations. In other reservoirs, forage limitations or competing populations of Centrarchids (e.g., Largemouth Bass) make establishment of consistent and/or harvestable Walleye fisheries difficult. However, in some West Virginia reservoirs, Walleye populations appear to be improving and angler interest increasing. To better manage Walleye fisheries, WVDNR biologists developed a statewide management plan to address management efforts such as stocking and regulations (WVDNR 2015). Further research will be important to adaptively manage these fisheries.

**Cheat Lake, WV**

The Lake Lynn Hydro Project (commonly referred to as Cheat Lake) was created by damming the Cheat River in Monongalia County, WV in 1926 (Core 1959). The river was impounded to serve the needs of a hydroelectric generating facility located near the mouth of the Cheat River. The resulting reservoir has an area of 700 ha and stretches approximately 21 kilometers long. An operating license issued by the Federal Energy Regulatory Commission (FERC) in 1994 mandated that target reservoir water level changes be maintained throughout the year in order to help enhance recreation and minimize impacts to aquatic life (Wellman et al. 2008). Lake elevations must be maintained in three different ranges depending on time of year. From May through October, lake levels must be held between 264.5 and 265.1 meters (full pool) above sea level to enhance lake recreation. From November through March, lake levels can fluctuate between 261.2 and 265.1 meters to maximize hydropower generation. Finally, during the month of April lake levels must be held between 263 and 265.1 meters in an attempt to improve spawning success of Walleye and Yellow Perch. Despite best efforts to institute fluctuation restrictions to minimize impacts to aquatic life, it is still possible that seasonal fluctuations could affect fish populations. Specifically, concerns existed that current water level fluctuations in March and April could negatively impact Walleye and Yellow Perch spawning success.

In addition to potential existing impacts from water level fluctuations, the Cheat Lake ecosystem is currently in recovery from decades of impairment due to upstream acid mine drainage. Since the creation of the reservoir, the Cheat River watershed has been significantly impacted by acid mine drainage. Water quality reached a low in the 1970's when pH levels in main Cheat Lake averaged less than 5.0 (WVDNR unpublished data). Some remediation efforts of acid mine drainage in the watershed began in the 1980's (Rick Buckley OSMRE, personal communication). However, a large increase in mine drainage treatment began in the 1990s with the coordination of multiple government agencies and non-profit organizations (Rick Buckley OSMRE, personal communication). Funding for the abatement of abandoned mine lands and other funding opportunities have made possible the extensive mitigation work that has been completed throughout the watershed. As a result of decades of acid mine drainage treatment throughout the watershed, water quality has improved within Cheat Lake. However, periodic depressions in pH during the early 2000s highlighted the continued risk of impact from acidic sources.

Biomonitoring surveys suggest improvement in the Cheat Lake fish community in recent years. Biological improvements are likely the result of efforts to remediate upstream pollution from acid mine drainage. In addition, after likely being extirpated from Cheat Lake due to poor water quality (Core 1959), the Walleye (*Sander vitreus*) population of Cheat Lake has seen recent improvements as a result of management efforts from the West Virginia Division of Natural Resources (WVDNR). Improved water quality and stocking efforts have led to a resurgent Walleye fishery within Cheat Lake. However, natural reproduction is limited, and little is known about the life history of Walleye in Cheat Lake and how current water level regimes and other environmental influences affect the Walleye population.

This dissertation research evaluated recovery of the fish community within Cheat Lake after decades of acidification, with specific focus on the ecology and population characteristics of the reestablished Walleye population. In the research chapters that follow, I examine 1). The long-term recovery of the fish community of Cheat Lake after decades of acidification; 2). The population characteristics of the reestablished Walleye population; 3). The distribution and space use patterns of Walleye within Cheat Lake; 4). The environmental correlates associated with large scale movements of Walleye within Cheat Lake; 5) and in the last chapter I synthesize the findings of this dissertation into possible management actions and recommendations for the future management of the Cheat Lake fish community.

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# Chapter 2 – Long-term recovery of a fish community in an acid impacted hydropower reservoir


## Abstract

Cheat Lake, a hydropower reservoir in northern West Virginia, has been impacted by acid mine drainage since the formation of the reservoir in 1926. As a result, several fish species were extirpated or nearly so from the reservoir, and fish species richness and abundance were limited. Surveys from 1952–1977 indicated only 15 species present, with Brown Bullheads (*Ameiurus nebulosus*) and White Suckers (*Catostomus commersonii*) accounting for the large majority of fishes collected (56% and 26% mean relative abundance). Due to successful efforts to improve water quality within the watershed, the fish community of Cheat Lake has substantially changed over the last few decades. To assess these changes and to monitor for potential impacts from hydropower operations, biomonitoring has been conducted regularly on Cheat Lake since 1990 using boat electrofishing and gill netting surveys. Data from these surveys were analyzed to determine if significant changes have occurred to the Cheat Lake fish community over time. Since 1990, 18,387 fishes representing 44 species have been collected in Cheat Lake. The mean annual relative abundance of captured fishes from the period of 2011–2015 was over 4 times greater than the mean annual relative abundance captured during the period of 1990–2001. Abundances of many individual species increased dramatically. The acid sensitive Smallmouth Bass (*Micropterus dolomieu*) saw an increase in mean annual abundance from 2.9 fish/hr. from 1990–2001 to 38.5 fish/hr. from 2005–2015. Statistical analyses of fish community data using non-metric multidimensional scaling and generalized linear models suggest that the fish community has significantly changed over time. These changes are primarily due to increases in abundance of several species that comprise the fish community, and decreases in pollution tolerant species such as Brown Bullhead. The fish community of Cheat Lake exhibits significant spatial differences in community structure across reservoir zones

(i.e., riverine, transitional, lacustrine, and embayment zones). Species such as Smallmouth Bass, Channel Catfish (*Ictalurus punctatus*), Walleye (*Sander vitreus*), Golden Redhorse (*Moxostoma erythrurum*), Silver Shiner (*Notropis photogenis*), and Emerald Shiner (*Notropis atherinoides*) have increased in abundance and distribution throughout the reservoir. Additionally, fish species richness has significantly increased over time dependent on lake zone. Changes to the fish community have coincided with water quality improvement efforts throughout the watershed. Continuation of water quality improvement efforts are critical to the conservation of this valuable resource.

**Introduction**

Long-term biological monitoring is critically important for documenting trends in aquatic communities, such as temporal changes in environmental conditions (McClelland et al. 2012; Bennett et al. 2015; Marhadja et al. 2017; Starks et al. 2018). Data from long-term monitoring programs provide valuable insights on the natural and anthropogenic influences on temporal population change (McClelland et al. 2012; Bennett et al. 2015). Without long-term monitoring, it is often difficult to make science based management decisions (Walters 2001; Walters and Martrell 2004; Walters et al. 2005; McClelland et al. 2012; Bennett et al. 2015). However, published long-term monitoring research is often uncommon for aquatic ecosystems (Gutreuter et al. 1995; McClelland et al. 2012; Ross 2013; Bennett et al. 2015). Long-term biological monitoring can be especially important in systems negatively impacted by anthropogenic activities (Nielsen et al. 2009; Magurran et al. 2010; Ward-Campbell et al. 2017). This is especially true for systems where mitigation efforts are occurring, as long-term monitoring can be critical to accurately estimate any improvements that occur. Long-term monitoring programs are also critical for evaluating success or failure of management actions in place to improve conditions (McClelland et al. 2012).

Long-term monitoring can be critical for documenting decline and/or recovery of fish faunas influenced by environmental or anthropogenic stressors (McClelland et al. 2012; McCain et al. 2016). This is particularly true for fishes affected by stream acidification in the Appalachians of the eastern United States, a region where acid mine drainage and acid precipitation have long stressed fish assemblages and populations (Herlihy et al. 1993; Schorr and Backer 1996; Wigington et al. 1996; Van Sickle et al. 1996; Bott et al. 2012). The Cheat River watershed of northern West Virginia has experienced depressed water quality for over a century as a result of acid precipitation and acid mine drainage (Core 1959; Welsh and Perry 1997; Thorne and Pitzer 2004; Freund and Petty 2007; Merovich et al. 2007). Similarly, Cheat Lake, a reservoir in the lower Cheat River watershed, has also experienced the effects of acidification (Core 1959). In recent years, the Cheat River watershed and Cheat Lake have seen substantial water quality improvements likely owing to mitigation efforts throughout the watershed (Thorne and Pitzer 2004; McClurg et al. 2007).

Biomonitoring of the fisheries resources of Cheat Lake, WV, a hydropower reservoir, began in 1990 in response to needs for biological information necessary for the renewed issuance of a Federal Energy Regulatory Commission (FERC) license. Ultimately, the renewal license required for biomonitoring of the fish community of Cheat Lake for potential impacts caused by hydropower operations and acidification from acid mine drainage (Wellman et al. 2008). Additionally, the renewal license required restrictions on seasonal water level fluctuations. Specifically, lake elevations are to be maintained between 264.5–265.1 m (868–870 ft.) from May 1st to October 31st to enhance recreational activities (Wellman et al. 2008). Elevations are permitted to fluctuate between 261.2–265.1 m (857–870 ft.) from November 1st to March 31st to maximize power generation.  Finally, lake elevation is restricted to 263–265.1 m

(863–870 ft.) during April in an effort to limit potential impacts from fluctuations on Walleye and Yellow Perch (*Perca flavescens*) spawning (Wellman et al. 2008).

Several studies have been conducted on the water quality and biological communities of Cheat Lake and its tailwaters intermittently since its creation in the late 1920's (Core 1959; Stilson 1969; Hivick 1972; Wellman et al. 2008). Water quality data have been collected several times each decade since 1929 (Core 1959; Stilson 1969; Hivick 1972; Wellman et al. 2008). Previous studies concluded that Cheat Lake water quality was extremely acidic and artificially oligotrophic as a result of impacts from acid mine drainage (Core 1959; Volkmar 1972; Edens 1975; Janicki 1980). Studies on the zooplankton and phytoplankton communities revealed severely impaired and simplistic communities supporting only a few tolerant taxa (Volkmar 1972; Janicki 1980). The first major survey of the fish community was conducted in the 1950's (Core 1959). This study concluded that the fish community was significantly impaired from AMD impact. With the enactment of the Clean Water Act (CWA) in 1972 and the Surface Mining Control and Reclamation Act (SMCRA) of 1977, steps began to be taken nationwide to reduce pollution of waterways. Specifically, SMCRA required acid mine drainage to be treated and also helped provide funds to reclaim abandoned mine sites (Thorne and Pitzer 2004). Although a handful of projects were completed in the 1980's to remediate abandoned mine lands, more intensive efforts did not occur until after a large mine blowout occurred in the watershed in 1994 (Cline 1999; Steelman and Carmin 2002; Thorne and Pitzer 2004). Several agencies and non-profit organizations have contributed to acid mine drainage abatement projects within the watershed. Over 200 land reclamation and water treatment projects have been completed since 1994 (Rick Buckley OSMRE, personal communication). Not every reclamation project treated water quality directly, but even those that did not, often benefited water quality indirectly (Rick Buckley OSMRE, personal communication). Since 2000, greater than 5 million dollars have been invested towards Cheat River restoration, including funds from EPA Section 319 nonpoint source funding and matching funds from the Office of Surface Mining Reclamation and Enforcement (Capacasa 2016). Between 2000 and 2013, over 1.7 million pounds of AMD pollution were reduced within the watershed (Capacasa 2016). In addition, over 100 miles of streams are directly treated for acidification within the watershed via the WVDNR limestone fines program (WVDNR, unpublished data).

The primary goal of this study was to evaluate spatial and temporal changes that have occurred to the Cheat Lake fish community. Specifically, we sought to determine if overall fish abundance, species-specific abundance, species richness and fish community structure has changed temporally and spatially in comparison to improving water quality conditions longitudinal variations in reservoir characteristics.

## Methods

### *Study area*

Cheat Lake, a 700 ha hydropower reservoir located in northern West Virginia, has been impacted by stream acidification since construction in 1926. The reservoir, created by damming the Cheat River near the West Virginia-Pennsylvania border, supports a hydroelectric generating facility. The reservoir maintains a somewhat riverine shape, with moderate sinuosity and steep slopes throughout portions of the reservoir (Figure 2.1). The reservoir is approximately 21 km in length and has a maximum depth of 24 m near the dam. The reservoir is dimictic, experiencing seasonal stratification of water temperature and dissolved oxygen. Downstream of Cheat Lake, the Cheat River (hereafter Lower Cheat River) flows for approximately 5.3 km into the Monongahela River in Point Marion, PA.

For this study, we subdivided Cheat Lake into four zones: riverine, transitional (middle main lake), lacustrine (lower main lake), and embayment (Figure 2.1). Separation of these zones was based on characteristics defining reservoir morphology including bathymetry and water chemistry. The transitional and lacustrine zones are typically 2.5–3.0 times wider in cross section than that of the narrow riverine and embayment zones (Figure 2.1). Hydrologically, river flow strongly regulates the riverine section, but has a reduced influence going downstream from transitional to the lacustrine zones. The embayments, with narrow connections to the main lake, are least influenced by the Cheat River flow. During winter, the formation and persistence of ice cover reflects the influence of river flow, with the embayment and lacustrine zones more likely to maintain ice cover longer than the transitional and riverine zones. Additionally, bathymetry varies greatly across the different zones. The riverine and transitional zones are much shallower than both the lacustrine and embayment zones. There are also notable habitat differences between the zones. The riverine zone is dominated by sand and coarser substrates and usually lacks aquatic vegetation. In contrast, the other zones have substrates primarily composed of silt/clay particles and also have areas of aquatic vegetation growth. Specifically, the transitional zone and embayment zone have more aquatic vegetation present than both the lacustrine and riverine zones. Finally, there are also historic and current water chemistry differences between the zones. Historically, the embayment zone was more suitable for aquatic life compared to the other zones due to reduced influence of acidification. The embayment areas are largely separated from the main lake and were historically buffered by incoming tributaries therefore creating more suitable water chemistry conditions (i.e., higher pH). Also, the zones often differ in water temperature and dissolved oxygen, particularly during warm, summer months. The riverine zone usually has cooler, more oxygenated water and does not typically experience stratification. The transitional zone usually has subsurface water temperature and dissolved oxygen levels comparable to the lacustrine and embayment zones, but stratification is often less severe. The lacustrine and embayment zones experience the greatest amount of stratification, with lower hypolimnetic oxygen levels often near zero during warm, summer months.

*Water Quality Monitoring*

Data on water quality were collected intermittently prior to 1997, associated with periodic studies on the ecosystem of Cheat Lake (Core 1959; Stilson 1969; Hivick 1972; Volkmar 1972; Edens 1975; Janicki 1980; WVDNR unpublished data). Given Cheat Lake's historic impairment from AMD, pH data were of particular interest for our study, and included measurements at varying intensities in 1956, 1965, 1968, 1969, 1971, 1977, and 1990. Monitoring of pH in Cheat Lake also was conducted multiple times a year (6–13 samples per year) during biomonitoring surveys that occurred from 1997–2015. Additionally, beginning in 1997, pH values were recorded daily at the hydrostation on Cheat Lake from March through November of each year. Beginning in 2004, a YSI model 600 XLM continuous monitor was placed at the head of Cheat Lake that recorded pH values hourly. Utilizing available data, minimum and mean pH values were summarized for both the main lake and embayments.

*Pre-Biomonitoring Fish Surveys*

From 1952–1977, periodic fish surveys were conducted on Cheat Lake (Core 1959; WVDNR unpublished data). Surveys utilized a variety of gear including experimental gill nets, fyke nets, and boat electrofishing. Records and reports from these surveys provide little detail on dimensions of gear and sampling effort. Due to this lack of detail, data from these studies are purely qualitative, providing relative estimates of species presence/absence and proportional relative abundance. Surveys were conducted in 1952, 1955, and 1956 utilizing gill netting and fyke netting in Cheat Lake. Survey locations and gear dimension/sampling effort were either vague or not provided (Core 1959; WVDNR 1972, unpublished data). Data from the 1955 and 1956 surveys included information on presence and proportional relative abundance of fish species. Data from the 1952 survey only included species captured and anecdotal notes on dominant species. Surveys were also conducted by WVDNR in 1973, 1974, and 1977 using experimental gill nets and boat electrofishing (WVDNR 1973; WVDNR 1974; WVDNR 1977, unpublished data). Again, little information was provided on gear dimensions or sampling effort. However, survey locations were provided in these reports. Data from 1974 included information on presence and proportional relative abundance of fish species. Data from 1973 and 1977 only provided species captured and anecdotal notes on dominant species.

*Biomonitoring Fish Surveys*

Biomonitoring fish surveys were conducted on Cheat Lake using night-time boat electrofishing and gill netting. Biomonitoring electrofishing surveys were conducted at least twice yearly during spring (May/June) and fall (September/October) in 1990, 1997, 1998, 2001, 2005, 2008, and yearly from 2011–2015. During the years of 1990, 1998, 2001, and 2008, a summer (July/August) survey was also done. Biomonitoring gill net surveys were conducted at least twice yearly (spring and fall) during the same years except for 2013 and 2015 when gill netting was not conducted. A summer survey was completed in 1990, 1998, and 2001. Biomonitoring surveys were conducted at stations located in each lake zone (Riverine, Main Lake, Embayments; Figure 1). Main lake stations were further designated as either lower main lake (L1 & L2) or middle main lake (L3) for some analyses. Electrofishing surveys were conducted during night-time hours using pulsed-DC electrofishing (4–6 A). Electrofishing effort changed during the biomonitoring period. In 1990, two distance based transects (160 m per transect) were conducted at each site. However, these transects were recorded as requiring on average 15 min of effort for each 160 m transect. From 1997–2001, two 15 minute transects were electrofished per site. From 2005–2015, one 10 minute transect was electrofished per site. Additionally, only 6 stations were surveyed from 1990–2001, while 8 stations were surveyed from 2005–2015. Due to changes in total effort, electrofishing data were standardized by catch-per-unit-effort (fish/hour) for analytical purposes. Gill net surveys were conducted using experimental nets 38.1 meters (125 ft.) in length and 1.8 m (6 ft.) deep with five equal panels of 19 (0.75), 25 (1.0), 38 (1.5), 51 (2.0), and 64 (2.5) mm bar mesh (inches in parentheses). In 1990, 1997, 1998, and 2001, straight mesh nets (38 mm mesh) of the same length and depth were also used. At each station, two nets (one experimental and one straight mesh from 1990–2001) were deployed before dusk and retrieved after dawn the following day resulting in soak times of approximately 12 hours. The two nets at each station were set approximately 100 meters apart and were set perpendicular to the shoreline.

Captured fishes were identified to species and were measured (total length) to the nearest millimeter. During fall surveys fishes were also weighed to the nearest gram. Some juvenile game fishes (i.e., sunfishes) and non-game fishes (i.e., minnows or darters) of similar length were grouped into length bins (i.e., 10–20 mm) by species, counted, and batch weighed. Small, non-game fishes were often fixed in 10 % formalin, and processed in the laboratory.

*Data Analysis*

Data were analyzed using a combination of summary statistics, ordination techniques, and generalized linear mixed models. We calculated species richness, overall catch-per-unit-effort for all fishes combined ($CPUE_{overall}$), overall catch-per-unit-effort for large bodied fishes only ($CPUE_{large}$) and CPUE by species (based on species, gear type, and lake region). Our estimate of overall catch per unit effort for large bodied fishes ($CPUE_{large}$) excluded small bodied fishes including minnows and darters (Chick et al. 2004). We used $CPUE_{large}$ for our overall fish abundance statistical analyses. Small bodied species such as minnows and darters were excluded in abundance analyses to minimize bias and variance of overall fish abundance associated with the potential for highly variable catch rates due to benthic lifestyles or other capture difficulties (Chick et al. 1999; Flotemesch and Blocksom 2005; Ruetz III et al. 2007; Koryak et al. 2009). Boat electrofishing capture efficiencies for small minnow species and darters are often low due to habitat use of these species (benthic lifestyle of darters), behavioral traits (shoaling behavior of shiners), and physiological adaptations (reduced or absent air bladder in darters) (Chick et al. 1999; Flotemesch and Blocksom 2005; Ruetz III et al. 2007; Koryak et al. 2009). Data for small-bodied species were included in community analyses using non-metric multidimensional scaling (NMDS) and multivariate generalized linear models, because these data were predicted to represent changes to community structure. We also calculated proportional relative abundance by species to make qualitative comparisons between historic data (pre-1990) and biomonitoring data. Proportional relative abundance was calculated as the percent composition of a species for an individual sampling event. Temporal and spatial differences in measurements of overall $CPUE_{large}$ and species richness were analyzed using generalized linear mixed model analysis (McCain et al. 2016). We visually evaluated the spatial and temporal change in fish communities in Cheat Lake using non-metric multidimensional scaling (NMDS). We statistically tested spatial and temporal changes in fish communities with multivariate generalized linear models using the mvabund package in R (Wang et al. 2012). Rare species (present in < 5 % of all samples; Starks et al. 2018) were removed from community analyses due to sensitivity of analyses to rare species.

Due to inconsistency and relative ineffectiveness of the method in Cheat Lake during biomonitoring months, gill net data were excluded from statistical analyses. Limitations due to debris build up, low catch rates, and steep shorelines, resulted in inconsistent sampling effectiveness for most species of fish. Some species, such as Yellow Perch and Walleye which were captured more effectively during other studies in colder months, had highly variable catch rates during the warmer biomonitoring months. Catfishes were a group of fish consistently captured using gill nets, however, frequent surveys with zero catch complicate analysis options. Therefore, temporal patterns in Brown Bullhead and Channel Catfish abundance were visually assessed using graphically plotted catch-per-unit effort (fish/net-night) over time. Additionally, summaries of species captured and abundances from gill net data were included for descriptive purposes.

We calculated CPUE as an estimate of overall fish abundance for each sample and for each species captured. We also calculated species richness for each sample. We tested for spatial and temporal changes in overall large bodied fish abundance ($CPUE_{large}$; excluding minnows and darters) and species richness using generalized linear mixed model analysis in R (McCain et al. 2016). Specifically, we used the packages glmer.nb and glmer in R, to model fish abundance with a negative binomial distribution and species richness as a Poisson distribution (McCain et al. 2016). A log-link function was utilized for both the fish abundance and species richness models (McCain et al. 2016). The generalized linear mixed model for fish abundance specified both temporal (year) and spatial (lake zone) fixed effects, and an interaction effect between year and lake zone. Like the model for overall fish abundance, the model for species richness utilized the same model structure. Both models incorporated survey site as a random effect to account for potential spatiotemporal autocorrelation. Significance level for fixed effects was set at $\alpha = 0.05$ (McCain et al. 2016).

For analyses of fish community changes across space and time, we used multivariate statistical techniques including NMDS and multivariate generalized linear models (mvabund; McCain et al. 2016). Multivariate statistical analyses were conducted in PRIMER 7 (NMDS) and

R (mvabund) (Primer-E Ltd., Ivybridge, UK, R version 3.3.0, R Core Team 2014). To visually examine spatiotemporal changes in fish community structure we used NMDS. Non-metric multidimensional scaling is a visual ordination technique that identifies patterns in community structure and relies on the use of a species resemblance matrix across sampling sites (Bennett et al. 2015; McCain et al. 2016). We generated our species resemblance matrix using Bray-Curtis distances derived from a species abundance matrix from Cheat Lake sampling sites (Bennett et al. 2015; McCain et al. 2016). We examined the change in species presence/absence community structure from 1952–2015 using annual presence/absence data from each sampling year. We also analyzed changes in community structure using species abundance data from 1990–2015. Species abundances (CPUE) were square root transformed to help normalize data and decrease bias associated with abnormally high abundances during specific sampling periods (McClelland et al. 2012; Bennett et al. 2015). Specifically, we were interested in identifying patterns in community structure associated with sampling year and different lake zones. Graphical results from NMDS were limited to two dimensional plots and sites were represented by both sample year and lake zone. Sites were plotted using the values from the Bray-Curtis similarity matrix. Distances in plot space between sites are determined by the similarity in fish communities (McClelland et al. 2012). Sites close together in space have more similar fish communities, while sites further apart in space have increasingly dissimilar fish communities (Clarke and Warwick 2001; McClelland et al. 2012). In addition to plotting sites based on fish community similarity, we also used Pearson correlations between species abundances and NMDS axes to visually illustrate which species contribute most to differences in fish community patterns (Bennett et al. 2015).

We used multivariate generalized linear models (multivariate GLM) to statistically test for temporal (sampling year) and spatial (lake zone) effects on fish community structure. Traditionally, distance based approaches (i.e., Analysis of Similarity (ANOSIM), Permutational

Analysis of Variance (PERMANOVA)) have often been used to assess differences in community structure, however, these approaches have been shown to confound location and dispersion effects (Warton et al. 2012; McCain et al. 2016). Instead, we incorporated a model based approach using package mvabund in R, which utilizes multivariate generalized linear models that specify a quadratic mean-variance relationship (Warton 2011; Wang et al. 2012; McCain et al. 2016). For our fish abundance data, we used a GLM and specified a negative binomial distribution with a log-link function (McCain et al. 2016). Our model structure incorporated fixed effects of sampling year, lake zone, and an interaction term of year and lake zone. We examined residual plots which did not indicate a noticeable pattern suggesting that the negative binomial distribution was appropriate (McCain et al. 2016).

## Results

### *Water Quality*

Water quality data for Cheat Lake were summarized for the time period of 1952–2015. Both mean and minimum pH values were on average lower in the main lake section compared to the embayments (Figure 2.2) representing some degree of refuge from acidity in the embayments. Annual main lake mean pH values averaged only 4.5 prior to 1990 (Figure 2.2), and annual main lake minimum pH values averaged only 3.9 during this same time period (Figure 2.2). Annual main lake mean pH in 1990 still indicated acid impairment but showed some improvement in water quality compared to previous years with an overall mean pH of 5.8 and minimum pH of 4.1 (Figure 2.2). Annual main lake mean pH since 1997 has remained greater than 6.0 (overall mean of 6.7) and average main lake annual minimum pH was 5.9 (Figure 2.2).

In contrast, annual mean pH of the embayments averaged 6.3 prior to 1990 (Figure 2.2) and annual minimum pH values in the embayments averaged 5.18 during this same time period (Figure 2.2). Like the main lake section, the embayments also experienced increases in pH over time. Annual mean pH in the embayments in 1990 was 6.7, while minimum pH in the embayments during this year was 5.7 (Figure 2.2). Since 1997, the mean annual pH has averaged 7.1 and minimum annual pH has averaged 6.5 (Figure 2.2).

*Fish Abundance, Catch-Per Unit Effort, and Species Richness*

From 1990–2015, a total of 18,387 fishes representing 44 species were captured using both boat electrofishing and gill netting (Table 2.1). A total of 16,198 fishes from 39 species were collected using electrofishing and 2,189 fishes from 27 species were collected using gill nets (Table 2.1). Considering separate years, the lowest electrofishing $CPUE_{overall}$ during our study was in 1990 (118 fish/hr.), and the lowest gill net CPUE was 3.0 fish/net-night in 1998 (Table 2.2). The highest electrofishing $CPUE_{overall}$ (681 fish/hr.) occurred in 2015 and the highest gill net CPUE (12 fish/net-night) occurred in both 2005 and 2012 (Table 2.2). Yearly species richness ranged from 27 species in 1990, 2011, 2012, and 2013, to 33 species in 2008. The highest average $CPUE_{overall}$ for both electrofishing and gill netting occurred in the riverine zone of Cheat Lake (Table 2.2). The $CPUE_{overall}$ for the riverine zone averaged 323 fish/hour for electrofishing and 13 fish per net-night for gill netting (Table 2.2). The embayments of Cheat Lake had the second highest average $CPUE_{overall}$ with an average of 301 fish/hour (electrofishing) and 6 fish/net-night (gill netting). The main lake zone (lower and middle lake sites combined) had the lowest average $CPUE_{overall}$ with an average of 258 fish/hour (electrofishing) and 5 fish/net-night (gill netting).

There were 22 species used for statistical analysis of fish abundance ($CPUE_{large}$) after excluding minnows and darters. Results from the generalized linear mixed model suggest a significant increase in fish abundance ($CPUE_{large}$) occurred from 1990–2015 (Table 2.5). In addition to there being a significant effect of time, fish abundance was also significantly affected by lake region (Table 2.5). There was also a significant interactive effect of time and lake region on fish abundance (Table 2.5), suggesting that fish abundance changed differently over time depending on lake region. Specifically, there were 2.5 times as many fish sampled per hour on average from 2001–2008 compared to 1990–1998 (Figure 2.4). Additionally, there were over 4 times as many fish collected per hour from 2011–2015 compared to 1990–1998 (Figure 2.4). Abundance of fishes was greater on average in the main lake zone compared to both the embayments and riverine zones (Figure 2.4). Also, abundance of fishes showed larger increases in both the riverine zone (6.5 times higher in 2011–2015 vs. 1990–1998) and the main lake zone (6.1 times higher in 2011–2015 vs. 1990–1998) compared to increases observed in the embayments (2.2 times higher in 2011–2015 vs. 1990–1998; Figure 2.4). These differences in abundance over time by lake zone are demonstrated in plotted model predicted values (Figure 2.6).

Statistical results also suggest that there was a significant interactive effect of time and lake region on species richness (Table 2.5) suggesting that species richness changed differently over time dependent on lake region. Examination of the plotted model predicted values for species richness illustrates this interactive effect (Figure 2.4). Specifically, while species richness does not substantially increase over time in the embayment zone, species richness shows considerably greater rates of increase in each of the other zones (Figure 2.4). Total yearly species richness since biomonitoring began has ranged from 27–34 species per sampling year. Species richness has seen a notable increase over time in the riverine zone, middle main lake zone, and lower main lake zone (Figure 2.3). The riverine zone had lows of 8 and 9 species captured by electrofishing during 1990 and 1997, respectively (Figure 2.3). However, in later years (i.e., 2005–2015) yearly species richness has exceeded 20 species (Figure 2.3). Gill net species richness in the riverine zone experienced lows of 5, 7, and 4 species captured in 1990, 1997, and 1998, respectively. In 2005 and later surveys, no fewer than 12 species per year were captured with gill nets in the riverine zone. Species richness in the embayment zone has remained relatively consistent over time (Figure 2.3). Additionally, several species were collected during the biomonitoring period for the first time in Cheat Lake. New species collected during the time period from the start of biomonitoring (1990) to the most recent collection (2015) include Banded Darter, Fantail Darter, Greenside Darter, Mimic Shiner, Muskellunge, Popeye Shiner, Spotted Bass, Silver Shiner, Walleye, and White Bass. These were species absent in the historical surveys (1952–1977) and in the original 1990 biomonitoring survey, but that appeared in subsequent years.

*Multivariate Community Analyses*

Fish community data revealed patterns of presence and abundance of particular species lakewide and across lake region. Species captured in Cheat Lake can be generally separated into non-game/forage species (non-sportfish) and sportfish species. Across space and time, the most abundant forage species in Cheat Lake captured by electrofishing (in order of overall abundance) included Emerald Shiner, Mimic Shiner (*Notropis volucellus*), Brook Silverside (*Labidesthes sicculus*), Logperch (*Percina caprodes*), Golden Redhorse, Silver Shiner, and Gizzard Shad (*Dorosoma cepedianum*) (Appendix 2.1). Emerald Shiner was the most abundant forage species collected lakewide, with a mean electrofishing CPUE of 55.93 fish/hr. (Appendix 2.1). However, there were differences in dominant forage species across lake region. In main lake sites, Emerald Shiner was still the most abundant forage species with a mean electrofishing CPUE of 78.7 fish/hour (Table 2.3). In embayment sites, Brook Silverside was the most abundant forage species collected with a mean electrofishing CPUE of 49.2 fish/hour (Table 2.3). In riverine sites, Mimic Shiner was the most abundant forage species collected with a mean electrofishing CPUE of 94.09 fish/hour (Table 2.3). The most abundant sportfish species captured in Cheat Lake (in order of overall abundance) included Bluegill (*Lepomis macrochirus*), Green Sunfish (*Lepomis cyanellus*), Smallmouth Bass, Largemouth Bass (*Micropterus salmoides*), Pumpkinseed (*Lepomis gibbosus*), Spotted Bass (*Micropterus punctulatus*), Rock Bass (*Ambloplites rupestris*), Yellow Perch, White Bass (*Morone chrysops*), Black Crappie (*Pomoxis nigromaculatus*), Channel Catfish, and Walleye (Appendix 2.1). Bluegill was the most abundant sportfish collected lakewide, with a mean electrofishing CPUE of 66.3 fish/hour (Appendix 2.1). Similar to forage species, there were differences in dominant sportfish species across lake region. Bluegill were also the most abundant sportfish species in both the embayment and main lake sites with mean electrofishing CPUE of 110.48 fish/hour and 73.41 fish/hour, respectively (Table 2.3). In riverine sites, Smallmouth Bass were the most abundant sportfish collected with a mean electrofishing CPUE of 58.19 fish/hour (Table 2.3).

The most abundant species captured by gill nets included Channel Catfish (18.5% of total catch), Gizzard Shad (13.3%), Golden Redhorse (10.7%), White Bass (9.1%), and Yellow Perch (8.0%) (Appendix 2.2). Species relative abundances captured by gill nets varied by lake zone. In the embayment zone the most abundant species captured included Black Crappie (19.4% of catch), Gizzard Shad (16.1%), and Channel Catfish (10.4%). In the main lake, Yellow Perch were the most abundant species captured (14.8%), followed by Brown Bullhead (10.1%), Gizzard Shad (9.4%), and Channel Catfish (9.2%). The strong contribution of Brown Bullhead was heavily skewed by greater abundances in 1990 and 1997. Finally, riverine zone gill net catches were dominated by Channel Catfish (28% of catch), Gizzard Shad (14.7%), Golden

Redhorse (13.9%), and White Bass (13.2%). Complete gill net CPUE information can be found in Appendix 2.2.

Although several species appeared to increase in abundance over time according to gill net CPUE, gill nets were not very effective at consistently capturing most species of fish. However, catfish species within the lake were routinely captured. The two most abundant catfish species within the lake, Channel Catfish and Brown Bullhead, both displayed contrasting changes in abundance over time. Plotted values of gill net CPUE over time illustrate decreasing abundance of Brown Bullhead over time (Figure 2.6). While never extremely abundant during the biomonitoring period, Brown Bullhead were nearly 16 times less abundant in the 2010s (mean CPUE of 0.05 fish/net-night) compared to the 1990s (mean CPUE of 0.79 fish/net-night) (Appendix 2.2; Figure 2.6). Channel Catfish displayed the opposite trend, with plotted values of gill net CPUE suggesting increasing abundance over time (Table 2.7). An average of over 6 times as many Channel Catfish were captured in the 2010s (mean CPUE 2.1 fish/net-night) compared to the 1990s (mean CPUE 0.33 fish/net-night) (Appendix 2.2; Figure 2.6).

Results from NMDS suggest significant spatial and temporal differences in fish community structure of Cheat Lake. Specifically, fish community composition showed significant differences in similarity across lake zones (embayment, lower, middle, and riverine) and across study years (1990–2015) based on electrofishing data. Non-metric multi-dimensional scaling showed visible separation between early electrofishing surveys (1990–2001) and more recent surveys (2005–2015). In general, spatial orientation of sites moves from bottom-left to top-right in NMDS space from early to recent surveys (Figures 2.10). The earliest survey years (1990 and 1997) are especially distant from more recent surveys, possibly indicating large differences in fish communities. Plotting of Pearson correlations of select species in NMDS space revealed trends in abundance of several species over time which likely influenced dissimilarities of fish communities between years. Brown Bullhead was the only species with a visible correlation to early study years, designated by its placement on the far bottom-left of the plot (Figure 2.10). The placement of Brown Bullhead in NMDS space near early sampling years indicates abundance of Brown Bullhead contributed to the dissimilarity between early sampling years and later sampling years. In contrast, a number of sportfish and forage species (Channel Catfish, Emerald Shiner, Gizzard Shad, Green Sunfish, Largemouth Bass, Pumpkinseed, Smallmouth Bass, Spotted Bass, Walleye, White Bass, and Yellow Perch) showed varying degrees of correlation toward more recent study years (Figures 2.10). The orientation of these species in NMDS space suggests that changes in their abundance contributed to differences in fish communities between early study years and later study years.

Although NMDS results suggest significant differences in lake fish communities over time, fish communities were also distinguishable by lake zone in NMDS space. The NMDS results plotted by lake zone show riverine fish communities oriented bottom-right in NMDS space, embayment and lower lake communities oriented top-left in NMDS space, and middle lake communities positioned in between (Figure 2.9). Essentially, NMDS orientation of fish communities in Cheat Lake move in a downstream direction from bottom-right to top-left in NMDS space (Figure 2.9). As with the NMDS results plotted by year, plotting of Pearson correlations of select species in NMDS space revealed trends in abundance of several species by lake zone. Species such as Largemouth Bass, Spotted Bass, Bluegill, Green Sunfish, Brook Silverside, and Gizzard Shad oriented more towards Embayment and Lower Lake zone sites (Figure 2.9). In contrast, species such as White Bass, Walleye, Channel Catfish, Yellow Perch, Smallmouth Bass, Logperch, Emerald Shiner, Mimic Shiner, and Golden Redhorse oriented more toward Riverine zone sites (Figure 2.9). Orientation of certain species towards a specific lake zone suggests that their abundance influenced differences in fish communities between zones. Visible separation of samples by both year and lake zone suggests that both factors influenced NMDS orientation of samples.

Supporting the NMDS results, multivariate GLM (mvabund) results indicated significant differences in fish community composition by year and lake zone from electrofishing data (Table 2.6). Univariate tests indicated that eighteen species significantly influenced the observed changes in fish communities across space and/or time (Table 2.6). Fourteen species significantly influenced differences in fish communities over time (Table 2.6). Smallmouth Bass contributed the most to differences in fish communities over time, accounting for over 20% of the observed deviance (Table 2.6). Supporting this, Smallmouth Bass mean CPUE was over 13 times higher from 2011–2015 compared to mean CPUE in the 1990s (Table 2.3; Figure 2.5). Largemouth Bass (17%), Bluegill (12.5%), Smallmouth Bass (11.7%), and Green Sunfish (10.3%) accounted for the largest percentage of observed deviance across lake region (Table 2.6). Largemouth Bass were most abundant in embayment areas, with mean embayment site CPUE over 20 times higher than mean riverine site CPUE and 1.28 times higher than main lake site CPUE (Table 2.3). Bluegill were also most abundant in embayment areas, with mean embayment site CPUE over 8 times higher than mean riverine site CPUE and 1.33 times higher than mean main lake site CPUE (Table 2.3). Smallmouth Bass were most abundant in riverine areas, with mean riverine site CPUE over 7 times higher than mean embayment site CPUE and 2.62 times higher than mean main lake CPUE (Table 2.3). Green Sunfish were most abundant in main lake sites, with mean main lake site CPUE over 21 times higher than mean riverine site CPUE and 1.26 times higher than mean embayment site CPUE (Table 2.3).

Multivariate GLM results also suggested a significant interactive effect between lake zone and year on fish community structure changes (Table. 2.6). Specifically, five species significantly contributed to fish community changes when considering time and lake zone together (Table 2.6). These species and their contribution to percent deviance included Black Crappie (14.8%), Green Sunfish (9.8%), Smallmouth Bass (9.2%), Largemouth Bass (8.6%), and Yellow Perch (8.5%) (Table 2.6). This indicates that abundance of these species did not change equally across lake region. For instance, although Black Crappie abundance increased in each lake region over time, these changes were most notable in the main lake zone. Black Crappie abundance was negligible in this zone in the 1990s (mean main lake CPUE of 0.06 fish/hour) but increased substantially by the 2011–2015 time period (mean main lake CPUE of 11 fish/hour). Likewise, Green Sunfish abundance increased most notably over time in the main lake and embayment zones. Abundance of Green Sunfish was comparably low in these zones in the 1990s (mean embayment CPUE of 4.11 fish/hour and mean main lake CPUE of 1.61 fish/hour) but increased dramatically by the 2011–2015 time period (mean embayment CPUE of 77.4 fish/hour and mean main lake CPUE of 110 fish/hour). Smallmouth Bass increased in abundance over time in all lake zones, but increases were most substantial in the main lake and riverine zones. Abundance of Smallmouth Bass was comparably low in the 1990s in the main lake zone (mean CPUE of 1.81 fish/hour) and riverine zone (8.56 fish/hour), but increased dramatically by the 2011–2015 time period (mean make lake CPUE of 30 fish/hour and mean riverine CPUE of 68.2 fish/hour). Largemouth Bass continually increased in abundance in both the embayment and main lake zones, but increases were greatest in the main lake zone. Largemouth Bass mean CPUE increased from 4.78 fish/hour in the 1990s to 45.4 fish/hour in the 2011–2015 time period in the main lake zone. Finally, although Yellow Perch abundance did not increase in the embayment zone over time, increases in abundance were substantial in both the main lake and riverine zones. Yellow Perch abundance increased from lows of 1.02 fish/hour mean main lake CPUE and 4 fish/hour mean riverine CPUE in the 1990s to highs of 21.6 fish/hour mean main lake CPUE and 22 fish/hour mean riverine CPUE from 2011-2015.

*Historical vs. Recent Fish Community Structure*

Many new species were collected in the biomonitoring period compared to the historic data period. During the historic data period, only 15 species were collected (Table 2.4). The most abundant species captured were Brown Bullhead (56% mean relative abundance) and White Sucker (26% mean relative abundance) (Table 2.4). No other species comprised on average any more that 7% relative abundance (Table 2.4). Largemouth Bass, Bluegill, Black Crappie, Rock Bass, and Green Sunfish comprised 7%, 4%, 3%, 2%, and 1%, respectively (Table 2.4). All other species captured during this period (Northern Hogsucker (*Hypentelium nigricans*), Channel Catfish, Golden Redhorse, Pumpkinseed, Common Carp (*Cyprinus carpio*), Yellow Bullhead (*Ameiurus natalis*), Logperch, Johnny Darter (*Etheostoma nigrum*)) comprised less than 1% of the catch on average. During the biomonitoring period 44 species were collected (Table 2.3). In contrast to surveys during the historic period, during the biomonitoring period, abundance was more evenly distributed among species (no species comprised more than 10% of the catch, on average). Where Brown Bullhead and White Sucker were quite common from 1952–1977, during the biomonitoring period these two species were quite uncommon (2% and 1% average relative abundance, respectively).

**Discussion**

Due largely to acidic conditions, Cheat Lake once supported only limited aquatic life (Core 1959; WVDNR unpublished data). However, due to improvements in water quality, notably pH, and a reduction in acidic conditions, fish communities within the lake have seen dramatic changes. Specifically, results from this study indicate that fish community structure in Cheat Lake has changed significantly over time since initiation of biomonitoring in 1990. Changes in the fish community coincided with improvements in water quality in the post-SMCRA era. Specifically, increases in overall fish abundance in Cheat Lake and increases in abundance of individual species suggest improved water quality and/or habitat conditions. The pH conditions of Cheat Lake have dramatically improved over time and past studies have shown how acidic conditions can lead to reduction or extirpation of many species (Haines 1981;

Magnuson et al. 1984; Baker et al. 1990; Tremblay and Richard 1993; Schorr and Backer 1996; McCormick and Leino 1999; McClurg et al. 2007). Many species intolerant to low pH (i.e., Smallmouth Bass, Walleye, cyprinids, etc.) have shown substantial increases in abundance in Cheat Lake. In contrast, those species tolerant to acidic conditions that were once dominant (Brown Bullhead, White Sucker), now represent only a small fraction of the fish community. Although fish abundance has increased lakewide, increases have been particularly noticeable in the riverine and main lake zones. These are also areas that have been most impacted by AMD in the past. This is in contrast to the embayments which have been partially buffered from acidification due to clean water inputs from incoming tributaries. Therefore, it is expected that the riverine and main lake areas would experience the greatest improvement in water quality over time. These changes in the fish community have been possible due to more favorable conditions resulting from acid mine drainage treatment within the Cheat River watershed. However, much of the observed improvements in water quality are dependent on continuous treatment of acid mine drainage within the watershed. Interruptions or discontinuation of water treatment would almost certainly result in increased acidic conditions and the return of impaired fish communities.

Statistical results provide supporting evidence that Cheat Lake fish populations have changed positively over time. Statistical results showed that early fish surveys (1990–2001) supported higher abundances of tolerant bullhead species and lower abundances of other sportfish and forage species. Over time, fish communities have seen increases in important sportfish and forage species, and thus fish communities from recent surveys (2005–2015) are significantly different than fish communities from early surveys (1990–2001). Many species have significantly increased in abundance since biomonitoring began. Based on multivariate generalized linear model analysis of electrofishing catch data, the following species significantly contributed to changes in fish community structure through increases in abundance:

Smallmouth Bass, Green Sunfish, White Bass, Spotted Bass, Channel Catfish, Gizzard Shad, Rock Bass, Emerald Shiner, Yellow Perch, Pumpkinseed, Silver Shiner, Largemouth Bass, Black Crappie, and Walleye. Additionally, gill net data suggest that Channel Catfish have significantly increased in abundance while Brown Bullhead have significantly decreased.

Continuing improvements to the fishery resources of Cheat Lake are likely at least partly a result of improvements in water quality in the Cheat River watershed. Improvements in water quality are the result of AMD abatement projects in the Cheat River watershed upstream of Cheat Lake (McClurg et al. 2007). Several species that have increased in abundance are known to be particularly sensitive to acidic conditions. In particular, species such as Walleye, Smallmouth Bass, Emerald Shiner, and Silver Shiner are known to be sensitive to acidification (Butler et al. 1973; Beamish et al. 1975; Hulsman et al. 1983; Kelso 1988) and are thus good indicators of improved water quality conditions. Smallmouth Bass are known to be one of the first species to be lost when acidification occurs (Beamish et al. 1975), therefore their changes in abundance provide a particularly good indication of the improvements that have occurred. Smallmouth Bass were entirely absent from historic fish surveys in Cheat Lake (1952–1977), and abundance was low (2.97 fish/hr.) in early biomonitoring surveys (1990–2001). However, abundance increased substantially (38.5 fish/hr.) in later surveys (2005–2015).

Increase in Walleye abundance can be partially attributed to the continuance of the WVDNR stocking program. Stocking of Walleye fingerlings in Cheat Lake has provided critical supplementation to the limited natural reproduction. However, Walleyes have likely benefited from increases in spring pH as Walleye eggs and larvae are sensitive to acidic conditions (Hulsman et al. 1983). Thus, increases in pH have likely benefited natural recruitment of Walleye in Cheat Lake. Capture of young of year Walleyes in recent years in which stocking did not occur or was limited indicates increased success of natural reproduction. Increases in natural reproduction have likely benefited from stocking success which has helped increase the spawning population of Walleyes in Cheat Lake.

Some species have been documented as tolerating acidic conditions better than other fish, yet they have also seen increases in abundance in Cheat Lake. In particular, Yellow Perch, Pumpkinseed, and Rock Bass have in some studies been noted as moderately tolerant of acidic conditions (Wales and Beggs 1986; Schofield and Driscoll 1987; Tremblay and Richard 1993). However, for Rock Bass other studies have suggested this species to be sensitive to acidification (Schofield and Driscoll 1987). Even Yellow Perch and Pumpkinseed which have been suggested to be moderately tolerant have been documented to be extirpated by acidification (Magnuson et al. 1984). These species could be indirectly benefiting from reduced acidification via increases in lake productivity, available forage, or habitat changes (e.g., increased vegetated habitat). Yellow Perch could have benefited from increases in aquatic vegetation habitat which provides essential shelter for juvenile Yellow Perch (Dibble et al. 1996). Two species that are known to be especially tolerant to low pH, Brown Bullhead and White Sucker, have went from dominating the Cheat Lake fish community to being nearly absent from surveys. Whereas these species have no competitors in acidic conditions, with improving water quality competition from other more sensitive species likely leads to a reduction in abundance of these tolerant species. Channel Catfish replaced Brown Bullhead as the most dominant catfish species in Cheat Lake following improved water quality. Likewise, Golden Redhorse have replaced White Sucker as the most dominant sucker species. Both Channel Catfish and Golden Redhorse are more sensitive to acidic conditions than Brown Bullhead and White Sucker, but with good water quality these species have successfully replaced their tolerant counterparts.

In addition to fish abundance, species richness has also significantly increased over time. Specifically, from 1952–1977, only 15 species were captured. Since 1990, a total of 44 species have been captured. Species richness has also increased since biomonitoring began in

1990. However, increases in species richness have not changed equivalently across lake zones. Specifically, increases in species richness have been greater in riverine and main lake zones, compared to the embayment zone. When looking at graphical results, it is apparent that although species richness has steadily increased over time in riverine and main lake zones, species richness in the embayments has remained relatively stable. This could be due in part to the embayments experiencing some sheltering from acidic conditions due to clean water inputs from incoming tributaries.

Better water quality in the embayments has been apparent over time with these areas consistently experiencing higher pH than the main lake and riverine areas. Annual mean and minimum pH has been higher in embayment areas than in main lake and riverine zones for most of the existence of Cheat Lake. It was not until recent years that pH in these areas became comparable. The embayments (Morgans Run and Rubles Run) both are fed by tributaries with good water quality. These AMD free tributaries likely help buffer the embayment areas from the lower pH values experienced in the riverine and main lake zones. Increases in richness over time with improving pH conditions are not surprising, given that many species of fish were at one time extirpated from Cheat Lake.

Other studies have also documented the disappearance of species from acidified waters (Beamish et al. 1975; Beamish 1976; Magnuson et al. 1984; Schofield and Driscoll 1987; Mills et al. 2000; Schorr and Backer 2006) and some studies have also documented the eventual return of species with improving conditions (Mills et al. 2000; Willams and Turner 2015). Since biomonitoring began, several species were documented for the first time since prior to the 1952 fish survey. Species documented for the first time in recent history include Popeye Shiner (*Notropis ariommus*), Mimic Shiner, Silver Shiner, Emerald Shiner, White Bass, Walleye, Muskellunge (*Esox masquinongy*), Greenside Darter (*Etheostoma blennioides*), and Banded Darter (*Etheostoma zonale*). Some of these species may have been introduced by anglers, while others may have emigrated into Cheat Lake from clean water refuges (i.e., tributaries). Regardless of the source, the occurrence of these species provides further indication of improved water quality.

Although increases in pH and improvements in water quality over time are likely the main contributing factor to observed changes in fish community composition, there are possible indirect effects from water quality improvements that have likely benefited Cheat Lake fisheries. Most notably, increases in productivity and forage as a result of pH increases have likely contributed to changes in fish community composition and fish abundance. Many man-made reservoirs undergo a “trophic upsurge” for several years after construction as a result of released nutrients (Miranda and Bettoli 2010). As a result of this trophic upsurge there are often dramatic increases in animal biomass and growth within reservoirs (Miranda and Bettoli 2010; Turgeon et al. 2016). For most of its existence, productivity of Cheat Lake was dramatically limited due to acidic conditions (Core 1959; Volkmar 1972; Janicki 1980). Studies on phytoplankton and zooplankton communities of Cheat Lake during the 1970s when acidic conditions were prevalent suggested extremely simple communities indicative of artificially oligotrophic conditions (Volkmar 1972; Janicki 1980). With treatment of mine drainage and increases in pH within Cheat Lake, productivity as a result has increased resulting in what could be viewed as a delayed trophic upsurge. Additionally, acidification has been shown to depress or hinder growth of many aquatic plants (Gorham and Gordon 1963; Roberts et al. 1985; Jackson and Charles 1988). The ability for a greater diversity of plants to grow and be available as habitat is another potential pathway for changes in fish community structure. Also, improvements in water quality have likely led to increases in available macroinvertebrates which serve as important forage to fishes (Mills and Schindler 1986). Increased productivity and other secondary impacts of improved water quality has important effects throughout the food chain (zooplankton, macroinvertebrates, forage fish) and abiotic habitat (aquatic vegetation). Thus, this increase in productivity and subsequent effects has likely contributed to the dramatic increase in fish abundance and fish growth in recent years in Cheat Lake.

In addition to water quality as a driver of fish community changes, stability of water level management since biomonitoring began has also likely benefited the fisheries of Cheat Lake. Beginning in 1994, lake level fluctuations were restricted to 2.1 m (7 ft.) in April with the intent to benefit Walleye and Yellow Perch spawning. Also, lake level fluctuations were restricted to 0.6 m (2 ft) from May–October to accommodate recreational use of the lake and to benefit spawning of other fishes such as Centrarchids. Cheat Lake does not see the drastic swings in lake levels that many other West Virginia reservoirs experience as most other West Virginia reservoirs are intended for flood control purposes. These relatively stable water levels have potentially contributed to improved natural reproduction of some species. Other studies have identified lake levels as important drivers in recruitment and year class strength of multiple species (Martin et al. 1981; Miranda et al. 1984; Noble 1986; Kallemeyn 1989; Jude 1992; Reinart et al. 1997; Sammons and Bettoli 2000). Species in these studies (Largemouth Bass, Spotted Bass, Black Crappie, White Crappie, White Bass, Yellow Perch, Buffalo, Walleye) generally responded to stable or high water levels with increased recruitment and year class strength (Martin et al. 1981; Miranda et al. 1984; Noble 1986; Kallemeyn 1989; Jude 1992; Reinart et al. 1997; Sammons and Bettoli 2000). In contrast, years with low water levels usually correlated with poor recruitment and low year class strength (Martin et al. 1981; Miranda et al. 1984; Noble 1986; Kallemeyn 1989; Jude 1992; Reinart et al. 1997; Sammons and Bettoli 2000). High water levels provide access to more littoral habitat which in turn provides greater area for spawning, juvenile fish foraging, and shelter for young fish (Sammons and Bettoli 2000). Limiting water level fluctuations in Cheat Lake to 0.6m from May–October likely benefits some species, particularly those that spawn during this time period. However, the current Cheat Lake water level fluctuation rules for winter months and April still allow for the possibility of impacts to spawning of some fishes, particularly Walleye and Yellow Perch. During Cheat Lake Walleye stocking assessment surveys in early spring (March/April), Yellow Perch eggs have often been seen dewatered after spawning occurred and lake levels were dropped (WVDNR unpublished data). Additionally, other work on Cheat Lake Walleyes (see Chapter 5) has suggested that Walleyes spawn in relatively shallow water near the head of the lake and the potential exists for egg dewatering to occur for this species as well.

In addition to significant temporal changes, our results suggest that Cheat Lake fish communities are also inherently different spatially. Fish community composition was significantly different across lake zones suggesting fish communities in different areas of Cheat Lake are significantly different from one another. These spatial differences are likely the result of differences in habitat of these zones and typically followed an upstream to downstream longitudinal gradient from riverine habitat to lacustrine habitat. For instance, the riverine zone has characteristics more closely resembling lotic (pronounced flow, rockier habitat, little to no thermal stratification, etc.) environments compared to the other zones of Cheat Lake. In contrast, the embayment and main lake zones have characteristics more indicative of lentic habitat (limited flow, deeper water, soft sediment bottom, thermal stratification, etc.). Correlated with these habitat differences by reservoir zone, fish communities also varied by reservoir zone. These longitudinal differences in fish communities have been documented in other studies (Beamesderfer and Rieman 1991; Agostinho et al. 1999; Michaletz and Gale 1999; Gido et al. 2002; De Oliveira et al. 2005; Miranda and Bettoli 2010). In other studies, species typically associated with riverine zones favor flowing water and harder substrates for a portion of their life history (Miranda and Bettoli 2010). Species associated with lacustrine zones are typically lake adapted species that may be more pelagic or better adapted to areas with little flow and soft sediment (Miranda and Bettoli 2010). In our study, species with significantly greater abundance within the riverine zone included Smallmouth Bass, Mimic Shiner, Golden Redhorse, and Rock

Bass. Except for Mimic Shiner, these species are those typically associated with lotic habitats in other systems (Lee 1980; Jenkins and Burkhead 1994). Although Mimic Shiner were more abundant in the riverine zone within Cheat Lake, other studies have suggested they prefer vegetated, lentic habitats (Willis and Magnuson 2000). Species significantly more abundant in the main lake or embayment zones in our study included Largemouth Bass, Bluegill, Green Sunfish, Pumpkinseed, Black Crappie, and Spotted Bass. These species are those often associated with lentic habitats in other systems (Lee 1980; Jenkins and Burkhead 1994). These stark longitudinal differences in fish community structure has influenced management strategies in other reservoirs (Buynak et al. 1989; Miranda and Bettoli 2010). Alternative management strategies such as stratification of sampling regimes, differences in habitat management, and differences in harvest regulations by zone have been considered or implemented in other systems (Buynak et al. 1989; Miranda and Bettoli 2010). Some of these management strategies have been utilized for Cheat Lake (habitat management considerations by zone, sampling patterns for different species, etc.). Additionally, this information is important for anglers to consider when targeting particular species of fish.

In summary, our results suggest that the fisheries resources of Cheat Lake have drastically improved over time largely due to improved water quality and possibly in part to stable hydrological conditions. Cheat Lake fish communities continue to see increases in abundance of several important sportfish species and the forage species that support these sportfish. This study has also confirmed that fish communities are significantly different across lake zones in Cheat Lake. In particular, fish communities in the riverine zone of Cheat Lake, where conditions are more lotic, are significantly different from main lake and embayment sites that are more lentic. Dominant species in the riverine zone are those that favor lotic conditions such as Smallmouth Bass and Rock Bass, while dominant species in main lake and embayment zones are those that favor lentic conditions such as Largemouth Bass and Bluegill. Cheat Lake at one point was considered a dead fishery by anglers and biologists alike, and fisheries management was not attempted due to the limitations created by poor water quality. Not only have the fisheries of Cheat Lake rebounded with improved water quality, fish communities are in the best condition that they have likely ever been since the creation of the reservoir over 90 years ago. Given the healthy populations of a variety of sportfish, Cheat Lake represents a quality resource for anglers. However, given the fragile nature of AMD mitigation funding and hydrological dynamics with the lake, future monitoring is critical for ensuring the persistence of quality fishery resources within the lake.

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**Table 2.1.** Temporal trends in total catch for electrofishing and gill net surveys in Cheat Lake by region.

| | | Total Catch | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Region | Gear | **1990** | **1997** | **1998** | **2001** | **2005** | **2008** | **2011** | **2012** | **2013** | **2014** | **2015** | **Total** |
| Riverine | Night Boat Electrofishing | 35 | 92 | 93 | 129 | 957 | 270 | 609 | 560 | 295 | 403 | 591 | 4034 |
| | Biomonitoring Gill Nets | 16 | 16 | 24 | 51 | 225 | 211 | 136 | 220 | . | 146 | . | 1045 |
| Main | Night Boat Electrofishing | 432 | 526 | 863 | 830 | 356 | 392 | 521 | 733 | 606 | 841 | 748 | 6848 |
| | Biomonitoring Gill Nets | 78 | 73 | 75 | 55 | 74 | 81 | 52 | 113 | . | 83 | . | 684 |
| Embayments | Night Boat Electrofishing | 591 | 948 | 548 | 1030 | 294 | 313 | 186 | 246 | 369 | 314 | 477 | 5316 |
| | Biomonitoring Gill Nets | 99 | 78 | 26 | 62 | 74 | 32 | 13 | 40 | . | 36 | . | 460 |
| Lake Total | Night Boat Electrofishing | 1058 | 1566 | 1504 | 1989 | 1607 | 975 | 1316 | 1539 | 1270 | 1558 | 1816 | 16198 |
| | Biomonitoring Gill Nets | 193 | 167 | 125 | 168 | 373 | 324 | 201 | 373 | . | 265 | . | 2189 |

**Table 2.2**. Temporal trends in CPUE for electrofishing (fish/hr.) and gill net (fish/net-night) surveys in Cheat Lake by region.

| | | CPUE (fish/hr or fish/net-night) | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Region** | **Gear** | **1990** | **1997** | **1998** | **2001** | **2005** | **2008** | **2011** | **2012** | **2013** | **2014** | **2015** |
| Riverine | Night Boat Electrofishing | 23.3 | 92.0 | 62.0 | 86.0 | 957.0 | 270.0 | 609.0 | 560.0 | 295.0 | 403.0 | 591.0 |
| | Biomonitoring Gill Nets | 2.7 | 4.0 | 4.0 | 8.5 | 18.8 | 17.6 | 11.3 | 18.3 | . | 12.2 | . |
| Main | Night Boat Electrofishing | 96.0 | 175.3 | 143.8 | 138.3 | 356.0 | 392.0 | 521.0 | 733.0 | 606.0 | 841.0 | 748.0 |
| | Biomonitoring Gill Nets | 3.3 | 2.0 | 1.1 | 2.2 | 3.5 | 3.6 | 2.5 | 7.4 | . | 6.0 | . |
| Embayments | Night Boat Electrofishing | 197.0 | 237.0 | 182.7 | 343.3 | 441.0 | 469.5 | 279.0 | 369.0 | 553.5 | 471.0 | 318.0 |
| | Biomonitoring Gill Nets | 8.3 | 9.8 | 2.2 | 5.2 | 9.3 | 4.0 | 1.6 | 5.0 | . | 4.5 | . |
| Lake Total | Night Boat Electrofishing | 117.6 | 182.0 | 143.2 | 189.4 | 602.6 | 365.7 | 493.5 | 577.1 | 476.3 | 584.3 | 681.0 |
| | Biomonitoring Gill Nets | 5.4 | 7.0 | 3.0 | 4.0 | 11.7 | 10.1 | 6.3 | 11.7 | . | 8.3 | . |

**Table 2.3**. Temporal trends in CPUE (fish/hr.) for electrofishing by decade and lake region. Bolded species and values with an asterisk indicate significance in mvabund results. E = Embayment Zone, M = Main Lake Zone (Lower Lake and Middle Lake combined), R = Riverine Zone. 1990s = surveys from 1990, 1997, and 1998; 2000s = surveys from 2001, 2005, and 2008; 2010s = surveys from 2011, 2012, 2013, 2014, and 2015. Standard errors in parentheses.

| Species | 1990s | 2000s | 2010s | E | M | R |
|---|---|---|---|---|---|---|
| Banded Darter | 0.00 (0) | 0.13 (0.11) | 0.00 (0) | 0.00 (0) | 0.09 (0.07) | 0.00 (0) |
| **Black Crappie*** | **0.83 (0.46)*** | **1.19 (0.60)*** | **6.75 (1.22)*** | **4.92 (1.03)*** | **5.20 (1.16)*** | **1.00 (0.49)*** |
| **Bluegill*** | 46.20 (6.56) | 73.51 (9.68) | 77.78 (10.78) | **110.52 (10.46)*** | **82.92 (9.36)*** | **13.33 (3.98)*** |
| Bluntnose Minnow | 4.82 (1.40) | 7.32 (2.83) | 6.23 (1.83) | 7.87 (1.57) | 7.16 (2.30) | 2.91 (1.62) |
| Brook Silverside | 26.51 (6.14) | 39.65 (12.89) | 30.53 (5.58) | 49.20 (7.70) | 27.78 (4.74) | 21.00 (12.64) |
| Brown Bullhead | 0.65 (0.25) | 0.16 (0.12) | 0.38 (0.19) | 0.03 (0.04) | 0.42 (0.14) | 0.88 (0.33) |
| Creek Chub | 0.06 (0.08) | 0.00 (0) | 0.00 (0) | 0.06 (0.08) | 0.00 (0) | 0.00 (0) |
| **Channel Catfish*** | **0.15 (0.09)*** | **1.79 (0.55)*** | **5.03 (1.12)*** | 0.47 (0.21) | 1.79 (0.38) | 5.39 (1.63) |
| Common Carp | 0.13 (0.09) | 0.38 (0.19) | 2.55 (0.66) | 0.41 (0.20) | 1.85 (0.49) | 1.27 (0.79) |
| **Emerald Shiner*** | **17.91 (5.89)*** | **5.16 (1.18)*** | **109.20 (26.03)*** | 24.08 (9.27) | 78.70 (25.06) | 52.15 (13.17) |
| Fantail Darter | 0.11 (0.12) | 0.00 (0) | 0.00 (0) | 0.09 (0.12) | 0.00 (0) | 0.00 (0) |
| Flathead Catfish | 0.06 (0.04) | 0.00 (0) | 0.00 (0) | 0.00 (0) | 0.03 (0.02) | 0.00 (0) |
| Freshwater Drum | 0.03 (0.04) | 0.13 (0.11) | 0.00 (0) | 0.16 (0.12) | 0.00 (0) | 0.00 (0) |
| **Gizzard Shad*** | **0.72 (0.32)*** | **1.57 (0.50)*** | **9.83 (1.96)*** | 4.42 (1.05) | 8.19 (1.89) | 2.73 (0.90) |
| **Golden Redhorse*** | 3.47 (1.00) | 9.49 (2.16) | 8.40 (1.42) | **2.42 (0.90)*** | **5.30 (1.23)*** | **12.15 (2.17)*** |
| Golden Shiner | 0.09 (0.07) | 0.03 (0.04) | 0.90 (0.30) | 0.45 (0.27) | 0.49 (0.22) | 0.36 (0.22) |
| Greenside Darter | 0.00 (0) | 0.16 (0.12) | 0.15 (0.15) | 0.00 (0) | 0.29 (0.17) | 0.00 (0) |
| **Green Sunfish*** | **2.24 (0.61)*** | **31.89 (4.67)*** | **62.03 (12.13)*** | **50.11 (7.49)*** | **62.89 (11.72)*** | **2.88 (0.68)*** |
| Hybrid Sunfish | 0.16 (0.10) | 0.82 (0.37) | 0.60 (0.20) | 1.00 (0.49) | 0.54 (0.17) | 0.18 (0.16) |
| Johnny Darter | 0.54 (0.22) | 0.82 (0.23) | 1.20 (0.29) | 1.10 (0.28) | 1.00 (0.26) | 0.64 (0.26) |

| | | | | | | |
|---|---|---|---|---|---|---|
| **Largemouth Bass*** | **8.26 (1.50)*** | **11.88 (1.97)*** | **30.15 (3.73)*** | **33.29 (3.48)*** | **25.94 (3.22)*** | **1.64 (0.50)*** |
| **Logperch*** | 15.52 (5.09) | 44.25 (5.14) | 31.64 (5.26) | **37.04 (5.43)*** | **21.36 (2.58)*** | **33.64 (8.14)*** |
| **Mimic Shiner*** | 0.06 (0.04) | 70.80 (25.73) | 39.08 (16.97) | **1.39 (0.65)*** | **5.18 (2.96)*** | **94.09 (34.26)*** |
| Muskellunge | 0.00 (0) | 0.00 (0) | 0.23 (0.17) | 0.14 (0.12) | 0.18 (0.15) | 0.00 (0) |
| Northern Hogsucker | 0.88 (0.27) | 0.60 (0.28) | 0.30 (0.18) | 0.39 (0.20) | 0.78 (0.26) | 0.36 (0.17) |
| Popeye Shiner | 0.00 (0) | 1.25 (0.51) | 0.00 (0) | 0.00 (0) | 0.00 (0) | 0.91 (0.51) |
| **Pumpkinseed*** | **5.03 (1.01)*** | **7.10 (2.24)*** | **24.83 (5.49)*** | **3.46 (0.67)*** | **27.12 (4.94)*** | **8.94 (4.30)*** |
| Rainbow Darter | 0.07 (0.05) | 0.41 (0.16) | 0.45 (0.18) | 0.77 (0.23) | 0.27 (0.13) | 0.09 (0.11) |
| River Chub | 0.04 (0.04) | 0.41 (0.25) | 0.15 (0.10) | 0.00 (0) | 0.04 (0.03) | 0.45 (0.29) |
| **Rock Bass*** | **3.19 (0.76)*** | **11.85 (1.73)*** | **14.55 (2.28)*** | **6.10 (1.10)*** | **5.43 (0.68)*** | **19.42 (3.25)*** |
| **Silver Shiner*** | **0.00 (0)*** | **4.01 (1.01)*** | **9.38 (3.12)*** | 13.02 (4.54) | 3.58 (1.32) | 2.24 (0.86) |
| **Smallmouth Bass*** | **2.90 (0.75)*** | **27.80 (6.06)*** | **39.30 (3.90)*** | **6.38 (0.96)*** | **18.46 (2.26)*** | **48.33 (6.62)*** |
| Spotfin Shiner | 0.29 (0.14) | 5.01 (1.01) | 1.05 (0.56) | 0.31 (0.17) | 2.26 (0.66) | 2.61 (0.90) |
| **Spotted Bass*** | **1.98 (1.14)*** | **16.99 (1.97)*** | **18.45 (1.81)*** | **20.91 (2.26)*** | **14.86 (1.88)*** | **7.12 (1.28)*** |
| **Walleye*** | **0.00 (0)*** | **1.54 (0.68)*** | **2.93 (0.69)*** | 0.67 (0.32) | 1.92 (0.49) | 2.30 (0.97) |
| **White Bass*** | **0.16 (0.13)*** | **1.13 (0.45)*** | **9.00 (1.83)*** | 0.82 (0.32) | 5.88 (1.29) | 5.42 (2.15) |
| White Sucker | 0.10 (0.12) | 0.00 (0) | 0.08 (0.07) | 0.00 (0) | 0.14 (0.10) | 0.00 (0) |
| Yellow Bullhead | 1.04 (0.22) | 2.22 (0.46) | 1.80 (0.39) | 0.93 (0.33) | 2.25 (0.35) | 1.67 (0.46) |
| **Yellow Perch*** | **2.70 (0.87)*** | **4.48 (1.18)*** | **17.63 (2.80)*** | 4.06 (1.07) | 11.41 (2.37) | 12.73 (2.81) |

**Table 2.4.** Mean relative abundance of species captured from 1952–1977.

| Species | Relative Abundance (% catch) |
|---|---|
| Brown Bullhead | 56% |
| White Sucker | 26% |
| Largemouth Bass | 7% |
| Bluegill | 4% |
| Black Crappie | 3% |
| Rock Bass | 2% |
| Green Sunfish | 1% |
| Northern Hogsucker | 1% |
| Channel Catfish | <1% |
| Golden Redhorse | <1% |
| Pumpkinseed | <1% |
| Common Carp | <1% |
| Yellow Bullhead | <1% |
| Logperch | <1% |
| Johnny Darter | <1% |

**Table 2.5**. Analysis of deviance and variance table from generalized linear mixed model analyses for overall fish abundance and species richness. Asterisk * indicates statistical significance at α = 0.05.

| | Large Fish Abundance (CPUE) | | Species Richness | |
|---|---|---|---|---|
| | Chi-square | p-value | Chi-square | p-value |
| Year | 15.374 | <0.001* | 0.0122 | <0.726 |
| Region | 20.542 | <0.001* | 13.322 | <0.01* |
| Year*Region | 20.411 | <0.001* | 13.286 | <0.01* |

**Table 2.6**. Results of mvabund analysis of fish community composition changes. Species with significant contribution to the parameter deviance are listed with percent contribution provided in parentheses. Asterisk * indicates statistical significance at $\alpha = 0.05$.

| Parameter | Residuals DF | DF | Deviance | p-value | Significant Species |
|---|---|---|---|---|---|
| Year | 182 | 1 | 415.7 | 0.001* | Smallmouth Bass (20.2%), Green Sunfish (12.8%), White Bass (8.5%), Spotted Bass (8.2%), Channel Catfish (5.5%), Gizzard Shad (5.0%), Rock Bass (4.9%), Emerald Shiner (4.4%), Yellow Perch (4.2%), Pumpkinseed (4.1%), Silver Shiner (4.0%), Largemouth Bass (3.8%), Black Crappie (2.5%), Walleye (2.4%) |
| Zone | 179 | 3 | 659.5 | 0.002* | Largemouth Bass (17.0%), Bluegill (12.5%), Smallmouth Bass (11.7%), Green Sunfish (10.3%), Mimic Shiner (9.0%), Logperch (5.3%), Golden Redhorse (5.2%), Pumpkinseed (4.9%), Rock Bass (3.4%), Black Crappie (2.9%), Spotted Bass (2.8%) |
| Year*Zone | 176 | 3 | 219.9 | 0.006* | Black Crappie (14.8%), Green Sunfish (9.8%), Smallmouth Bass (9.2%), Largemouth Bass (8.6%), Yellow Perch (8.5%) |

**Figure 2.1.** Biomonitoring sampling locations for Cheat Lake.

**Figure 2.2.** Temporal trends in water quality for main Cheat Lake and embayments (1956 – 2016). Gray bars represent mean annual pH. Black bars overlayed on gray bars represent minimum annual pH. The black line transecting all bars highlights pH of 6.0.

**Figure 2.3.** Temporal trends in species richness by lake zone. Black dots represent mean annual species richness. Standard error bars are given.

**Figure 2.4.** GLMM model predicted values of species richness by lake zone over time (1990–2015). E = Embayment Zone, L = Lower Lake Zone, M = Middle Lake Zone, R = Riverine Zone. Colored lines represent model predicted values of species richness. Colored bands represent 95 % confidence intervals for species richness value predictions.

**Figure 2.5.** Temporal trends in electrofishing CPUE (fish/hr.) by lake zone for large bodied fishes in Cheat Lake (1990 – 2015). Main lake zone = lower lake and middle lake combined. Standard error bars are given.

**Figure 2.6.** GLMM model predicted values of fish abundance (CPUE (fish/hr.)) by lake zone over time (1990–2015). E = Embayment Zone, L = Lower Lake Zone, M = Middle Lake Zone, R = Riverine Zone. Colored lines represent model predicted values of CPUE. Colored bands represent 95 % confidence intervals for CPUE value predictions.

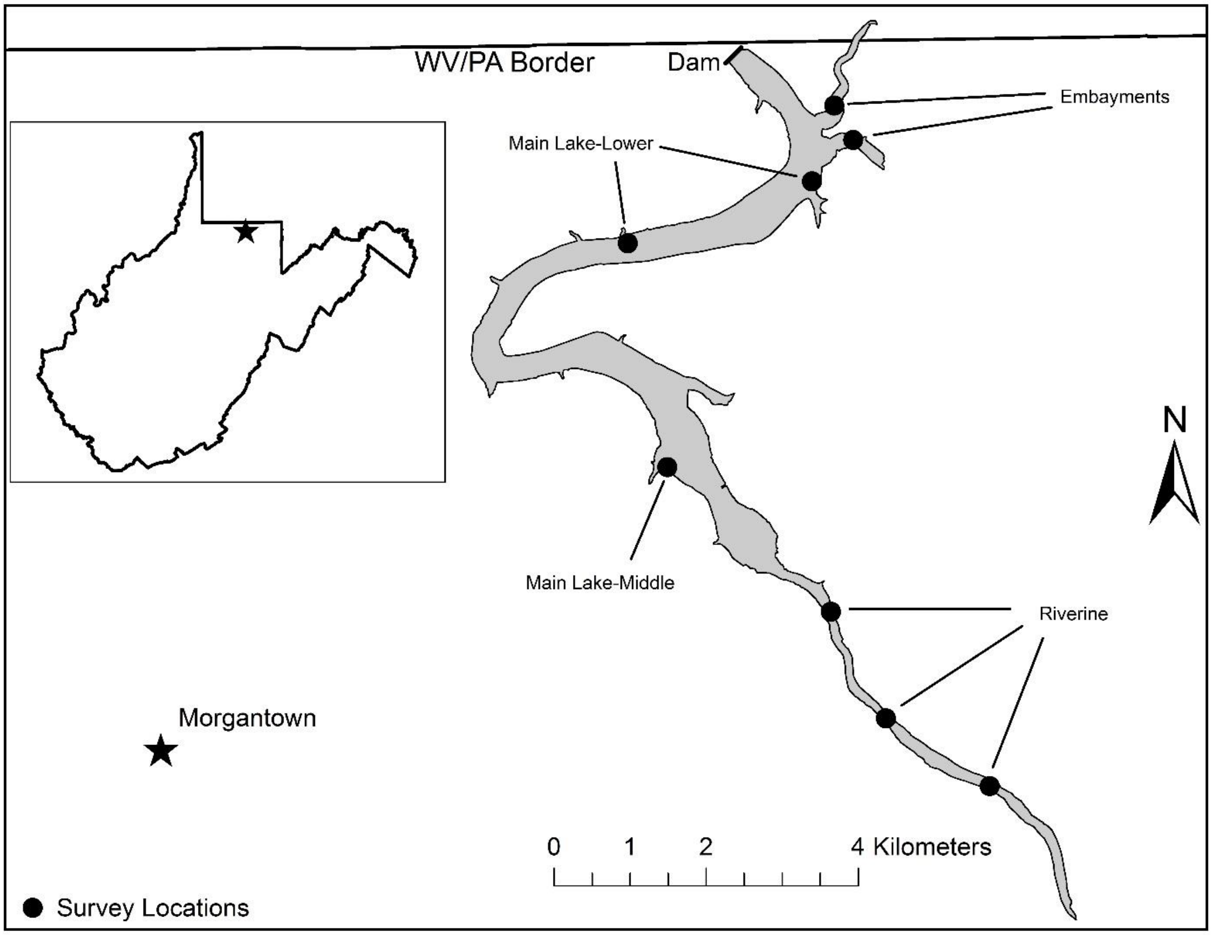
**Figure 2.7.** Temporal trends in electrofishing CPUE (fish/hr.) for Smallmouth Bass in Cheat Lake (1990–2015). Standard error bars are given.

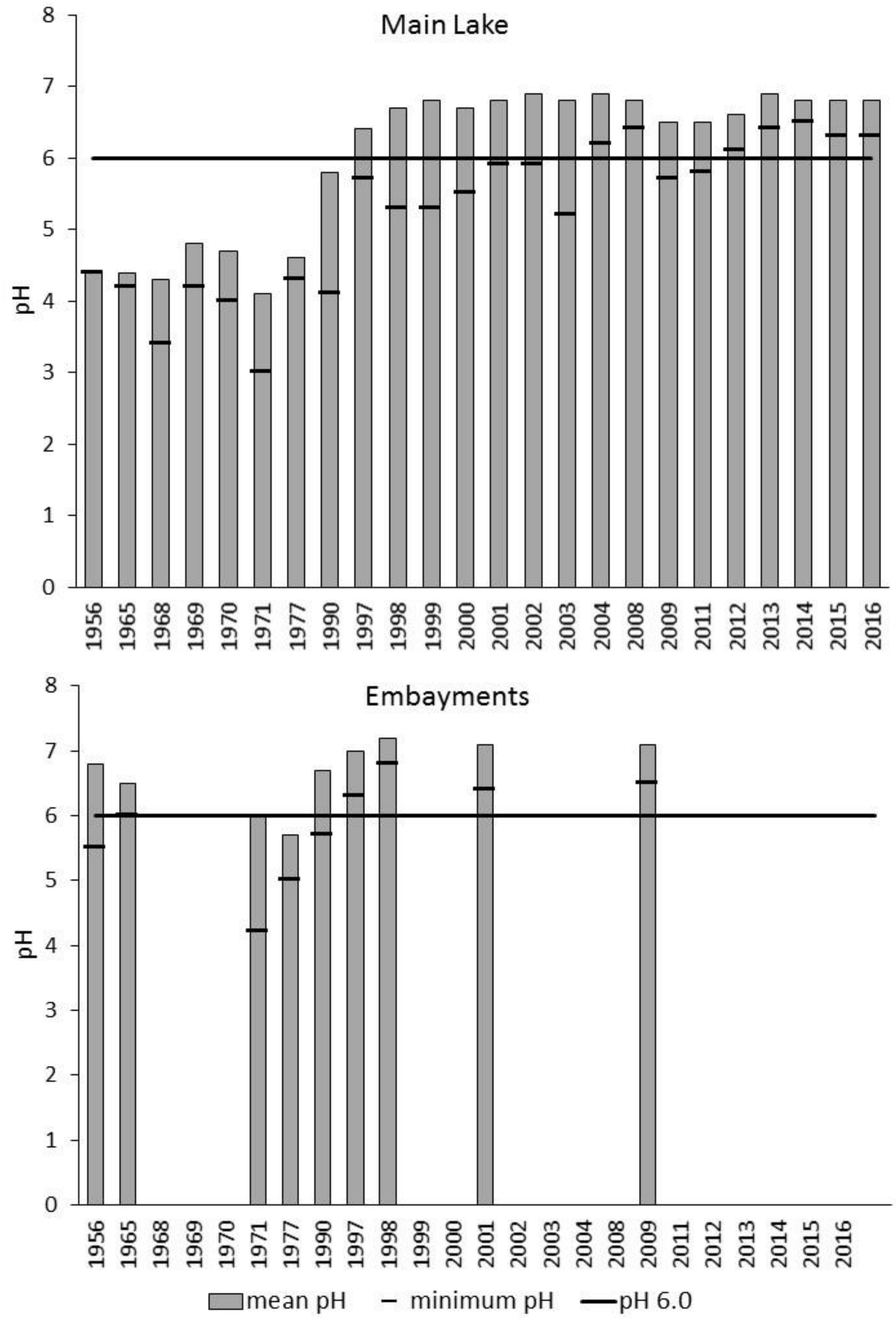
**Figure 2.8.** Temporal trends in gill net CPUE (fish/net-night) for Channel Catfish and Brown Bullhead (1990–2015). Standard error bars are given.

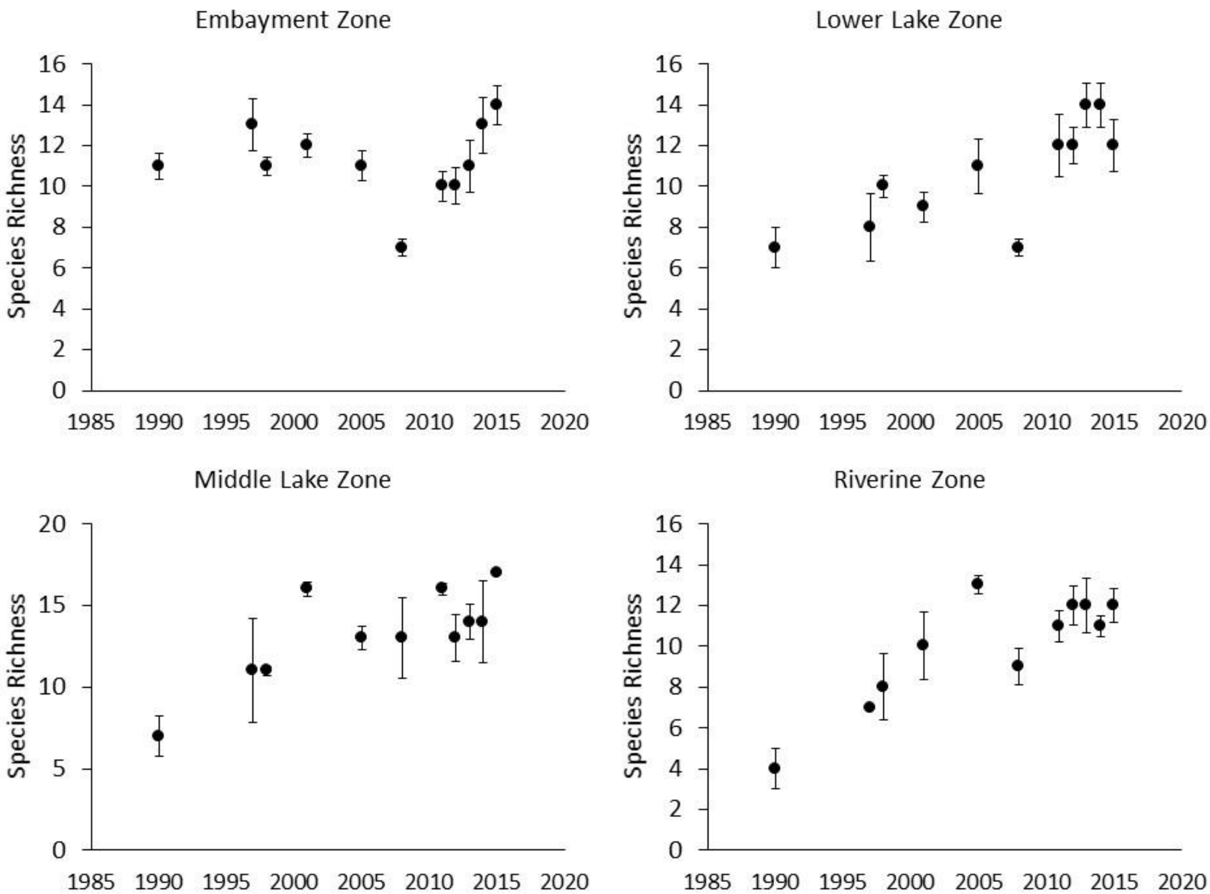
**Figure 2.9.** NMDS results plotted by year using Cheat Lake fish survey presence/absence data from 1952–1977 and 1990–2015.

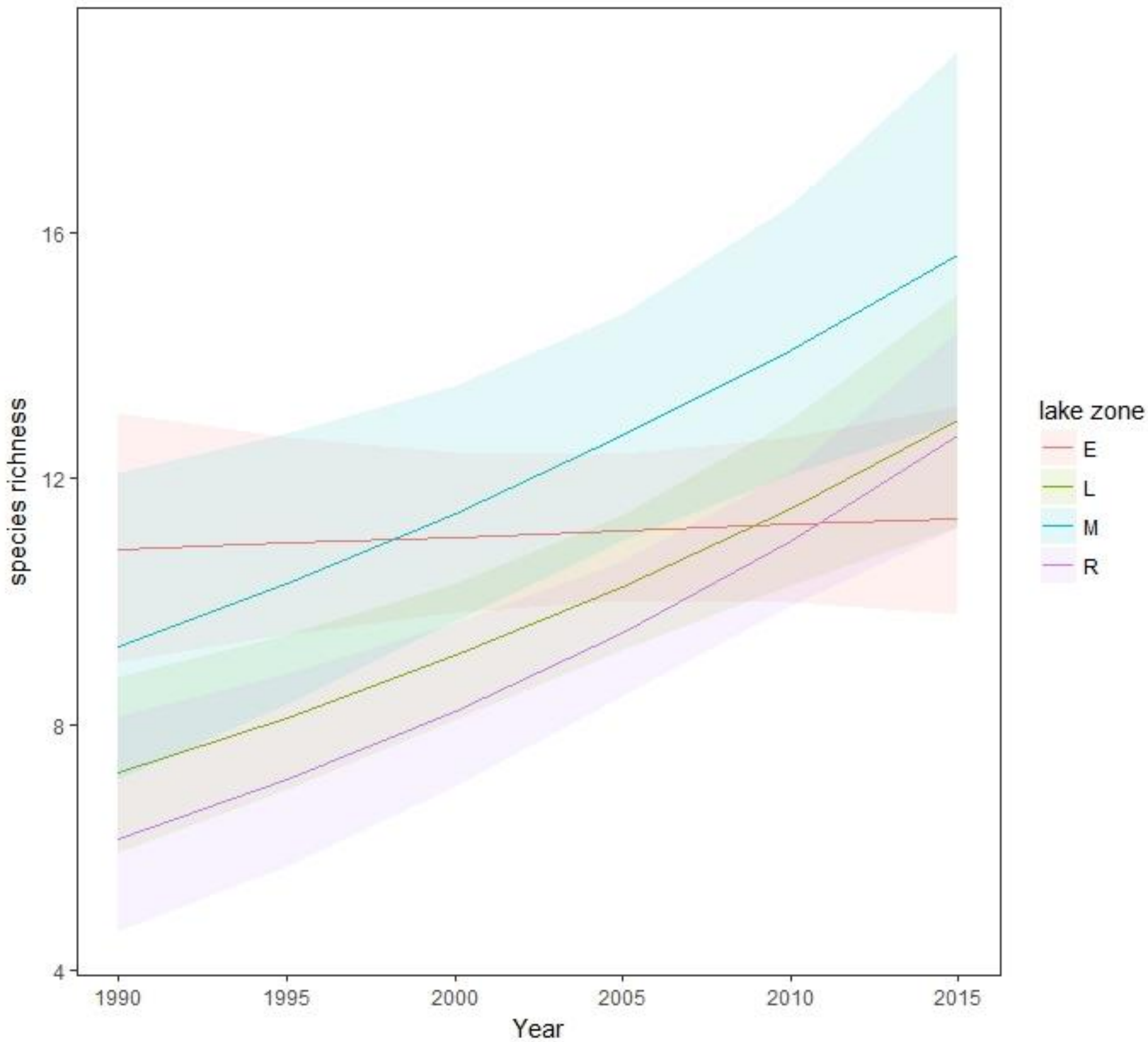
**Figure 2.10.** NMDS results plotted by lake zone (Riverine, Middle Lake, Lower Lake, and Embayments) for electrofishing survey CPUE data (fish/hr.) on Cheat Lake.

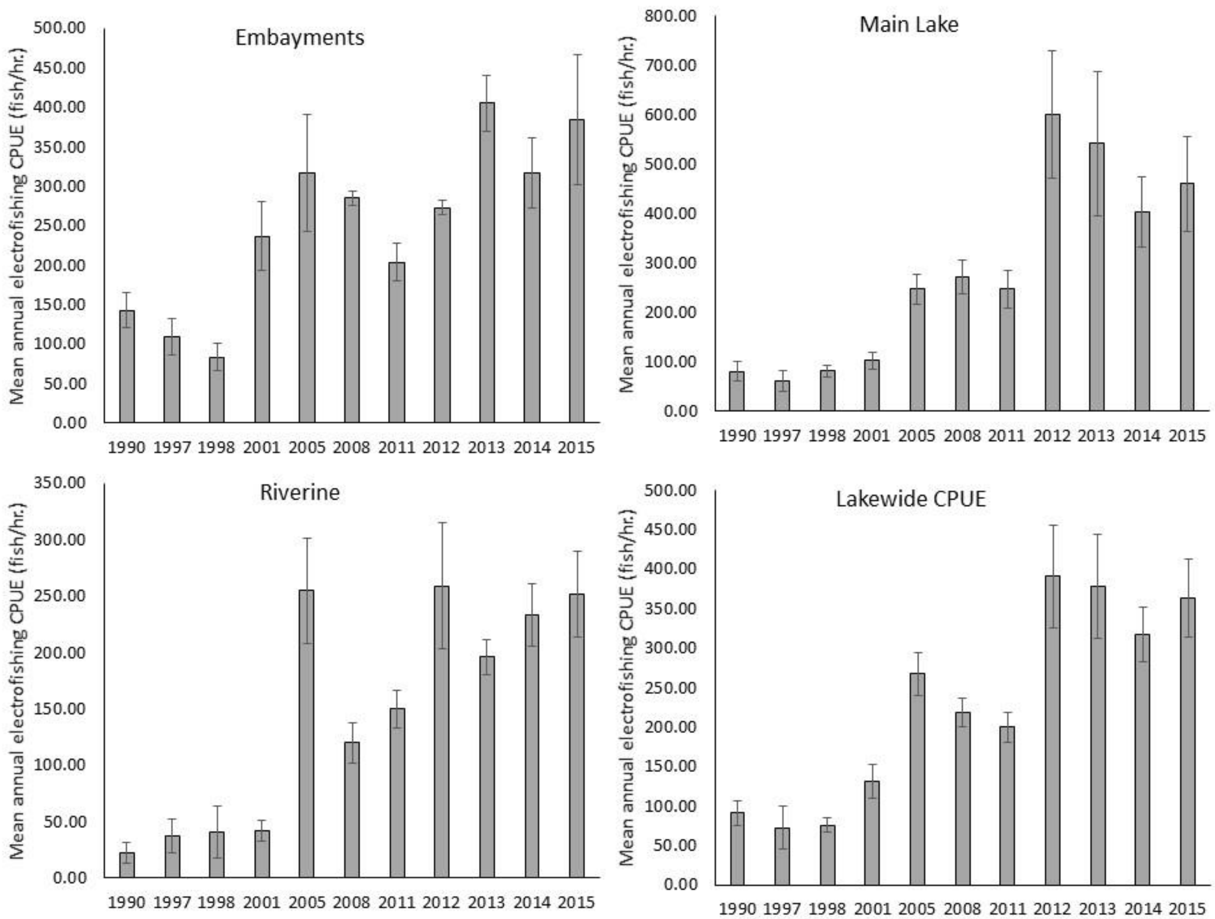
**Figure 2.11.** NMDS results plotted by year (1990–2015) for electrofishing survey CPUE data (fish/hr.) on Cheat Lake.

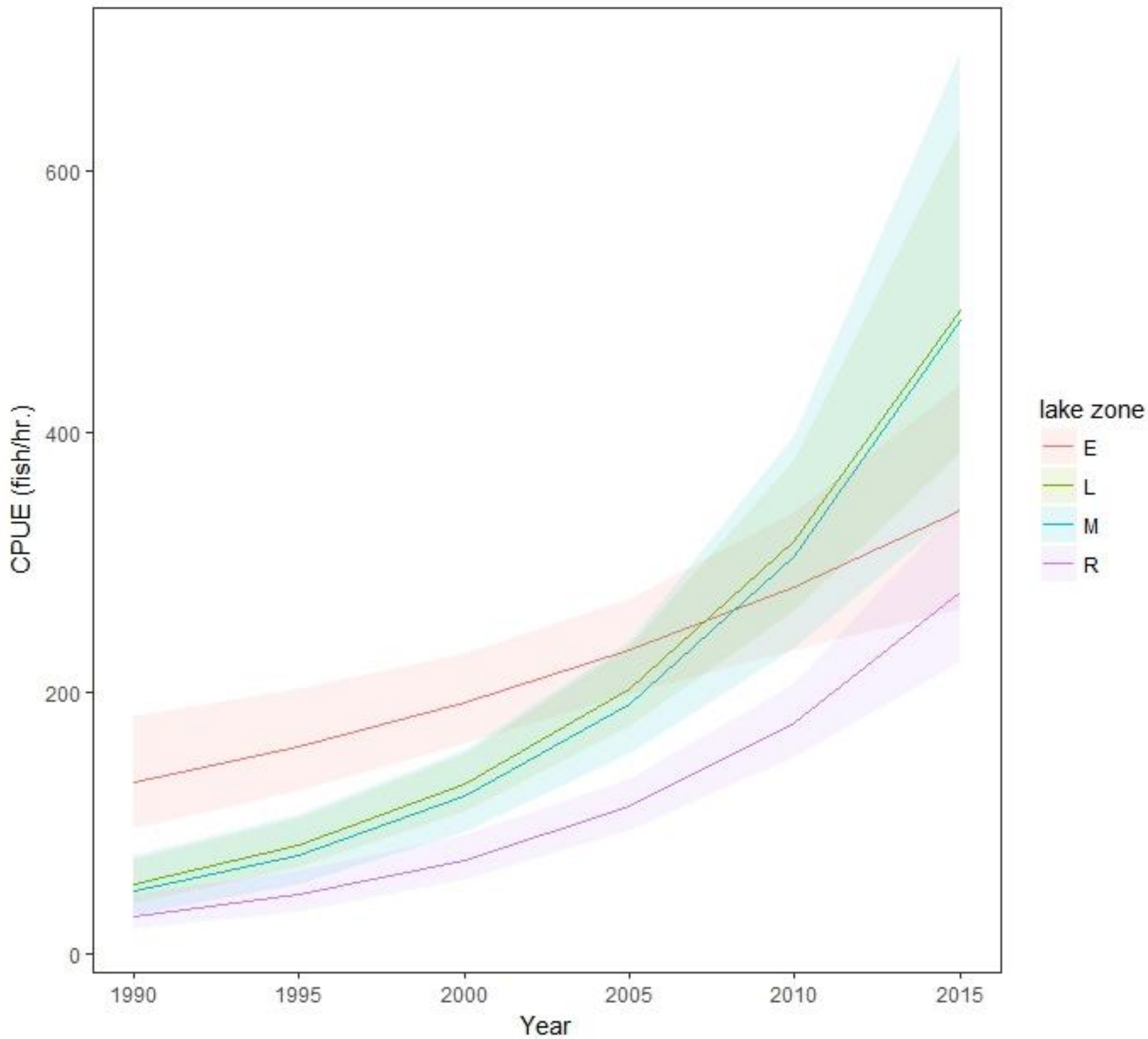

WV/PA Border
Dam
Embayments
Main Lake-Lower
Main Lake-Middle
Riverine
N
Morgantown
0 1 2 4 Kilometers
Survey Locations


Main Lake
pH
8
7
6
5
4
3
2
1
0
1956
1965
1968
1969
1970
1971
1977
1990
1997
1998
1999
2000
2001
2002
2003
2004
2008
2009
2011
2012
2013
2014
2015
2016
Embayments
mean pH
minimum pH
pH 6.0

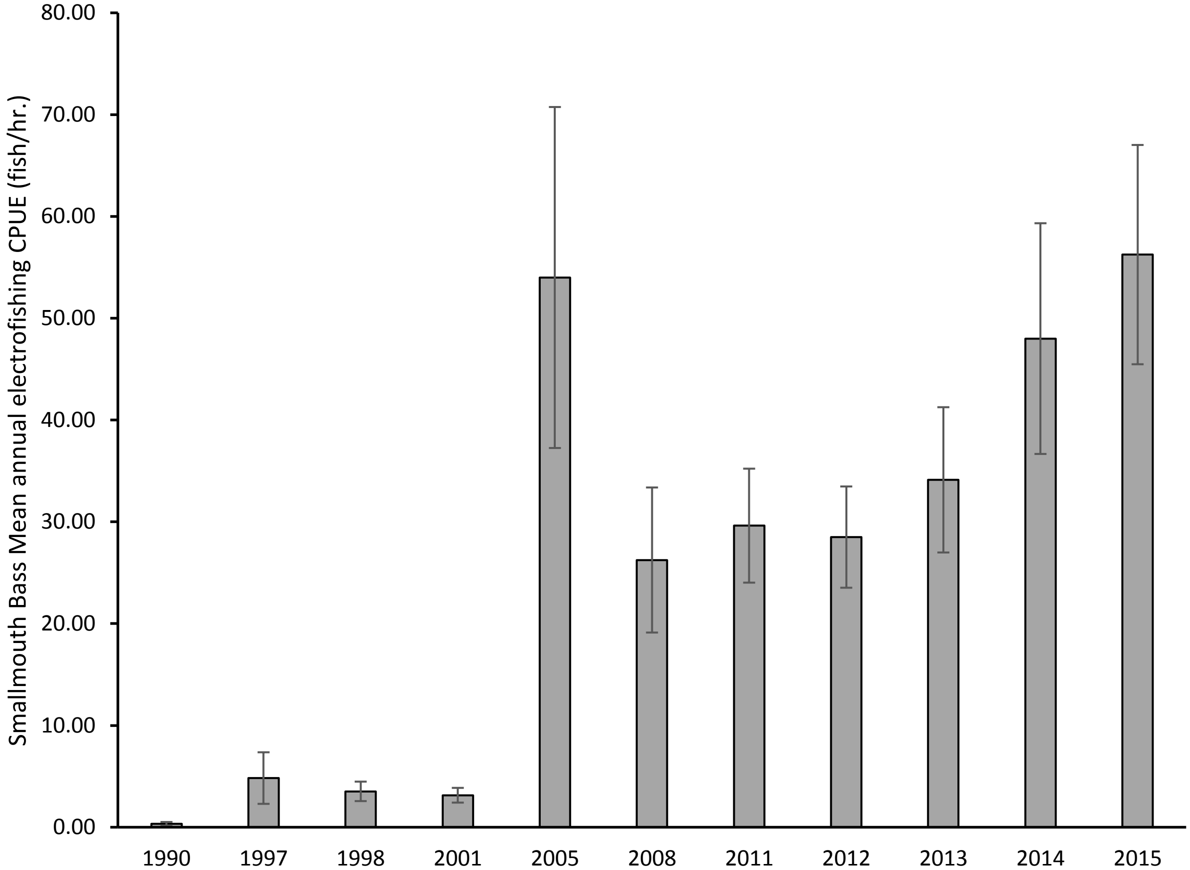

Embayment Zone
Lower Lake Zone
Middle Lake Zone
Riverine Zone
Species Richness
1985 1990 1995 2000 2005 2010 2015 2020


species richness
16
12
8
4
1990
1995
2000
2005
2010
2015
Year
lake zone
E
L
M
R

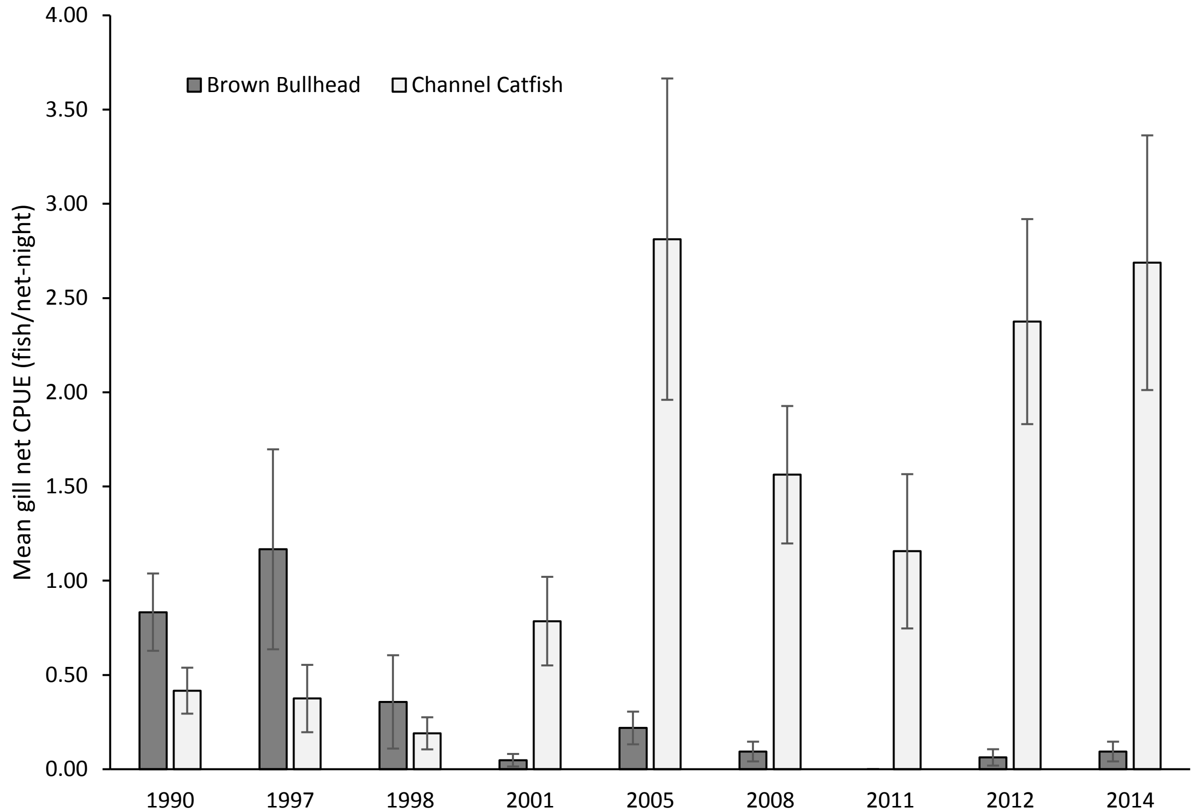

Embayments
Main Lake
Riverine
Lakewide CPUE
Mean annual electrofishing CPUE (fish/hr.)
1990 1997 1998 2001 2005 2008 2011 2012 2013 2014 2015

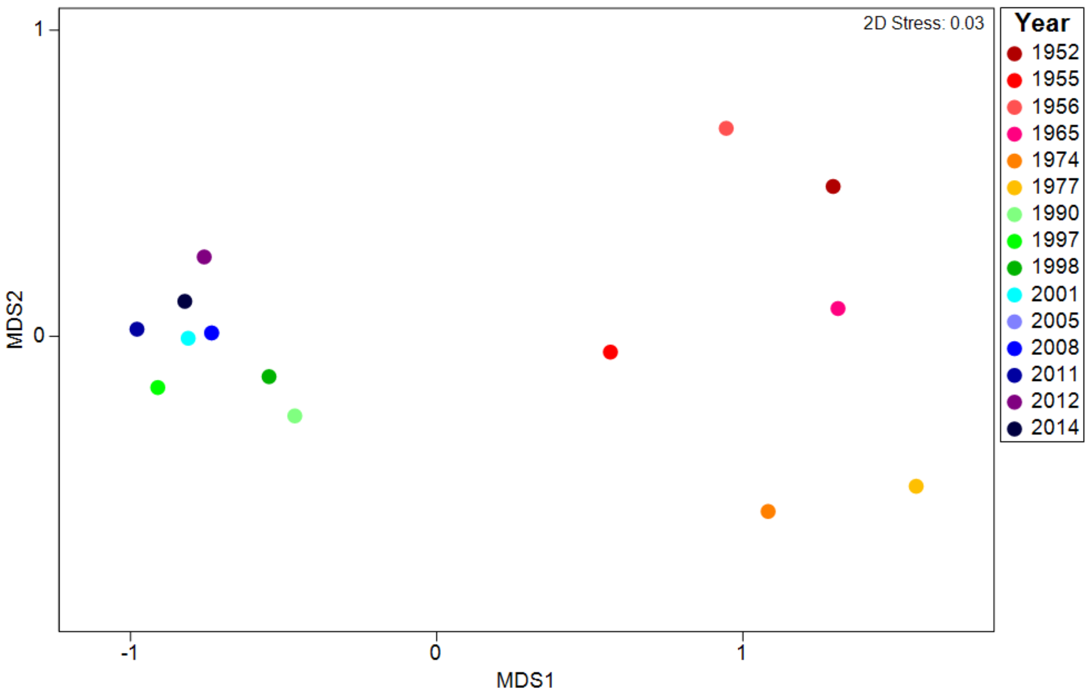


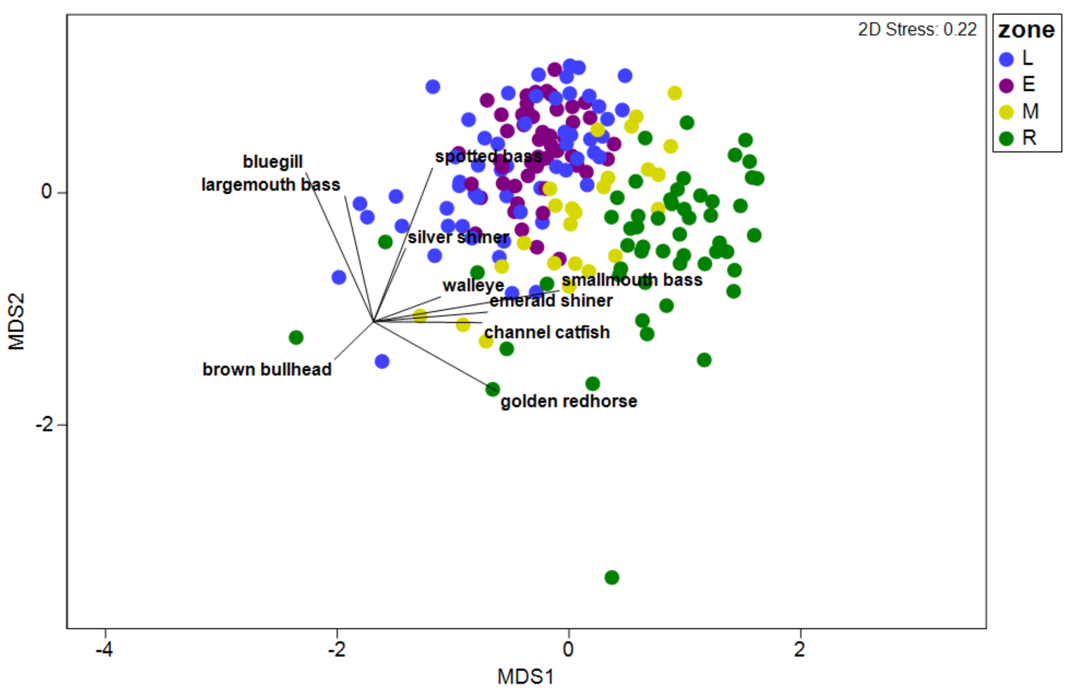
600
400
200
0
CPUE (fish/hr.)
1990
1995
2000
2005
2010
2015
Year
lake zone
E
L
M
R

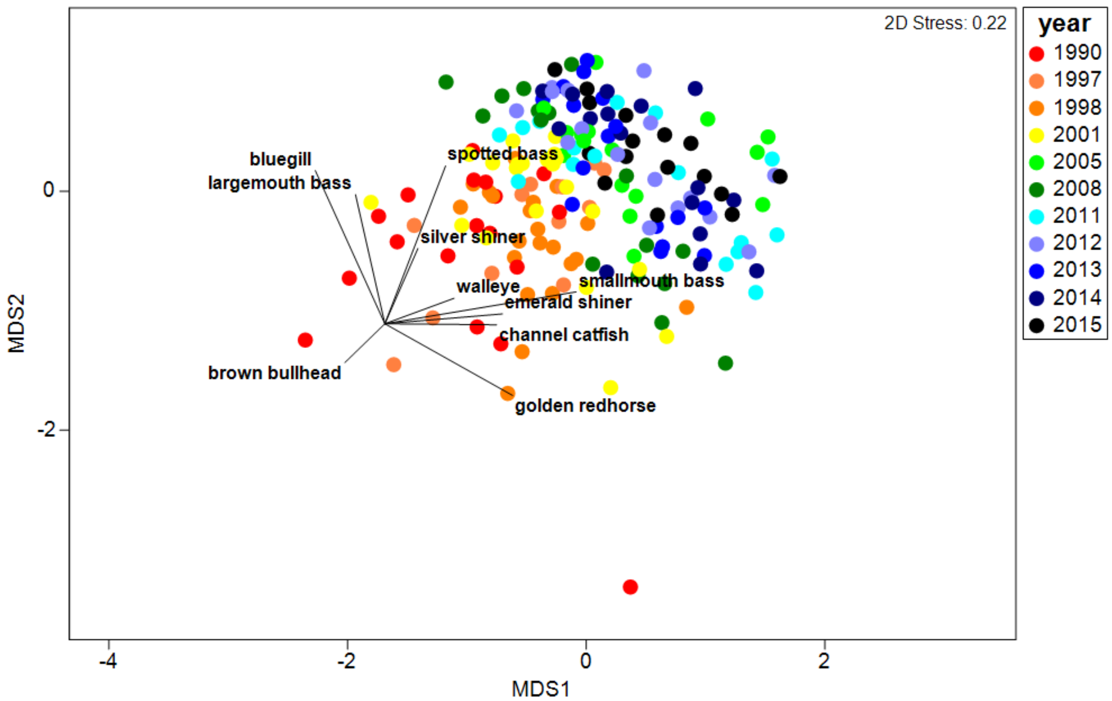


Smallmouth Bass Mean annual electrofishing CPUE (fish/hr.)
80.00
70.00
60.00
50.00
40.00
30.00
20.00
10.00
0.00
1990
1997
1998
2001
2005
2008
2011
2012
2013
2014
2015


Brown Bullhead
Channel Catfish
Mean gill net CPUE (fish/net-night)
4.00
3.50
3.00
2.50
2.00
1.50
1.00
0.50
0.00
1990
1997
1998
2001
2005
2008
2011
2012
2014


2D Stress: 0.03
Year
1952
1955
1956
1965
1974
1977
1990
1997
1998
2001
2005
2008
2011
2012
2014
MDS2
MDS1
1
0
-1


2D Stress: 0.22
zone
L
E
M
R
bluegill
largemouth bass
spotted bass
silver shiner
walleye
smallmouth bass
emerald shiner
channel catfish
brown bullhead
golden redhorse
MDS2
MDS1
0
-2
-4
2


2D Stress: 0.22
year
1990
1997
1998
2001
2005
2008
2011
2012
2013
2014
2015
bluegill
largemouth bass
spotted bass
silver shiner
walleye
smallmouth bass
emerald shiner
channel catfish
brown bullhead
golden redhorse
MDS1
MDS2
0
-2
-4
2

**Appendix 2.1**. Temporal trends in mean annual CPUE (fish/hr.) by species for Cheat Lake using electrofishing survey data for years sampled.

| Species | 1990 | 1997 | 1998 | 2001 | 2005 | 2008 | 2011 | 2012 | 2013 | 2014 | 2015 | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Banded Darter | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.38 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.03 |
| Black Crappie | 2.22 | 0.17 | 0.10 | 0.57 | 3.00 | 0.00 | 3.00 | 6.00 | 6.38 | 13.50 | 4.88 | 3.51 |
| Bluegill | 56.56 | 42.8 | 39.24 | 78.76 | 76.88 | 64.9 | 42.00 | 108.00 | 96.75 | 59.25 | 82.88 | 66.30 |
| Bluntnose Minnow | 4.56 | 6.58 | 3.33 | 6.57 | 13.88 | 1.50 | 10.88 | 7.13 | 3.38 | 3.00 | 6.75 | 6.26 |
| Brook Silverside | 9.11 | 36.5 | 33.90 | 22.19 | 67.50 | 29.25 | 27.38 | 23.63 | 13.13 | 37.88 | 50.63 | 29.87 |
| Brown Bullhead | 1.78 | 0.17 | 0.00 | 0.10 | 0.00 | 0.38 | 0.00 | 0.38 | 0.75 | 0.75 | 0.00 | 0.39 |
| Creek Chub | 0.00 | 0.00 | 0.19 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.02 |
| Channel Catfish | 0.11 | 0.33 | 0.00 | 0.86 | 1.88 | 2.63 | 5.63 | 7.13 | 3.00 | 3.00 | 6.38 | 2.71 |
| Common Carp | 0.11 | 0.00 | 0.29 | 0.38 | 0.38 | 0.38 | 3.00 | 0.75 | 3.00 | 3.00 | 3.00 | 1.26 |
| Emerald Shiner | 6.44 | 33 | 14.29 | 0.86 | 1.13 | 13.5 | 159.75 | 59.25 | 31.50 | 157.50 | 138.00 | 53.09 |
| Fantail Darter | 0.00 | 0.33 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.04 |
| Flathead Catfish | 0.00 | 0.17 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.01 |
| Freshwater Drum | 0.00 | 0.08 | 0.00 | 0.00 | 0.38 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.04 |
| Gizzard Shad | 0.56 | 0.00 | 1.62 | 2.10 | 1.88 | 0.75 | 13.88 | 4.13 | 13.13 | 8.63 | 9.38 | 4.98 |
| Golden Redhorse | 1.78 | 1 | 7.62 | 4.86 | 13.88 | 9.75 | 9.00 | 13.13 | 8.25 | 9.00 | 2.63 | 7.39 |
| Golden Shiner | 0.11 | 0.17 | 0.00 | 0.10 | 0.00 | 0.00 | 0.38 | 0.00 | 0.38 | 3.38 | 0.38 | 0.43 |
| Greenside Darter | 0.00 | 0.00 | 0.00 | 0.10 | 0.00 | 0.38 | 0.00 | 0.00 | 0.00 | 0.75 | 0.00 | 0.11 |
| Green Sunfish | 2.11 | 3 | 1.62 | 9.81 | 26.63 | 59.25 | 19.50 | 56.63 | 111.75 | 47.63 | 74.63 | 35.24 |
| Hybrid Sunfish | 0.11 | 0.00 | 0.38 | 0.57 | 0.00 | 1.88 | 0.00 | 0.38 | 1.13 | 1.50 | 0.00 | 0.54 |
| Johnny Darter | 0.44 | 1.08 | 0.10 | 0.57 | 0.00 | 1.88 | 0.38 | 0.75 | 1.50 | 1.13 | 2.25 | 0.85 |
| Largemouth Bass | 11.67 | 4.17 | 8.95 | 7.14 | 18.00 | 10.5 | 23.25 | 40.50 | 30.38 | 35.63 | 21.00 | 18.85 |
| Logperch | 4.56 | 29.42 | 12.57 | 18.76 | 47.25 | 66.75 | 14.63 | 29.63 | 19.44 | 29.25 | 65.25 | 27.98 |
| Mimic Shiner | 0.00 | 0.17 | 0.00 | 3.90 | 186.75 | 21.75 | 71.63 | 63.75 | 10.13 | 7.13 | 42.75 | 34.24 |
| Muskellunge | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 1.13 | 0.00 | 0.10 |
| Northern Hogsucker | 0.56 | 1.33 | 0.76 | 0.29 | 1.50 | 0.00 | 0.00 | 0.00 | 0.00 | 1.13 | 0.38 | 0.54 |
| Popeye Shiner | 0.00 | 0.00 | 0.00 | 0.00 | 0.38 | 3.38 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.23 |
| Pumpkinseed | 7.11 | 4.08 | 3.90 | 1.43 | 13.13 | 6.75 | 7.88 | 57.38 | 16.13 | 22.13 | 20.63 | 14.17 |

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Rainbow Darter | 0.11 | 0.00 | 0.10 | 0.10 | 0.38 | 0.75 | 0.00 | 0.38 | 0.00 | 1.50 | 0.38 | 0.29 |
| River Chub | 0.11 | 0.00 | 0.00 | 0.10 | 1.13 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.75 | 0.18 |
| Rock Bass | 1.67 | 4.75 | 3.14 | 7.05 | 18.00 | 10.5 | 9.38 | 11.25 | 13.13 | 18.75 | 20.25 | 10.61 |
| Silver Shiner | 0.00 | 0.00 | 0.00 | 1.90 | 7.13 | 3 | 1.50 | 1.13 | 15.75 | 21.00 | 7.50 | 4.98 |
| Smallmouth Bass | 0.33 | 4.83 | 3.52 | 3.14 | 54.00 | 26.25 | 29.63 | 28.50 | 34.13 | 48.00 | 56.25 | 25.13 |
| Spotfin Shiner | 0.22 | 0.08 | 0.57 | 2.29 | 7.88 | 4.88 | 4.50 | 0.00 | 0.38 | 0.00 | 0.38 | 1.76 |
| Spotted Bass | 0.00 | 4.5 | 1.43 | 9.71 | 23.25 | 18 | 12.75 | 25.88 | 24.00 | 14.63 | 15.00 | 12.90 |
| Walleye | 0.00 | 0.00 | 0.00 | 1.24 | 3.00 | 0.38 | 4.88 | 2.25 | 0.75 | 2.25 | 4.50 | 1.71 |
| White Bass | 0.00 | 0.00 | 0.48 | 0.00 | 3.00 | 0.38 | 8.63 | 14.25 | 5.25 | 7.13 | 9.75 | 4.26 |
| White Sucker | 0.00 | 0.00 | 0.29 | 0.00 | 0.00 | 0.00 | 0.38 | 0.00 | 0.00 | 0.00 | 0.00 | 0.07 |
| Yellow Bullhead | 0.78 | 1.58 | 0.76 | 1.05 | 3.00 | 2.63 | 0.75 | 1.88 | 2.25 | 1.88 | 2.25 | 1.66 |
| Yellow Perch | 4.44 | 1 | 2.67 | 2.95 | 7.50 | 3.00 | 9.00 | 13.13 | 10.50 | 22.88 | 32.63 | 9.76 |

**Appendix 2.2**. Temporal trends in mean annual CPUE (fish/net-night) by species for Cheat Lake using gill net survey data for years sampled.

| Species | 1990 | 1997 | 1998 | 2001 | 2005 | 2008 | 2011 | 2012 | 2014 | Total |
|---|---|---|---|---|---|---|---|---|---|---|
| Black Crappie | 1.08 | 0.25 | 0.07 | 0.69 | 0.59 | 0.25 | 0.03 | 0.25 | 0.50 | 0.42 |
| Black Redhorse | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.06 | 0.00 | 0.00 | 0.00 | 0.01 |
| Bluegill | 0.03 | 0.04 | 0.02 | 0.02 | 0.03 | 0.00 | 0.09 | 0.03 | 0.00 | 0.03 |
| Brown Bullhead | 0.83 | 1.17 | 0.36 | 0.05 | 0.22 | 0.09 | 0.00 | 0.06 | 0.09 | 0.30 |
| Channel Catfish | 0.42 | 0.38 | 0.19 | 0.79 | 2.81 | 1.56 | 1.16 | 2.38 | 2.69 | 1.33 |
| Common Carp | 0.11 | 0.29 | 0.07 | 0.05 | 0.09 | 0.00 | 0.06 | 0.44 | 0.13 | 0.13 |
| Creek Chub | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.03 | 0.00 |
| Freshwater Drum | 0.00 | 0.04 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Gizzard Shad | 0.78 | 1.42 | 0.69 | 0.64 | 0.66 | 1.22 | 0.75 | 2.09 | 0.72 | 0.96 |
| Golden Redhorse | 0.44 | 1.25 | 0.17 | 0.40 | 1.09 | 1.09 | 0.59 | 1.31 | 1.06 | 0.77 |
| Green Sunfish | 0.03 | 0.00 | 0.00 | 0.00 | 0.06 | 0.13 | 0.03 | 0.06 | 0.03 | 0.04 |
| Largemouth Bass | 0.47 | 0.46 | 0.14 | 0.07 | 0.13 | 0.16 | 0.03 | 0.34 | 0.22 | 0.21 |
| Muskellunge | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.03 | 0.00 |
| Northern Hogsucker | 0.03 | 0.04 | 0.02 | 0.00 | 0.00 | 0.03 | 0.00 | 0.00 | 0.03 | 0.02 |
| Northern Pike | 0.03 | 0.04 | 0.02 | 0.02 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.01 |
| Pumpkinseed | 0.17 | 0.33 | 0.17 | 0.05 | 0.31 | 0.09 | 0.06 | 0.25 | 0.19 | 0.17 |
| Rainbow Trout | 0.03 | 0.00 | 0.00 | 0.00 | 0.03 | 0.00 | 0.00 | 0.00 | 0.00 | 0.01 |
| Rock Bass | 0.11 | 0.08 | 0.26 | 0.29 | 1.19 | 1.03 | 0.50 | 0.69 | 0.25 | 0.48 |
| Sauger | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.03 | 0.00 | 0.00 | 0.00 | 0.00 |
| Smallmouth Bass | 0.00 | 0.04 | 0.00 | 0.05 | 0.63 | 0.59 | 0.22 | 0.47 | 0.28 | 0.24 |
| Spotted Bass | 0.00 | 0.04 | 0.02 | 0.02 | 0.53 | 0.13 | 0.19 | 0.63 | 0.41 | 0.21 |
| Striped Bass | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.03 | 0.00 | 0.00 | 0.00 |
| Walleye | 0.00 | 0.04 | 0.00 | 0.24 | 0.56 | 0.66 | 0.44 | 0.84 | 0.59 | 0.36 |
| White Bass | 0.00 | 0.29 | 0.10 | 0.21 | 0.81 | 2.09 | 1.69 | 0.72 | 0.28 | 0.65 |
| White Sucker | 0.42 | 0.00 | 0.05 | 0.12 | 0.41 | 0.22 | 0.03 | 0.06 | 0.03 | 0.15 |
| Yellow Bullhead | 0.19 | 0.13 | 0.05 | 0.12 | 0.31 | 0.03 | 0.03 | 0.00 | 0.09 | 0.11 |
| Yellow Perch | 0.19 | 0.63 | 0.57 | 0.17 | 1.19 | 0.66 | 0.34 | 1.03 | 0.63 | 0.58 |

## Chapter 3 – Population characteristics of a reestablished reservoir Walleye population

### Abstract

Walleyes (*Sander vitreus*) were believed to be extirpated from Cheat Lake and the Cheat River watershed in West Virginia by 1950 due to acid mine drainage pollution. However, after extensive water quality improvements, reestablishment of Walleyes in Cheat Lake began with stocking efforts in 1999. Despite successfully reestablishing Walleyes into Cheat Lake, little is known about the population characteristics of this fishery. Population characteristics were evaluated via gill net and electrofishing survey catch data, age and growth analysis using sagittal otoliths and from diet information collected on captured fish. From 1990–2015, 193 Walleyes were collected with standardized fall gill net sampling and catch data were analyzed for significant temporal changes. An additional 123 Walleyes were captured for age and growth analysis. Three growth models (von Bertanlanffy, logistic, and Gompertz) were fit to length at age data and compared using Akaike's Information Criterion (AIC). Additionally, fall diets were collected from 46 age-1+ fish captured for age and growth analysis. Walleye gill net CPUE significantly increased over time, which was expected given stocking events. Age and growth analyses of male and female Walleyes using the AIC-selected von Bertalannfy growth models suggest that female Walleyes in Cheat Lake grow quickly and reach large maximum sizes compared to males (female $L_\infty$ = 754 mm; male $L_\infty$ = 502 mm). Both male and female Cheat Lake Walleyes reach quality size (≥ 380 mm) after two years of growth. Males and females began to show differences in growth rate at age-3, with females continuing to grow steadily and male growth slowing down. Age and growth analysis and fall electrofishing provided evidence of increasing natural reproduction, demonstrated by cohorts belonging to year classes without stocking and collection of young of the year when no stocking occurred. Finally, diet contents of

captured Walleyes suggest that Yellow Perch (*Perca flavescens*) are an important prey to Cheat Lake Walleyes. Yellow Perch were present in 67% of Walleye stomachs and were one of the largest prey items consumed on average. Walleye stocking into Cheat Lake has successfully resulted in reestablishing a Walleye population. Walleye growth and size structure is above average in Cheat Lake, potentially due in part to a diverse forage base that includes Yellow Perch. These findings suggest that the reestablishment of Walleyes to Cheat Lake has created a fishery of fast growing individuals that reach large sizes.

**Introduction**

Walleyes are large predators of aquatic ecosystems and are popular sportfish to recreational anglers (Quist et al. 2003; Bednarski et al. 2010). Due to their large size and predatory behavior, Walleyes often have a significant influence on the trophic structure of the aquatic ecosystems they inhabit (Pothoven et al. 2016). However, due to their popularity with anglers, Walleyes are often a heavily pressured sportfish which can influence their abundance and size structure (Johnson et al. 2015). Walleyes are widely distributed throughout North America, including both their native range and systems in which they have been introduced (Bozek et al. 2011). Due to their wide range and popularity, Walleye populations have been studied extensively regarding most aspects of their life history (Bozek et al. 2011). However, despite the extensive research that has been conducted on Walleye populations, there can be regional variations in life history and there exist several geographic areas in which Walleye literature is sparse (Bozek et al. 2011).

Walleyes are becoming an increasingly popular sportfish in West Virginia, but limited research has been conducted on Walleyes in West Virginia waters. However, in recent years Walleye research and management have gained increased focus in West Virginia by the West

Virginia Division of Natural Resources (WVDNR). In 2016, the WVDNR implemented a new Walleye management plan for West Virginia which includes fishing regulation changes aimed at improving Walleye fisheries. Despite increased angler interest and management focus, many West Virginia reservoirs currently only support limited Walleye fisheries that are often dependent on frequent fry or fingerling stockings (WVDNR, unpublished data). Limitations to sustainable Walleye populations could be related to such things as habitat, water quality, forage availability, or angling pressure, most of which remain unknown for West Virginia waters.

Cheat Lake and the Cheat River watershed historically supported a Walleye population (Core 1959). However, poor water quality as a result of acid mine drainage likely extirpated the native Walleye population (Core 1959). As a result of improving water quality, the WVDNR began stocking Walleye fry into Cheat Lake in 1999 (Table 3.1). To increase the likelihood of stocking success, the WVDNR began stocking fingerling Walleyes in 2001 (Table 3.1). Monitoring has been conducted on the Cheat Lake Walleye population to determine if stocking has been successful and if a naturally reproducing population is achievable. Considering their relative sensitivity to poor water quality and status as a large predator, research into population characteristics of Cheat Lake Walleyes also provides valuable information on the benefits of improving water quality that may be applicable in other systems. Research into population characteristics such as trends in abundance, size structure, growth, and recruitment is necessary to effectively manage a pressured population and is valuable in determining the success of stocking efforts (Bednarski et al. 2010; Johnson et al. 2015). In addition, with knowledge of these population characteristics, comparisons can be made to Walleye populations in other West Virginia reservoirs and across North America. Information gained on this population in a unique environmental situation will provide important knowledge for how Walleye populations respond to environmental improvement and subsequent reintroduction efforts. Comparisons with other populations can also provide better perspective as to the health and condition of the Cheat Lake Walleye population.

The primary objective of this study was to evaluate the status and describe the population characteristics of the Cheat Lake Walleye population, with emphasis on abundance, size structure, and growth. Specifically, we were interested in determining the trends in relative abundance of Walleyes in Cheat Lake since management efforts began, what contribution (if any) natural reproduction provides to the fishery, and the current age/size structure of the Cheat Lake Walleye population. We also sought to compare abundance, age, growth, and size structure of Cheat Lake Walleyes to other West Virginia reservoirs and to Walleye populations throughout North America.

## Methods

### *Study Area*

Cheat Lake (700 ha), historically impacted by acidification, is a hydropower reservoir located near the West Virginia-Pennsylvania border in Monongalia County, WV. The reservoir was formed in 1926 after damming the Cheat River for hydroelectric needs (Core 1959). The reservoir is characterized by steep slopes and relatively narrow width over most of its area. The reservoir is approximately 21 km in length and has a maximum depth of 24 m near the dam. The reservoir also experiences seasonal stratification of water temperature and dissolved oxygen in its lacustrine zone. The reservoir is largely composed of lacustrine habitat, with substrate that is dominated primarily of soft sediments (silt/clay). However, the headwaters of the lake retain riverine characteristics, with a greater influence from incoming river flow and a rockier (sand/gravel/cobble) substrate.

Cheat Lake and the Cheat River watershed that feeds it have been significantly impacted by acid mine drainage since the formation of the reservoir (Core 1959; Welsh and Perry 1997; Freund and Petty 2007; Merovich et al. 2007). As a result of poor water quality, Walleye and Yellow Perch were believed to be extirpated by the late 1940's (Core 1959). In recent years, the Cheat River watershed and Cheat Lake have seen substantial water quality improvements owing to mitigation efforts throughout the watershed (McClurg et al. 2007; see Chapter 2). Biomonitoring has indicated improving water quality and fish communities within Cheat Lake, likely as a result of mitigation efforts (see Chapter 2). Since 1999, in response to improving water quality conditions and the popularity of Walleye as a sport fish, the WVDNR initiated and has continued stocking of Walleyes in Cheat Lake.

*Fish Collection*

Walleyes were collected from Cheat Lake for estimates of relative abundance and size structure using sinking monofilament, multimesh gill nets during November in the years of 2005, 2008, and annually from 2012–2015. Additional data on Walleye abundance for temporal comparison were available from biomonitoring surveys in 1990, 1997, 1998, 2001, and 2011 in which October sampling with experimental gill nets was conducted. Monitoring sites included six stations positioned throughout Cheat Lake (Figure 3.1). One to two gill nets were set at each site (one per site during November Walleye surveys, two per site during October biomonitoring surveys) perpendicular to the shoreline. Gill nets used were 45.7 m in length and 1.8 m deep with six 7.6 m panels of 38, 51, 64, 38, 51, and 64 mm bar mesh. Nets were set prior to sunset and retrieved after sunrise the following day resulting in a soak time of approximately 12 hours. We also used fall electrofishing data from biomonitoring surveys from 1990–2015 for evaluation of young-of-the-year (YOY) and evidence of natural reproduction. Fall electrofishing surveys were conducted at night, and consisted of 10–15 minute transects per station depending on year. Due to variation in sampling effort, catch per unit effort of YOY Walleyes was calculated as fish per hour. Separate sampling was conducted to collect Walleyes for age, growth and diet analysis. Walleyes were collected for age, growth and diet analysis from 9 October 2013 to 22 November 2013 and from 25 September 2014 to 14 November 2014 using gill nets (of the same dimensions above) and night boat electrofishing. Gill nets were the primary method of capture for age and growth analysis, but electrofishing was used to more effectively capture YOY.

*Laboratory Processing*

Walleyes collected for age, growth, and diet analysis were immediately placed on ice to preserve specimens and slow the digestion of stomach contents. Sex was determined from captured fish through dissection and examination of gonads. Sagittal otoliths were removed from captured fish, cleaned of soft tissue, and placed dry into coin envelopes. Otoliths were prepared for aging by cracking them in half perpendicular to their longitudinal axis (Kocovsky and Carline 2001; Bednarski et al. 2010). We sanded otoliths using 400 or 600 grit wet/dry sandpaper and polished them with 1200 and/or 2500 grit sandpaper to improve visibility of annuli (Bednarski et al. 2010; Hilling et al. 2016). Otoliths were then placed in a basin of black modeling clay filled with water with the fractured side up to improve clarity (Taylor 2013). Otoliths were viewed under a dissecting scope at 20–40x magnification. Two readers independently viewed otoliths and counted annuli to estimate age. If readers disagreed on an age, then otoliths were examined by both readers in concert until a consensus age was reached (Kocovsky and Carline 2001).

We collected diet data on age-1+ and older Walleyes that were captured for age and growth analysis. Diet contents were examined by removing stomach contents, identifying consumed prey to the lowest practical taxonomic level, counting prey items and recording an approximate total length of prey fish consumed. Empty stomachs were noted and excluded from further analysis. All stomach contents were excised and processed the day of capture eliminating the need for preservation.

*Data Analysis*

Relative abundance of Walleyes was estimated via calculation of catch per unit effort (CPUE) or number of Walleyes captured per net-night. Each gill net set represented one net-night of effort. Overall trends in Walleye CPUE were analyzed using a mixed effects model in the nlme package in program R (Pinheiro et al. 2017). Walleye CPUE data were log + 1-transformed to improve normality and homogeneity of variance (Hubert and Fabrizio 2007). Fixed effects included in the model were as follows: time (i.e. sample year), lake region, and an interactive effect of time and lake region. Sampling site was included as a random effect to account for repeated measures at sites over time (Hubert and Fabrizio 2007). We also modeled the change in Walleye CPUE over time using only data from the stocking period (2001–2015) to determine if any significant changes have occurred in Walleye CPUE since stocking was initiated (excluding data from pre-stocking years).

Size structure of the Cheat Lake Walleye population was evaluated with length frequencies and proportional size distributions (PSD). We used length-group interval guidelines (i.e., 25 mm intervals) from Neumann et al. (2012) to construct the length-frequency histogram. We used length categories provided by Gabelhouse (1984) to estimate proportional size distributions which were categorized as follows: stock (250–379 mm), quality (380–509 mm), preferred (510–629 mm), memorable (630–759 mm), and trophy (≥ 760 mm). Proportional size distributions and 95% confidence intervals were calculated using the Fishery Analysis and Modeling Simulator software (FAMS version 1.64; Slipke and Maceina 2014).

For modeling of Walleye growth in Cheat Lake we fit three different growth models to length at age data and used an information theoretic approach to select the best fitting model (Katsanevakis 2006; Katsanevakis and Maravelias 2008; Taylor 2013; Hilling et al. 2016). Given sexual dimorphism in growth of Walleyes, we analyzed growth separately for males and females (Quist et al. 2003). The three candidate models were fit to Walleye length at age data using a Gauss-Newton algorithm in program R version 3.3.0 (R Core Development Team 2016; Hilling et al. 2016). The three candidate models included the von Bertalanffy growth model, logistic growth model, and Gompertz growth model, and each are described by the following equations:

von Bertalanffy: $$L(t) = L_\infty[1 - \exp(-k(t-t_0))]$$

Logistic: $$L(t) = L_\infty[1 + \exp(-G(t-t_0))]^{-1}$$

Gompertz: $$L(t) = L_\infty \exp[-(\exp(-G(t-t_0)))]$$

In each model L(t) represents predicted length at a given age (t). In the von Bertalannfy growth model equation, $L_\infty$ represents maximum or asymptotic length, k represents how quickly $L_\infty$ is reached, and $t_0$ is the theoretical age when length is equal to zero (Quist et al. 2012). The von Bertalanffy growth model assumes that there is a linear decrease in growth rate with increasing fish length (Katsanevakis 2006; Katsanevakis and Maravelias 2008). Both the logistic model and Gompertz model also include a maximum length term ($L_\infty$) (Hilling et al. 2016). However, the logistic and Gompertz models are sigmoidal curves with different assumptions regarding growth compared to the von Bertalanffy model (Hilling et al. 2016). Specifically, the Gompertz model predicts an exponential decrease in growth rate with age and the logistic model predicts symmetrical growth around an inflection point (Katsanevakis 2006; Quist et al. 2012; Hilling et al. 2016). The Gompertz model is described by the terms $t_0$ and G which represent the inflection point of the curve and the instantaneous growth rate at $t_0$, respectively (Quist et al. 2012; Hilling et al. 2016). In the logistic model, the terms $t_0$ and G represent the theoretical age when length is zero and the instantaneous growth rate at the origin of the curve, respectively (Quist et al. 2012; Hilling et al. 2016).

Akaike's Information Criterion (AIC) was used to select the best approximating growth model with the most parsimonious fit (Burnham et al. 2011). Specifically, Akaike's Information Criterion with a small sample bias (AICc) was used to rank models in order of decreasing fit (Burnham et al. 2011; Hilling et al. 2016). The AICc was calculated as follows:

$$AIC = n(\log\left(2\pi\frac{RSS}{n} + 1\right) + 2k$$

$$AICc = AIC + \frac{(2k(k + 1)}{(n - k - 1)}$$

In the AIC calculation, RSS is the residual sum of squares for a given model, $n$ is the number of observations in the sample and $k$ is the number of parameters estimated by the model (Katsanevakis and Maravelias 2008; Hilling et al. 2016). Growth models were ranked in order of decreasing fit using Akaike's Information Criterion with a small sample size bias correction (AICc) using the AICcmodavg package in R (Anderson 2008; Burnham et al. 2011; Mazzerole 2015). The growth model determined to have the smallest AICc value was considered the best approximating model (Burnham et al. 2011). The resulting AICc values were used to calculate Δ values and AICc weights ($w_i$) were calculated for each model and used as another measure of evidence for model support (Akaike 1983; Burnham and Anderson 2002; Hilling et al. 2016). Both were calculated as follows:

$$\Delta_i = AICc_i - AICc_{min}$$

$$wi = \frac{\exp(-0.5\Delta i)}{\sum_i^3 = 1 \exp(-0.5\Delta \mathrm{k})}$$

Walleye growth was also described as minimum, mean, and maximum length at age. Mean length at age data were used to compare Cheat Lake Walleye growth to North American Walleye growth standards published by Quist et al. (2003). Quist et al. (2003) published mean length at age growth standards for Walleye by developing a North American relative growth index (RGI). The RGI was developed by compiling and analyzing published Walleye length at age data from across North America (42 datasets on male growth; 38 datasets on female growth; Quist et al. 2003). We calculated the RGI for male and female Cheat Lake Walleyes using the equation RGI = ($L_t$ / $L_s$) X 100, where $L_t$ was the observed length at age and $L_s$ was the predicted age specific standard length (Quist et al. 2003). We calculated mean RGI for male and female Walleyes for each age class. An RGI of 100 indicates growth is similar to the average growth across North America, whereas values < 100 indicate below average growth and values > 100 indicate above average growth (Quist et al. 2003). Quist et al. (2003) also presented mean length at age values for Walleyes corresponding to the $5^{th}$, $10^{th}$, $25^{th}$, $50^{th}$, $75^{th}$, $90^{th}$, and $95^{th}$ percentiles of the national average for comparison. The age specific standard length estimates for male and female Walleyes (ages 1–8) were developed by Quist et al. (2003) by estimating a von Bertalannfy growth model for North American populations. The standard length equations developed by Quist et al. (2003) were as follows:

Female Walleyes: $L_s = 652\ (1 - e^{-0.266(age+0.346)})$

Male Walleyes: $L_s = 496\ (1 - e^{-0.419(age+0.083)})$

Age, growth, and CPUE data on Cheat Lake Walleyes were also compared to data collected on Walleye populations from other West Virginia Reservoirs. From 2008–2014, data were collected on Walleye populations from five West Virginia reservoirs (Burnsville, East Lynn, Stonecoal, Summersville, and Tygart Reservoirs; WVDNR, unpublished data). Data were collected using six single mesh, sinking monofilament gill nets per station. Nets were 22.9 m in length, 1.8 m in depth, with bar mesh sizes of 13mm, 25mm, 38mm, 51mm, 64mm, and 76mm (WVDNR, unpublished data). Estimates of CPUE, age, and growth were calculated for Walleyes captured in these five reservoirs. Due to differences in gill net dimensions compared to Cheat Lake surveys, comparisons are meant to be descriptive and were not statistically tested.

Age data were used to determine year class strength and contribution of natural reproduction or stocking (Goeckler et al. 2003). We calculated the percent frequency of year classes represented from aged Walleyes. Using these percent frequencies we determined if any Walleyes belonged to year classes when no stocking occurred in Cheat Lake, thus providing evidence of natural reproduction (Goeckler et al. 2003). We also examined fall electrofishing data from 1990–2015 and determined the number of young of the year Walleyes collected. Young of year Walleyes collected during years of no stocking would provide evidence of natural reproduction (Jude 1992; Goeckler et al. 2003; Riley et al. 2007; Warren and Bettoli 2014).

Diet data were summarized for Walleyes captured in gill nets from 25 September 2014 to 14 November 2014. Diets were summarized using percent frequency of occurrence ($Oi$) and mean percent frequency by number ($MNi$). Frequency of occurrence was calculated as $O_i = J_i P^{-1}$ x 100, where $J_i$ represents the number of fish containing a particular prey and $P$ represents the number of fish with food in their stomachs (Chipps and Garvey 2007). Mean percent composition by number was calculated as $MNi = \frac{1}{P}\sum_{j=1}^{P}\left(\frac{Nij}{\sum_{i=1}^{Q} Nij}\right)$ x 100, where $P$ was the total number of fish with food in their stomachs, $Q$ was the total number of prey types, and $Nij$ was the number of prey type $i$ in fish $j$ (Chipps and Garvey 2007). We also summarized diets by the minimum, mean, and maximum total length of prey species consumed.

## Results

### *Catch-Per-Unit-Effort (CPUE) and Size Structure*

A total of 193 Walleyes were collected during gill net monitoring surveys from 1990–2015 (Figure 3.2). Mean annual CPUE ranged from zero Walleye per net-night in 1990 and 1998, to 3.7 Walleye per net-night in 2008 (Figure 3.2). Only one Walleye (443 mm TL) was captured prior to when stocking was initiated in Cheat Lake in 1999, resulting in an overall mean CPUE of 0.04 fish/net-night from 1990–1998. Overall mean CPUE after stocking was initiated (2001–2015) was 1.55 fish/net-night. Results from the mixed model analysis suggested that Walleye CPUE has significantly increased with time ($F_{1,141} = 28.73$; $p < 0.0001$). Results from the mixed model analysis using only data from the stocking period (2001–2015) suggested that CPUE estimates over this period have not significantly increased with time ($F_{1,105} = 3.33$; $p = 0.07$). Examination of plotted CPUE over time (Figure 3.2) clearly shows that prior to stocking in 1999, Walleyes were nearly non-existent in Cheat Lake, aside from the capture of a lone individual in 1997. After stocking was initiated in 2001, Walleye CPUE immediately increased and has fluctuated with periods of low CPUE followed by spikes in CPUE in 2008, 2014, and 2015 (Figure 3.2). Compared to other West Virginia reservoirs, Cheat Lake has had moderate relative abundance of Walleyes since stocking began. Cheat Lake Walleye CPUE (overall mean = 1.55 fish/net-night; mean annual range = 0.3–3.7 fish/net-night) was higher on average than Walleye CPUE for Burnsville Lake (overall mean = 0.3 fish/net-night; annual range = 0.2–0.4 fish/net-night), East Lynn Lake (overall mean = 0.3 fish/net-night; annual range = 0.2–0.6 fish/net-night), and Stonecoal Lake (overall mean = 0.6 fish/net-night; annual range = 0.2–1.2 fish/net-night). Cheat Lake Walleye CPUE was lower compared to both Tygart Lake (overall mean = 2.3 fish/net-night; annual range = 2.3–2.3) and Summersville Lake (overall mean = 2.9 fish/net-night; annual range = 2.3–3.8).

Length frequency and proportional size distribution were calculated from a total of 123 Walleyes collected for age and growth analysis. Adult Walleyes were collected with gill nets (n=95), while YOY individuals were collected with boat electrofishing (n=28). Young of the year individuals ranged in length from 163–270 mm (Figure 3.3). Female Walleyes ranged in length from 378–790 mm, whiles males ranged in length from 379–600 mm (Figure 3.3). Likewise, based on the length frequency histogram, females represented most of the Walleyes collected for size classes over 500 mm (Figure 3.3). Additionally, a gap in sizes represented is apparent from 270–378 mm in the length frequency histogram, likely related to fast growth in young fishes (Figure 3.3). We also summarized Walleye lengths using length categories developed by Gabelhouse (1984). The Gabelhouse (1984) system categorizes lengths according to five categories including stock (S), quality (Q), preferred (P), memorable (M), and trophy (T). There were 21 individuals (17 %) that were smaller than the stock size (i.e., sub-stock). These individuals were all young of the year. For the remaining fish above stock size, proportional size distributions with 95% confidence intervals were calculated as: PSD = 92 ± 5.27, PSD-P = 40 ± 9.53, PSD-M = 7 ± 4.95, and PSD-T = 1 ± 1.93. Incremental PSDs with 95% confidence intervals were calculated as: PSD S-Q = 8 ± 8, PSD Q-P = 52 ± 15, PSD P-M = 33 ± 14, and PSD M-T = 6 ± 6. The PSD estimate of 92 indicates 92% of Walleyes of stock length or greater were quality size (≥ 380 mm) individuals. Additionally, the PSD-P (preferred size) value indicates 40% of captured Walleyes of stock length or greater were ≥ 510 mm. Memorable (PSD-M) and trophy (PSD-T) size Walleyes were also represented in the sample (7% and 1% of stock length or greater fish, respectively).

*Age, Growth, and Diet*

Otoliths were collected from 123 Walleyes for aging purposes. Two independent readers had an initial agreement rate of 91.1% for assigned ages. Agreement within one year was 99.2% and age was agreed upon in all instances after mutual examination by both readers. Age-0+ individuals (young of the year) were not sexed, and were used for both the male and female growth models. Sexual dimorphism in growth of Walleyes is not typically apparent in age-0 fish (Henderson et al. 2003). The convention for age designation of Walleyes followed guidelines by Devries and Frie (1996). Using these guidelines, fish are considered to have completed one year of life on January 1st of each year (Devries and Frie 1996). However, the national average growth calculated by Quist et al. (2003) was based on studies that used back calculation to determine length at age (thus corresponding to length at annulus formation in late spring/early summer), whereas our study was based on length of fishes captured in fall. To account for growth beyond the last annulus in our samples, we added one year to the ages assigned to each individual fish in our samples (Bednarski et al. 2010). This resulted in conservative estimates of growth for our study fish, but improves comparability with the national averages published by Quist et al. (2003).

We aged 123 individuals ranging in length from 163–790 mm, with ages ranging from 1–14 (ages adjusted + 1 year for comparability with Quist et al. 2003). An age frequency plot shows that most individuals were ages 1–5, with age 5 being the most abundant (Figure 3.4). Based on aging data, male and female Cheat Lake Walleyes reach quality size (≥ 380 mm) after two years of growth (i.e., age-1 individuals in the fall; assigned as age-2 for N.A. average comparison) (Table 3.4 and 3.5). Preferred size (≥ 510 mm) is typically reached by females after four years of growth (i.e., age-3 individuals in fall; assigned as age-4 for N.A. average comparison) (Table 3.4). Memorable size (≥ 630 mm) is typically reached by females after 6 years of growth (age-5 individuals in the fall; assigned as age-6 for N.A. comparison) (Table

3.4). One trophy size (≥ 690 mm) Walleye was captured measuring 790 mm in length that was estimated to be an age-8 individual when collected (assigned as age-9 for N.A. average comparison).

Of the four growth models (von Bertalannfy, logistic, and Gompertz) fit to our length at age data, the von Bertalannfy growth model was AICc selected as the best approximating model for both male ($w_i$ = 0.74) and female ($w_i$ = 1.0) Cheat Lake Walleye growth (Table 3.2). For female growth, there was no support for either the logistic or Gompertz models (Table 3.2), and there was little support (Gompertz $w_i$ = 0.19, $\Delta$ AICc = 2.74; logistic $w_i$ = 0.07, $\Delta$ AICc = 4.69) for either of these models for male growth (Table 3.2). The von Bertalannfy growth models for male and female growth indicated large differences in growth rates between sexes (Figure 3.5). Males and females began to show differences in growth rate at age-3, with female growth increasing steadily and male growth beginning to slow down (Figure 3.5). Females grew fast and large in Cheat Lake with an estimated asymptotic length of 754 mm and a *k* value of 0.31 (Table 3.3; Figure 3.5). In contrast, males had a much smaller estimated asymptotic length (502 mm) and a *k* value over two times as high than that of females, indicating that asymptotic length is reached quickly in males (Table 3.3; Figure 3.5). While female growth rate did not show much indication of slowing with age, male growth had largely plateaued by age-4 (Figure 3.5).

We compared growth of Cheat Lake Walleyes with average growth compiled from populations across North America (Quist et al. 2003) and from other West Virginia reservoirs (WVDNR, unpublished data). Compared to North American growth standards (Quist et al. 2003) mean lengths at age for female Cheat Lake Walleyes were greater than or equal to the $75^{th}$ percentile for all ages (Table 3.4). Furthermore, female mean lengths at age were greater than or equal to the $90^{th}$ percentile for ages 4 and 5, and were at the $95^{th}$ and above percentile (Quist et al. 2003) for ages 6 and up (Table 3.4). In contrast, male Cheat Lake Walleyes were at the $75^{th}$ and above percentile at ages 1 and 2, but were in the $50–75^{th}$ percentile for ages 3 and up

(Table 3.5). Cheat Lake Walleyes of all ages (both male and female) had mean RGI values > 100 (Tables 3.4 and 3.5). The VBGM predicted a much larger asymptotic length for female Cheat Lake Walleyes compared to the North American average (Quist et al. 2003; Table 3.6; Figure 3.6). Male Cheat Lake Walleyes also had a larger predicted asymptotic length than the North American average, but only slightly (Quist et al. 2003; Table 3.6; Figure 3.7). Female Cheat Lake Walleyes were also predicted to attain larger maximum length on average than female Walleyes from five other WV reservoirs (Table 3.6; Figure 3.8). Male Cheat Lake Walleyes were predicted to attain larger maximum lengths on average for all but one WV reservoir (East Lynn Lake) of comparison (Table 3.6; Figure 3.8).

Examination of year class frequency of aged Walleyes shows that most sampled fish were from year classes 2009–2014 (Figure 3.10). The most abundant year class in our sample was 2010, accounting for 28% of aged Walleyes (Figure 3.10). Two of the most abundant year classes, 2010 and 2012, were from successful fingerling stocking years (Table 3.1; Figure 3.10). However, beginning in 2008, Walleyes belonging to non-stocking year classes started to contribute to the population (Table 3.1; Figure 3.10). No stockings occurred in 2008, 2011, or 2013, yet contributions from these year classes steadily increased (Figure 3.10). Additionally, although stocking occurred in 2014, it is unlikely that stocked fish contributed much to the population due to low numbers stocked (< 7 fingerlings/hectare), high initial fingerling mortality observed (> 50%) and poor stocking conditions (high, turbid water and substantial decrease in water temperature; WVDNR, unpublished data). Therefore, fish representing the 2014 year class could be largely naturally reproduced. Additionally, young of the year Walleyes were captured in fall electrofishing surveys during years 2011 (0.4/hr.), 2013 (1.1/hr.), 2014 (3.0/hr.) and 2015 (7.7/hr.). No stockings occurred during 2011, 2013, or 2015, and very limited success was expected from 2014 stockings. This provides additional evidence of successful natural reproduction of Walleyes in Cheat Lake.

Diets of 46 age-1+ Walleyes (379–690 mm TL, mean = 493, SD = 89.3) collected from September 25th to November 15th, 2014 were examined for prey species consumed, size of prey, and prey abundance. Thirteen Walleyes (28.2%) had empty stomachs and 33 (71.7%) had prey in stomachs. Approximately 67% of Walleyes had consumed Yellow Perch (*Perca flavescens*) (Table 3.7). Other prey species consumed in order of decreasing frequency of occurrence included Gizzard Shad (*Dorosoma cepedianum*) (12 %), Emerald Shiner (*Notropis atherinoides*) (9 %), *Lepomis sp.* (9 %), and *Micropterus sp*. (3 %) (Table 3.7). Yellow Perch were the prey with the largest maximum size consumed by Walleyes (229 mm) (Table 3.7). Gizzard Shad and Yellow Perch were the largest prey items consumed on average (mean prey lengths of 121 mm and 110 mm, respectively) (Table 3.7).

**Discussion and Management Implications**

Although Walleyes were once extirpated from Cheat Lake, WV, due to water quality impairment, improvements in water quality since the 1990's have created more favorable conditions (see Chapter 2). The results of our study show that the Walleye stocking program in Cheat Lake has resulted in successfully reestablishing a Walleye fishery. Walleye CPUE went from near zero prior to stocking, to immediate and persistent abundance within the reservoir (Figure 3.2). Our results on age and growth of Cheat Lake Walleyes suggest that growth is faster than average, especially in females (Quist et al. 2003). Female Cheat Lake Walleyes can attain large maximum sizes on average compared to other North American populations (Quist et al. 2003; Figure 3.6). This could be due in part to a diverse forage base, with Yellow Perch and Gizzard Shad being important to diets of Cheat Lake Walleyes. Our data also provide evidence of successful and potentially increasing natural reproduction. Given the lack of knowledge on the population characteristics of this reestablished fishery, this data gathered on abundance, age, growth, and diet provide valuable information for future management of this fishery.

Additionally, information gained on this population of Walleyes reestablished after years of water quality degradation provides a valuable case study to other similar situations elsewhere.

Temporal monitoring data suggest that Walleye relative abundance in Cheat Lake has increased significantly since WVDNR began stocking Walleyes in 1999 (Figure 3.2). Walleyes used to be common within Cheat Lake and the Cheat River watershed as evidenced from past reports (Core 1959; WVDNR unpublished data). However, fisheries surveys were conducted extensively on Cheat Lake from the 1950's through the 1970's and no Walleyes were collected during this timeframe (Core 1959; WVDNR unpublished data). Likewise, Core (1959) stated that Walleyes were likely extirpated from Cheat Lake by the late 1940's due largely to acid mine drainage pollution. With improving water quality in the Cheat River watershed due to mitigation of acid mine drainage pollution, WVDNR began stocking Walleyes in Cheat Lake in 1999 (Table 3.1). Temporal monitoring was conducted on the Cheat Lake fish community and Walleye population from 1990–2015. Prior to the initiation of Walleye stocking, Walleyes were still effectively absent from the reservoir. Gill net CPUE was near zero (0.04 Walleye/net-night) from 1990–1998, with one adult Walleye captured (443 mm TL) in 1997 (Figure 3.2). Walleyes had not been stocked when this individual was captured. The origin of this fish is unknown, but could be evidence of a small, remnant population of Walleyes or perhaps more likely was the result of an angler introduction. Given the lack of Walleyes captured for decades in the lake, and the propensity for anglers to introduce sportfish, it seems more likely this fish was the result of an angler introduction. After stocking was initiated in Cheat Lake, Walleye gill net CPUE immediately increased and has averaged 1.55 fish/net-night during the post-stocking time period (2001–2015; Figure 3.2). Although Walleye CPUE has significantly increased over time, this significant change can be attributed to the differences in Walleye abundance before and after stocking. Walleye CPUE in gill net surveys has not significantly increased over time since stocking began. During this time, Walleye relative abundance has fluctuated with periods of relatively low abundance, followed by peaks in abundance in 2008 (3.7 fish/net-night), 2014 (2.8 fish/net-night), and 2015 (3.3 fish/net-night). The last two years (2014 and 2015) of monitoring showed consecutive peaks in relative abundance and it remains to be seen if an upward trend in abundance will persist or if it will continue to fluctuate between low and high CPUE numbers. Given continued improvements in water quality, increases in forage within Cheat Lake (see Chapter 2), and evidence of natural reproduction, it is possible that future overall mean Walleye abundance will increase.

Compared to relative abundance estimates from other studies, gill net CPUE of Walleyes in Cheat Lake is still quite low (Li et. al 1996; Munger and Kraal 1997; Porath et al. 2003; Ward et al. 2007; Isermann 2007; Katt et al. 2011; Bethke and Staples 2015). However, standard gill net surveys in these other states (e.g., Minnesota, Nebraska, South Dakota, etc.) typically utilize much longer gill nets and longer soak times (≥ 76 m, > 12 hours; Li et. al 1996; Munger and Kraal 1997; Porath et al. 2003; Ward et al. 2007; Isermann 2007; Katt et al. 2011; Bethke and Staples 2015) compared to the shorter gill nets and soak times used in our study and other WV reservoirs (≤ 45 m, < 12 hours). Additionally, the steep slopes of Cheat Lake and WV reservoirs could reduce effectiveness compared to lakes and reservoirs in other states. Nevertheless, compared to five other WV reservoirs, Cheat Lake had moderate Walleye abundance with gill net CPUE higher than 3 of the 5 populations (WVDNR, unpublished data).

We estimated size structure, age, and growth for 123 Walleyes ranging in length from 163–790 mm (mean 439 mm). Size structure estimates indicated high abundance of quality length (> 380 mm) and preferred length (> 510 mm) Walleyes in Cheat Lake (Figure 3.3). Additionally, both memorable (> 630 mm) and trophy length (> 760 mm) fish were present in samples. Additionally, Cheat Lake Walleyes exhibited fast growth and large maximum lengths, especially for females, when compared to average growth based on other North American populations (Quist et al. 2003; Figure 3.6). Age and growth analysis indicates that Cheat Lake

Walleyes show substantial differences in growth between males and females (Figure 3.5). Although male Walleyes typically don't exceed 502 mm total length, female Walleyes grow substantially larger. The largest female Walleye captured was 790 mm and the estimated female maximum length from growth models was 754 mm. Fast growth and large maximum sizes of Walleyes could be attributed to a number of factors including climate, forage availability, and density (Kocovsky and Carline 2001; Quist et al. 2003; Bednarski et al. 2010; Bozek et al. 2011). The milder climate found in West Virginia compared to northern latitudes with abundant Walleye populations could provide beneficial growing conditions in the form of a longer growing season, similar to conditions found in other studies (Kocovsky and Carline 2001; Quist et al. 2003; Bednarski et al. 2010; Bozek et al. 2011). Additionally, Cheat Lake has a diverse forage base that includes Yellow Perch, Gizzard Shad, and several species of shiners (*Notropis sp.*). Adequate forage of optimal size has been shown in other studies to benefit Walleye growth (Hartman and Margraf 1992; Quist et al. 2003; Bozek et al. 2011). Finally, density has also been suggested to impact Walleye growth (Kocovsky and Carline 2001; Bozek et al. 2011). Cheat Lake Walleyes are only moderately abundant compared to other West Virginia reservoirs. This relatively low density of Walleyes within Cheat Lake could be another factor contributing to fast growth.

Although it is apparent that fry and fingerling stockings have been critical to the reestablishment of the Cheat Lake Walleye fishery, this study provides evidence of increasing natural reproduction. Aged individuals belonging to year classes when no stocking occurred (i.e., 2008, 2011, 2013), and collection of young of the year in increasing numbers during fall electrofishing surveys during non-stocking years (i.e., 2011, 2013, 2015) have shown that natural reproduction is occurring and potentially increasing in Cheat Lake. The occurrence and potential increase in natural reproduction has likely resulted, in part, from successfully establishing an adult population from stocking, and improved spawning conditions (i.e., pH of

Cheat Lake headwaters during spring). Walleyes were extirpated from Cheat Lake by the late 1940's due to acid mine drainage pollution and therefore a viable population did not exist to allow for natural reproduction. Stocking efforts successfully reestablished Walleyes in the reservoir allowing for a potential spawning population to develop. Also, early life stages of Walleyes have been shown to be sensitive to acidic conditions (Hulsman et al. 1983; Rahel and Magnuson 1983). Waters with pH $< 6.0$ during spawning periods can lead to significantly increased mortality of eggs and larvae and ultimately the extirpation of Walleye populations (Hulsman et al. 1983; Rahel and Magnuson 1983). As recently as 1990, pH values in Cheat Lake frequently decreased to less than 5.0 (see Chapter 2). Although conditions continued to improve, early spring pH values regularly experienced depressions in which pH fell below 6.0 as recently as 2011 (see Chapter 2). However, since 2012, pH values in Cheat Lake have not reached levels less than 6.0 due to increasing acid mine drainage abatement occurring within the watershed (see Chapter 2). The reestablishment of Walleyes via stocking and these improving water quality conditions within Cheat Lake appear to have led to successful natural reproduction within Cheat Lake.

The results from our examination of diets of Cheat Lake Walleyes were similar to those found in other studies (Forney 1974; Hartman and Margraf 1992; Kocovsky and Carline 2001; Pothoven et al. 2016). Age 1+ Walleyes consumed a variety of prey fish, including Yellow Perch, Gizzard Shad, Emerald Shiner, *Lepomis sp.* and *Micropterus sp.* (Table 3.7). Specifically, diet examination of Walleyes indicated that Yellow Perch are an important forage species in Cheat Lake. Yellow Perch occurred in 67% of diets collected in Cheat Lake and were also one of the largest prey items encountered in stomach contents (Table 3.7). Yellow Perch have been shown to be important, but not necessarily preferred forage for Walleyes in many waters of the midwestern and northern United States (Forney 1974; Swenson 1977; Lyons and Magnuson 1987; Hartman and Margraf 1992; Kocovsky and Carline 2001). In some waters

Yellow Perch are a primary prey selected by Walleyes (Forney 1974; Swenson 1977; Lyons and Magnuson 1987), whereas in others they act as an important secondary prey source (Hartman and Margraf 1992; Kocovsky and Carline 2001). Gizzard Shad and Emerald Shiners have also been shown in previous studies to be important prey for Walleyes (Hartman and Margraf 1992; Kocovsky and Carline 2001). Gizzard Shad were the second most common prey item in Cheat Lake Walleye diets (12.1%), whereas Emerald Shiners were found in diets but at a lower frequency (6.1%). Young Gizzard Shad abundance in Cheat Lake is variable and it is possible that during years of high juvenile Gizzard Shad abundance that Walleyes increase foraging on this species (Hartman and Margraf 1992). Additionally, it is important to note that diets were only sampled in fall months and possibly differ at other times of the year. We also only examined diets from a relatively small sample size of stomachs with food present (n=33). To obtain a more representative sample of Walleye diets, a higher sample size during multiple seasons would be beneficial. Increased abundance of large Walleyes and fast growth of females suggests that good foraging and habitat conditions exist in Cheat Lake. The large population of Yellow Perch, and increasing abundance of important prey such as Gizzard Shad, Emerald Shiners, Silver Shiners, and Mimic Shiners may provide Cheat Lake Walleyes with a unique forage base for West Virginia conducive to fast and persistent growth.

The results of this study provide valuable information on the population characteristics of a reestablished Walleye fishery in Cheat Lake, WV. Results from this study will be beneficial for the future management of this reestablished Walleye fishery. Additionally, these results provide a unique example of the response of Walleyes to reestablishment after extirpation from environmental stressors. Currently, it appears the Walleye population is exceptionally healthy compared to other West Virginia reservoir populations. Cheat Lake Walleyes grow fast, attain large sizes, have abundant forage, and are showing evidence of natural reproduction. However, abundance is moderately low at times, and it is unknown how dependent this population will be on stocking efforts in the future. Additionally, angling pressure on this population remains unknown, but from opportunistic angler interviews pressure still appears to be low. Additional pressure and success of anglers could alter the current dynamics of this population. Future research on angler effort and harvest of Walleyes in Cheat Lake would significantly improve the ability to manage this population. Additionally, continued improvement and sustainability of this population will be dependent on adequate spawning and habitat conditions and/or stocking success. Walleyes were originally extirpated from Cheat Lake due to acidic conditions and acid mine drainage still persists in the watershed despite continued mitigation efforts. There have been no pH depressions since 2011, but if acidic conditions were to return, future natural reproduction of Walleyes could be significantly reduced. Additionally, spawning success of Walleyes in Cheat Lake could be impacted by water level fluctuations which can lead to egg and/or larval mortality (Bozek et al. 2011; see Chapter 5). Also, the fast growth and good condition of Cheat Lake Walleyes are dependent on adequate prey availability and foraging conditions. Forage availability for Walleyes could be impacted from worsening water quality or reduced recruitment of forage species owing to spring water level fluctuations (specifically for Yellow Perch). Future management efforts should focus on further monitoring of Walleye population characteristics, investigation of angler pressure on Cheat Lake Walleyes and continued work to ensure good water quality persists into the future.

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**Table 3.1.** Number of Walleyes stocked in Cheat Lake since reintroduction began in 1999.

| | Fry | Fingerlings |
|---|---|---|
| 1999 | 1,700,000 | |
| 2000 | 1,000,000 | |
| 2001 | | 50,000 |
| 2004 | | 50,000 |
| 2005 | | 43,812 |
| 2006 | | 46,362 |
| 2007 | | 33,346 |
| 2009 | | 6,800 |
| 2010 | | 87,712 |
| 2012 | | 31,775 |
| 2014 | | 5,000 |

**Table 3.2**. AICc model selection results for candidate growth models for Cheat Lake Walleyes.

| Model | K | $AIC_c$ | $\Delta AIC_c$ | $w_i$ |
|---|---|---|---|---|
| | Females | | | |
| **VBGM** | 4 | 838.38 | 0 | 1 |
| **Gompertz** | 4 | 849.78 | 11.4 | 0 |
| **Logistic** | 4 | 860.71 | 22.33 | 0 |
| | Males | | | |
| **VBGM** | 4 | 668.65 | 0 | 0.74 |
| **Gompertz** | 4 | 671.39 | 2.74 | 0.19 |
| **Logistic** | 4 | 673.34 | 4.69 | 0.07 |

**Table 3.3.** Parameter estimates for von Bertalanffy (VBGM), Gompertz, and logistic growth models for Cheat Lake, WV Walleye growth.

| | | Females | | Males | |
|---|---|---|---|---|---|
| **Model** | **Parameter** | **Estimate** | **SE** | **Estimate** | **SE** |
| **VBGM** | $L_\infty$ | 753.968 | 32.968 | 501.532 | 9.671 |
| | **k** | 0.313 | 0.037 | 0.746 | 0.113 |
| | $t_0$ | -0.172 | 0.102 | 0.184 | 0.122 |
| **Gompertz** | $L_\infty$ | 696.86 | 21.971 | 494.094 | 8.168 |

| | | | | | |
|---|---|---|---|---|---|
| | **k** | 0.516 | 0.044 | 1.044 | 0.141 |
| | **$t_0$** | 1.159 | 0.073 | 0.752 | 0.054 |
| **Logistic** | **L∞** | 665.592 | 17.591 | 490.291 | 7.569 |
| | **k** | 0.736 | 0.054 | 1.376 | 0.17 |
| | **$t_0$** | 1.787 | 0.099 | 1.1 | 0.047 |

**Table 3.4**. Summary of length at age data for Cheat Lake Walleyes (Females).

| Age | n | Mean TL (mm) | Mean RGI | SD | Percentile |
|---|---|---|---|---|---|
| 1 | 28 | 227 | 131 | 15.1 | 75-90 |
| 2 | 11 | 399 | 133 | 3.7 | 75-90 |
| 3 | 13 | 475 | 120 | 4.6 | 75-90 |
| 4 | 14 | 547 | 120 | 6.7 | 90-95 |
| 5 | 14 | 586 | 117 | 9.4 | 90-95 |
| 6 | 2 | 687 | 125 | 0.7 | 95-100 |
| 7 | 2 | 673 | 116 | 2.4 | 95-100 |
| 8 | . | . | . | . | . |
| 9 | 1 | 790 | 132 | . | n/a |

**Table. 3.5**. Summary of length at age data for Cheat Lake Walleyes (Males).

| Age | n | Mean TL (mm) | Mean RGI | SD | Percentile |
|---|---|---|---|---|---|
| 1 | 28 | 227 | 131 | 16.1 | 75-90 |
| 2 | 8 | 393 | 137 | 3.6 | 75-90 |
| 3 | 2 | 409 | 114 | 7.9 | 50-75 |
| 4 | 1 | 424 | 104 | . | 50-75 |
| 5 | 15 | 477 | 105 | 9.4 | 50-75 |
| 6 | 6 | 488 | 106 | 6.0 | 50-75 |
| 7 | 1 | 480 | 101 | . | 50-75 |
| 8 | . | . | . | . | . |
| 9 | 2 | 560 | 115 | 5.2 | n/a |
| 10 | 2 | 502 | 103 | 2.6 | n/a |
| 11 | . | . | . | . | . |
| 12 | . | . | . | . | . |
| 13 | . | . | . | . | . |
| 14 | 1 | 600 | 121 | . | n/a |

**Table 3.6**. von Bertalanffy growth parameters for Walleyes in Cheat Lake, North American average (Quist et al. 2003) and for five other West Virginia reservoirs.

| | $L_\infty$ | k | $t_0$ |
|---|---|---|---|
| Females | | | |
| Cheat Lake, WV | 754 | 0.313 | -0.172 |
| N.A. average (Quist et al. 2003) | 652 | 0.266 | -0.346 |
| East Lynn Lake, WV | 690 | 0.41 | 0.20 |
| Burnsville Lake, WV | 682 | 0.33 | -0.11 |
| Stonecoal Lake, WV | 655 | 0.36 | -0.31 |
| Tygart Lake, WV | 644 | 0.15 | -1.02 |
| Summersville Lake, WV | 422 | 0.68 | 0.16 |
| Males | | | |
| Cheat Lake, WV | 502 | 0.746 | 0.184 |
| N.A. average (Quist et al. 2003) | 496 | 0.419 | -0.083 |
| East Lynn Lake, WV | 558 | 0.67 | 0.37 |
| Burnsville Lake, WV | 500 | 0.65 | 0.16 |
| Stonecoal Lake, WV | 494 | 0.73 | -0.01 |
| Tygart Lake, WV | 416 | 0.43 | -0.56 |
| Summersville Lake, WV | 372 | 1.23 | 0.47 |

**Table 3.7**. Summary of diet contents from Cheat Lake Walleyes (n = 33).

| Prey Species | *Oi* | *MNi* | Prey size range (mm) | Mean prey size (mm) |
|---|---|---|---|---|
| Yellow Perch | 66.7 | 48.1 | 76-229 | 110 |
| Gizzard Shad | 12.1 | 23.1 | 84-132 | 121 |
| Emerald Shiner | 9.1 | 19.2 | 71-98 | 87 |
| *Lepomis sp*. | 9.1 | 5.8 | 40-76 | 58 |
| *Micropterus sp.* | 3.0 | 3.8 | 104 | 104 |

**Figure 3.1.** Walleye gill net sampling locations in Cheat Lake, WV.

**Figure 3.2.** Temporal changes in CPUE (Walleyes/net-night) of Fall Walleye gill net surveys for Cheat Lake. Error bars represent one standard error. Black dashed line represents the first year of Walleye stocking in 1999.

**Figure 3.3.** Sex-specific length frequency distribution (25-mm bins) of Cheat Lake, WV Walleyes (n (females) = 57, n (males) = 38, n (immature) = 28) collected for age and growth analysis.

**Figure 3.4.** Age frequency distribution (adjusted +1 year for comparison with Quist et al. 2003 growth standards) of Cheat Lake, WV Walleyes (n =123) collected for age and growth analysis during fall of 2013 and 2014.

**Figure 3.5.** The von Bertalanffy growth model fit to length at age data for 123 Cheat Lake Walleyes (ages 1–14). Female growth model is represented by black line and female mean length at age represented by circles. Male growth model is represented by blue line and male mean length at age represented by triangles. The von Bertalannfy model parameters for males and females are provided.

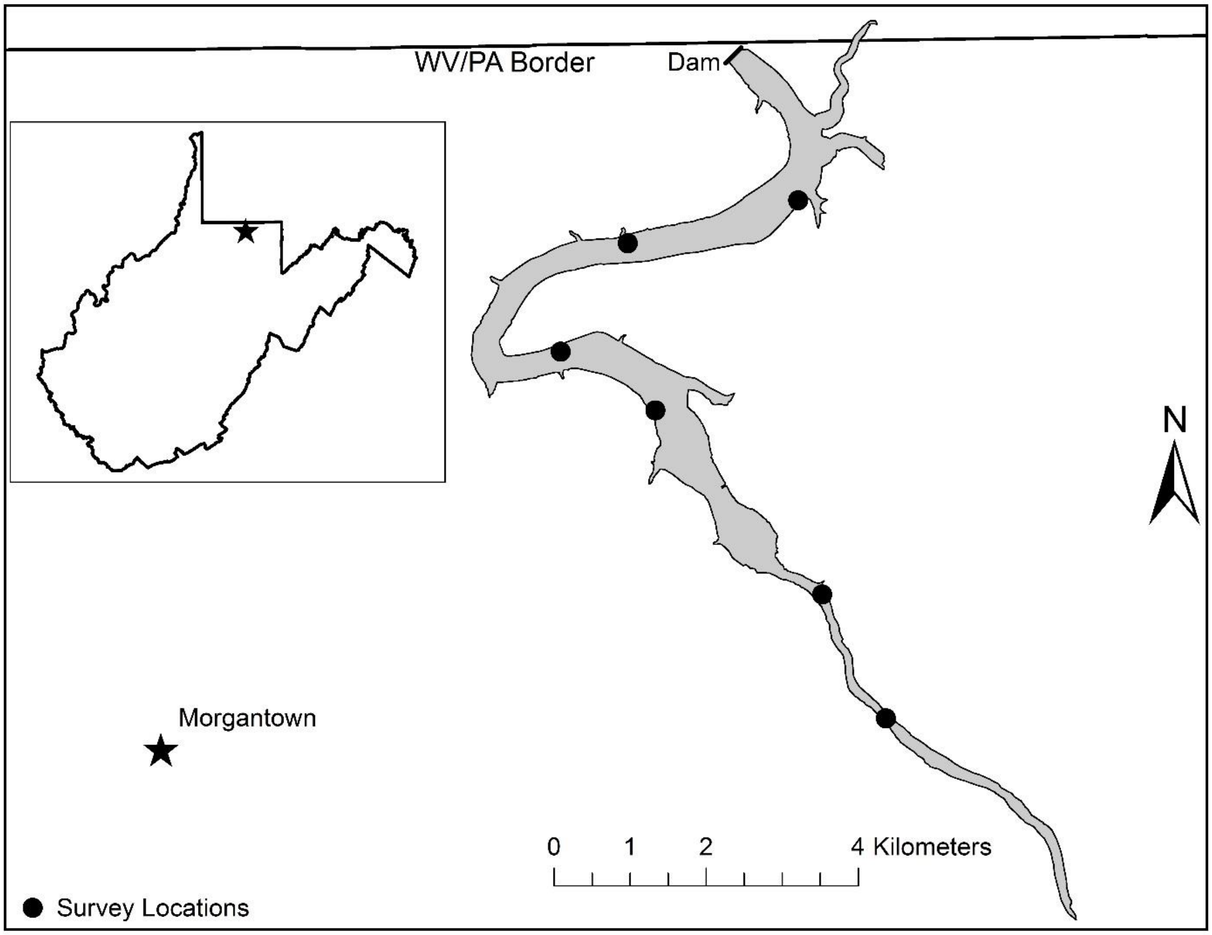
**Figure 3.6.** Comparison between growth rates of female Cheat Lake, WV Walleyes to the average North American growth rate (Quist et al. 2003) using von Bertalanffy growth models.

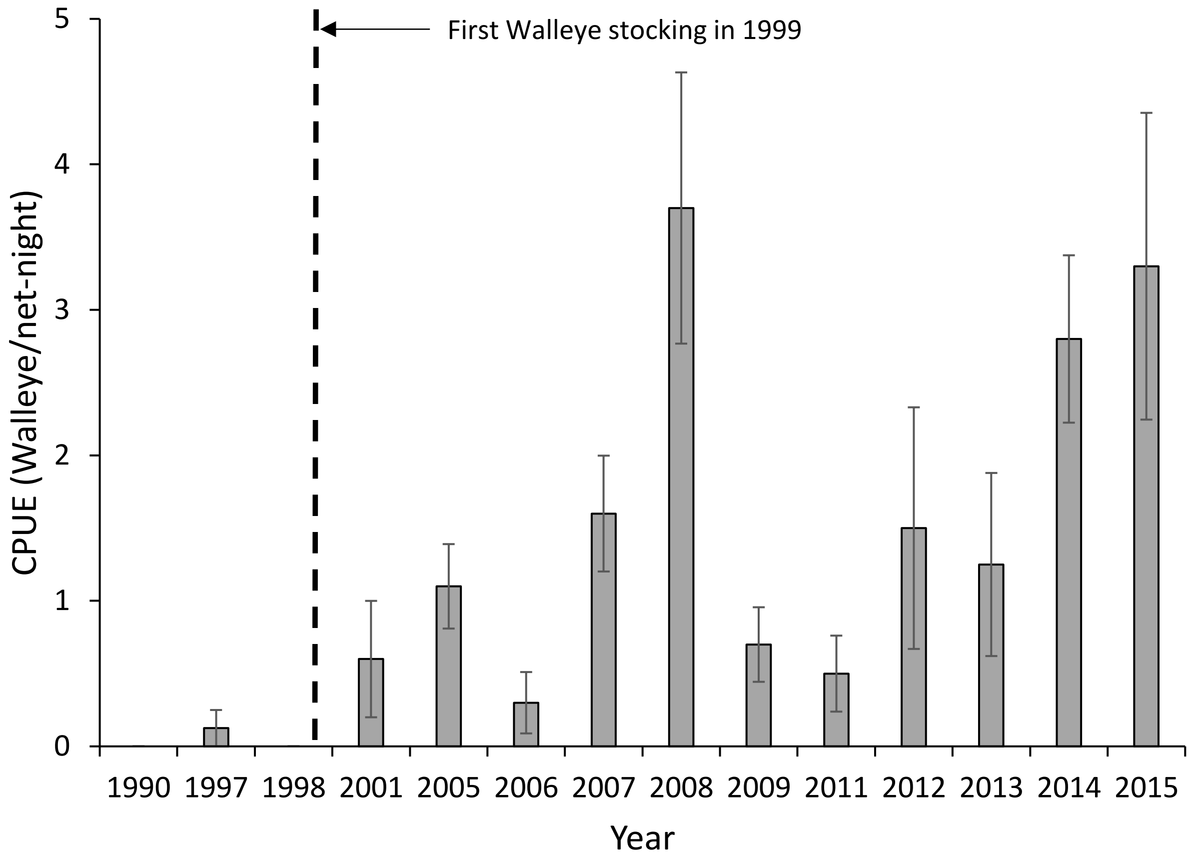
**Figure 3.7.** Comparison between growth rates of male Cheat Lake, WV Walleyes to the average North American growth rate (Quist et al. 2003) using von Bertalanffy growth models.

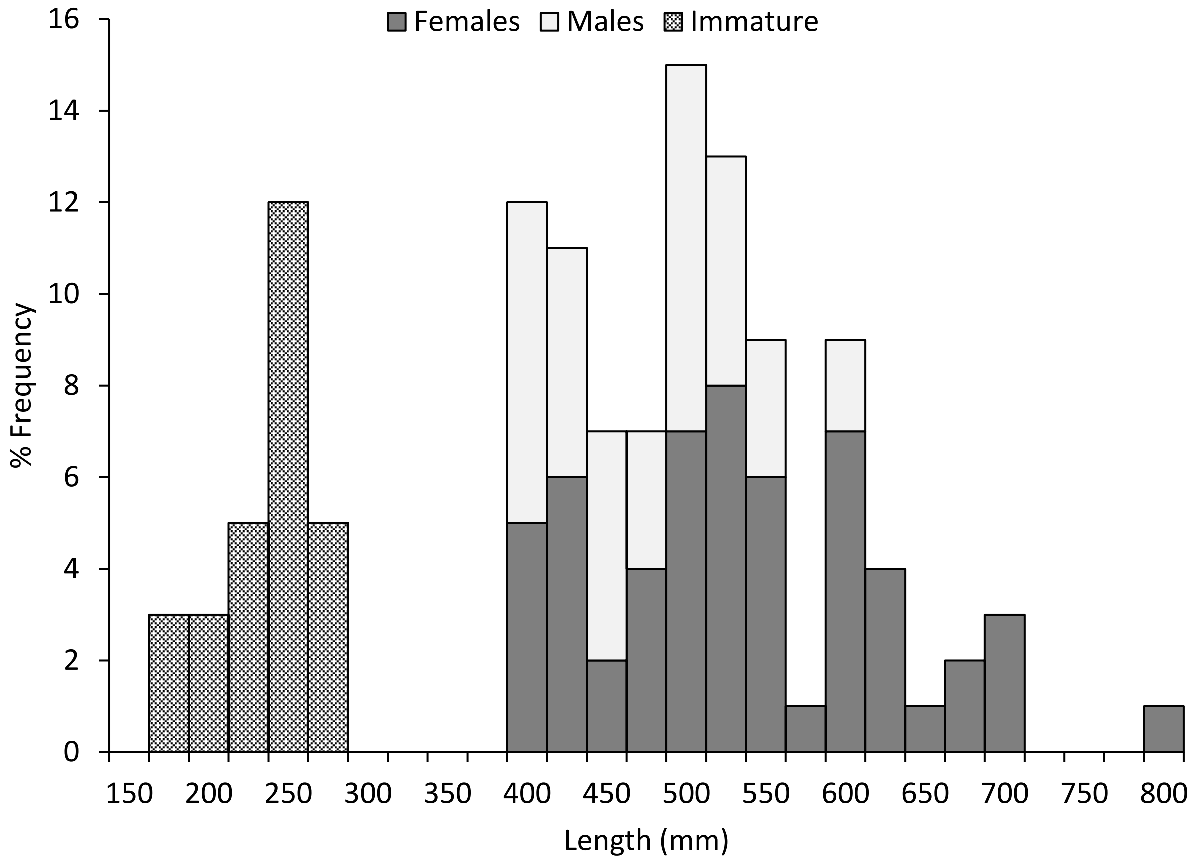
**Figure 3.8.** Comparison between growth rates of female Cheat Lake, WV Walleyes to the Walleye growth rates in five other West Virginia reservoirs (East Lynn, Burnsville, Stonecoal, Tygart, and Summersville Lakes) using von Bertalanffy growth models.

**Figure 3.9.** Comparison between growth rates of male Cheat Lake, WV Walleyes to the Walleye growth rates in five other West Virginia reservoirs (East Lynn, Burnsville, Stonecoal, Tygart, and Summersville Lakes) using von Bertalanffy growth models.

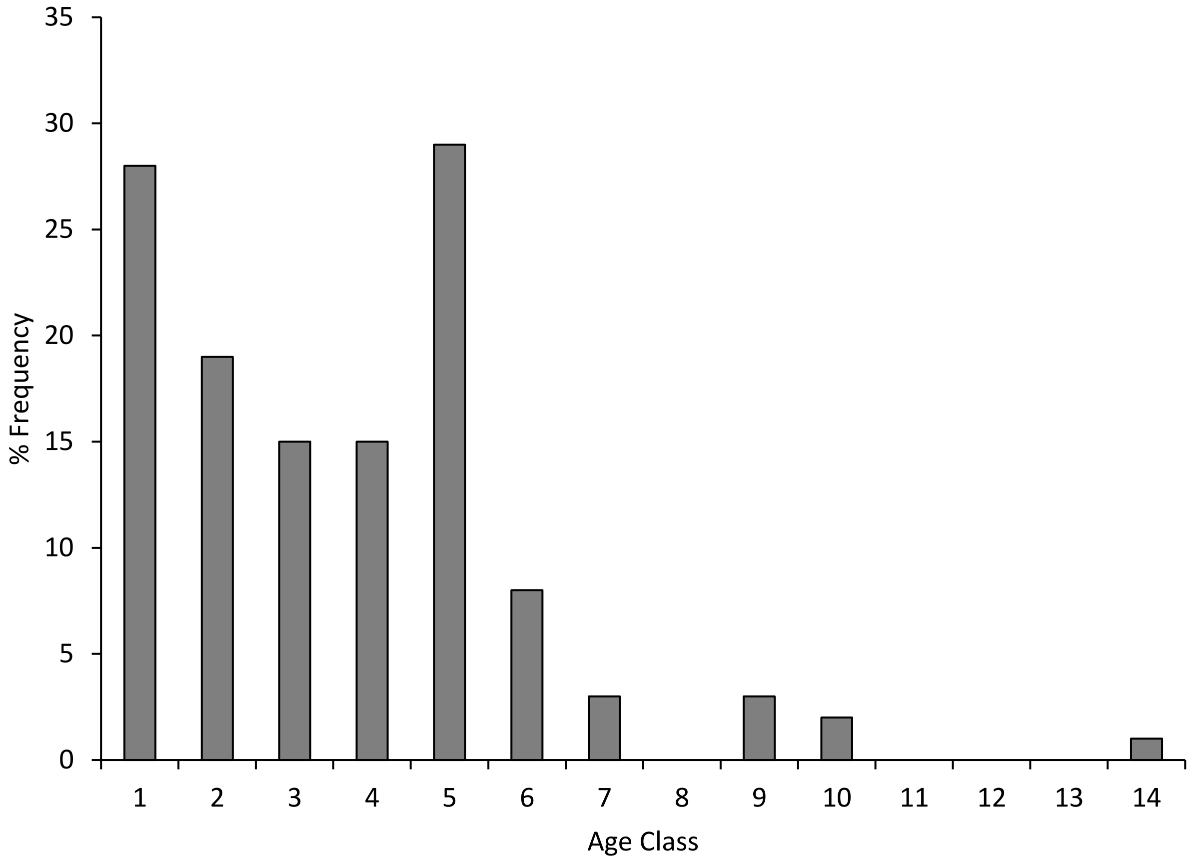
**Figure 3.10.** Year class frequency of Walleyes collected for age and growth analysis (n=123) during fall of 2013 and 2014. Years when fingerlings were stocked are represented by black bars. Years without Walleye stockings are represented by cross-hatched bars.


WV/PA Border
Dam
N
Morgantown
0 1 2 4 Kilometers
Survey Locations

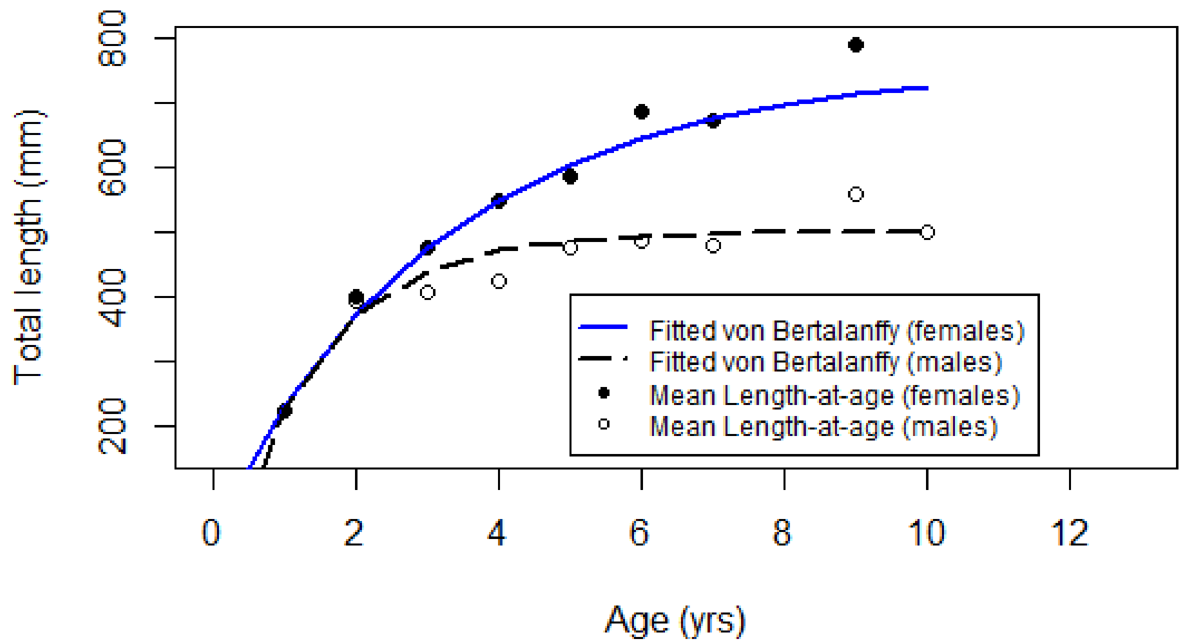

First Walleye stocking in 1999
CPUE (Walleye/net-night)
0
1
2
3
4
5
1990
1997
1998
2001
2005
2006
2007
2008
2009
2011
2012
2013
2014
2015
Year



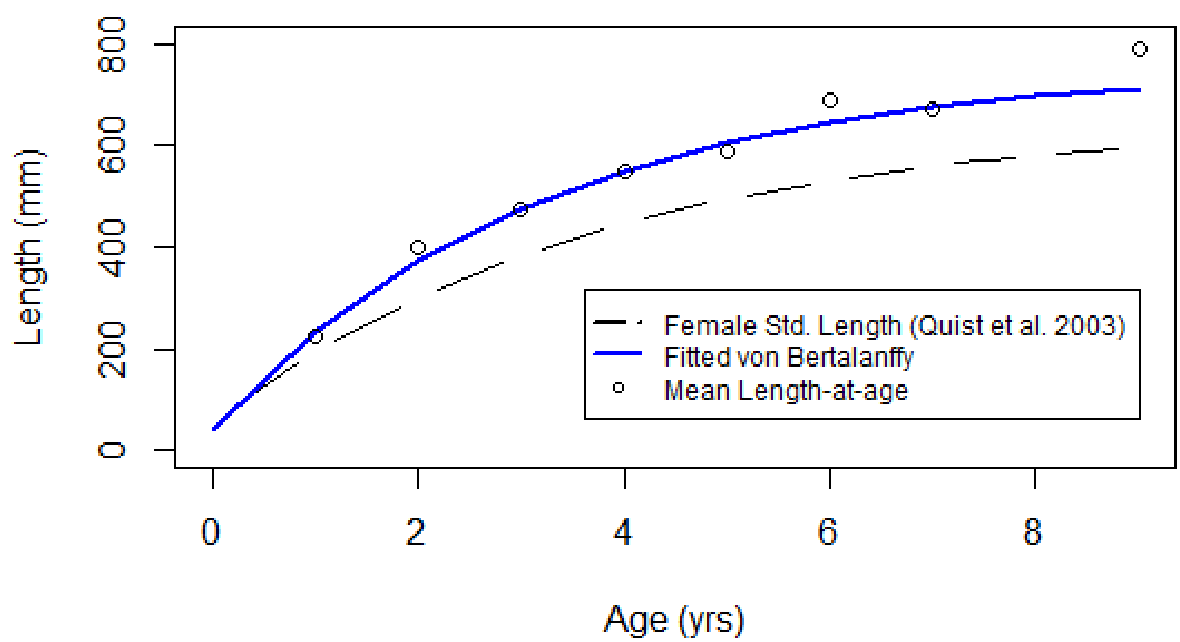
Females
Males
Immature
% Frequency
0
2
4
6
8
10
12
14
16
150
200
250
300
350
400
450
500
550
600
650
700
750
800
Length (mm)



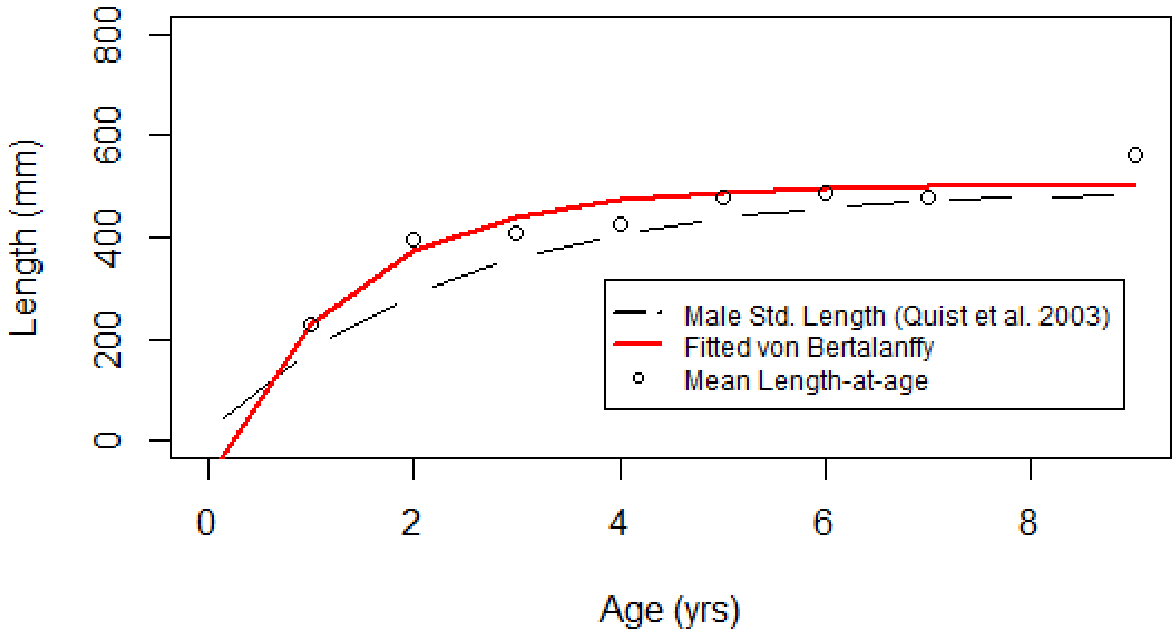
35
30
25
20
15
10
5
0
% Frequency
1
2
3
4
5
6
7
8
9
10
11
12
13
14
Age Class



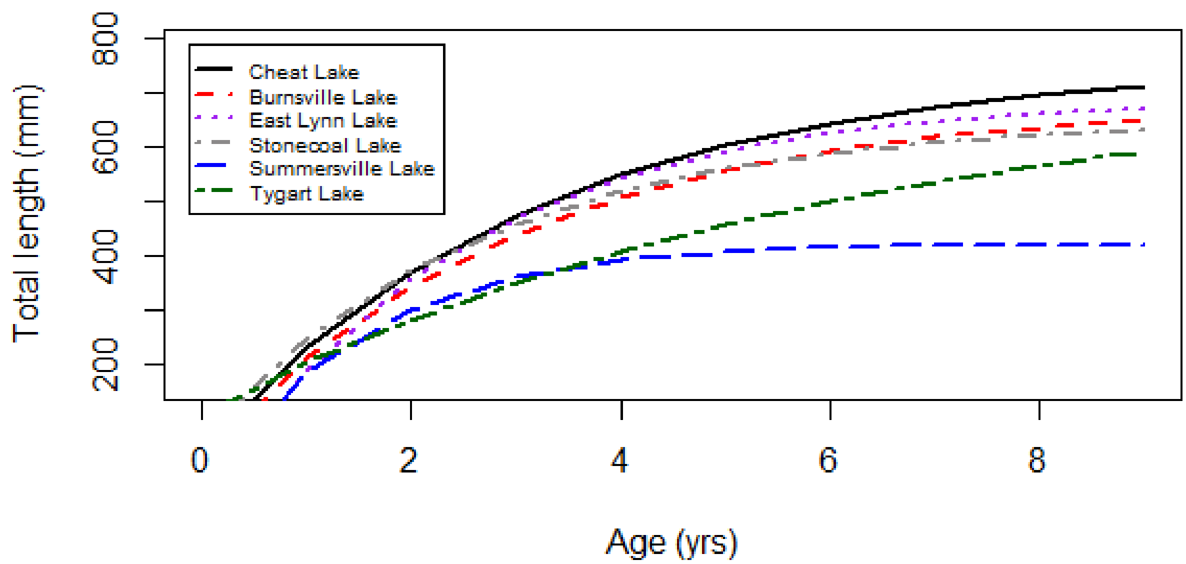
Total length (mm)
800
600
400
200
0
2
4
6
8
10
12
Age (yrs)
Fitted von Bertalanffy (females)
Fitted von Bertalanffy (males)
Mean Length-at-age (females)
Mean Length-at-age (males)

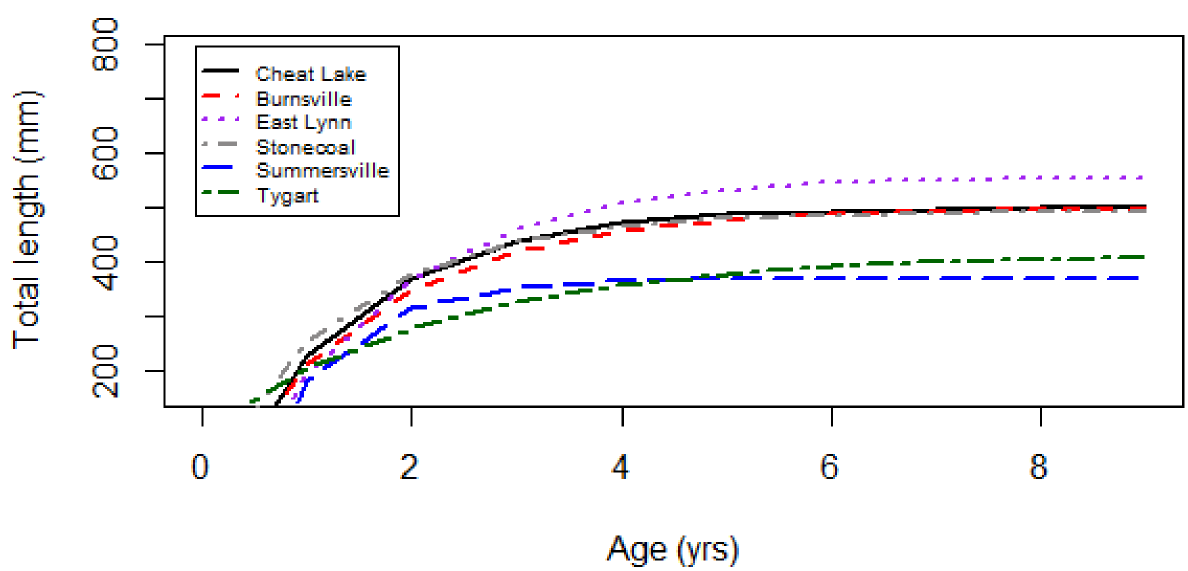



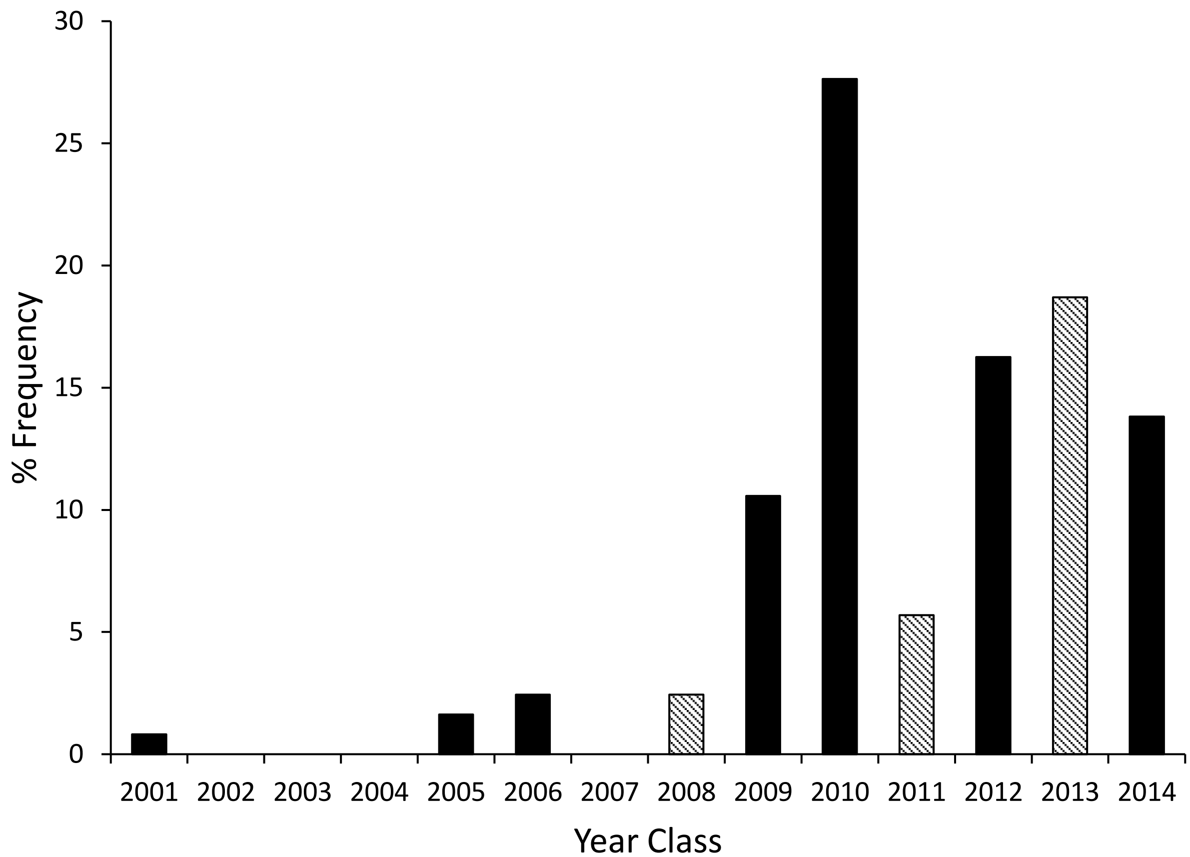
Length (mm)
800
600
400
200
0
0
2
4
6
8
Age (yrs)
Female Std. Length (Quist et al. 2003)
Fitted von Bertalanffy
Mean Length-at-age



Length (mm)
0
200
400
600
800
0
2
4
6
8
Age (yrs)
Male Std. Length (Quist et al. 2003)
Fitted von Bertalanffy
Mean Length-at-age


Cheat Lake
Burnsville Lake
East Lynn Lake
Stonecoal Lake
Summersville Lake
Tygart Lake
Total length (mm)
800
600
400
200
0
2
4
6
8
Age (yrs)


Cheat Lake
Burnsville
East Lynn
Stonecoal
Summersville
Tygart
Total length (mm)
800
600
400
200
0
2
4
6
8
Age (yrs)



30
25
20
15
10
5
0
% Frequency
2001
2002
2003
2004
2005
2006
2007
2008
2009
2010
2011
2012
2013
2014
Year Class

# Chapter 4 – Seasonal distribution and space use patterns of Walleyes in a hydropower reservoir

## Abstract

Knowledge and understanding of the ecology and spatial distribution of sportfishes, such as Walleye (*Sander vitreus*), are critical for fisheries management. Recently, a Walleye population was reestablished in Cheat Lake, a 700 ha hydropower reservoir in northern West Virginia, where movement patterns and spatial distribution of this species had not been described. From 2012–2015, seasonal movements and distribution of telemetered Walleyes in Cheat Lake were monitored using a stationary acoustic receiver array. Walleye locations were analyzed for seasonal changes in distribution and space use patterns as measured through seasonal distribution, home range, core range, and lake residency. Walleye movements and distributions varied seasonally and by sex. Overall, the most heavily used area of Cheat Lake by Walleyes were main lake habitats compared to riverine habitats (59.1% of overall time). Seasonally, riverine habitats were most heavily used from March–August (47.6%), with the highest proportion of use occurring in March (62.1%). In contrast, main lake habitat was most heavily used from September–February (73.9%), with the highest proportion of use occurring in January (87.9%). Additionally, male Walleyes were more likely to occupy riverine habitats compared to female Walleyes. Most Walleyes demonstrated seasonal shifts in core range and linear home range. Additionally, male Walleyes were more likely to have more than one core range compared to females. Number of monthly range shifts were higher than average from March–May, and October–November. Also, as indicated by residency index, male Walleyes were more likely to emigrate from Cheat Lake into the incoming river upstream compared to females. Overall, distribution and space use patterns indicated that Walleyes were overall more likely to experience range shift or changes in distribution in spring and fall months. These

temporal patterns of distribution were likely associated with spawning activity in spring and movement to overwintering habitats in fall. Knowledge of these spatial patterns will inform management efforts, as well as provide anglers with beneficial knowledge in targeting this improving fishery.

## Introduction

Understanding the spatial ecology of top predators in reservoir ecosystems is a critical component to conservation and management of reservoir fisheries (Craig 2000; Lucas and Baras 2000; Quist et al. 2003; Landsman et al. 2011; Daly et al. 2014). Top predators such as Walleyes are important in structuring fish communities and are also often popular sportfish (Craig 2000; Quist et al. 2003; Pothoven et al. 2016). Spatial distribution and home range of such species often varies seasonally depending on habitat needs associated with spawning, foraging, and overwintering (Williams 2001; DePhilip et al. 2005; Palmer et al. 2005; Foust and Haynes 2007; Bozek et al. 2011). Home and core range can also vary individually within a population or have sex based differences (Palmer et al. 2005; Bozek et al. 2011; Hayden et al. 2014). Knowledge of the seasonal distribution and spatial ecology of top predators can greatly benefit reservoir fisheries management through understanding of spatial trophic structure and spatial vulnerability of populations to fishing pressure (Craig 2000; Quist et al. 2003; Pothoven et al. 2016).

Given the economic importance of recreational and commercial Walleye fisheries (Schmalz et al. 2011), managers need information on the extensive movements and seasonal shifts in distribution of Walleyes in conjunction with spawning, foraging, and overwintering (Paragamian 1989; DePhillip et al. 2005; Hanson 2006; Bozek et al. 2011). Several tagging studies have examined the spatial ecology of Walleyes (Eschemeyer and Crowe 1955; Crowe 1962; Paramagian 1989; DePhillip et al. 2005; Palmer et al. 2005; Hanson 2006; Hayden et al. 2014). Past studies have focused mostly on Walleye movements and distribution in northern or midwestern states (Holt et al. 1977; Paramagian 1989; Williams 2001; DePhillip et al. 2005; Hanson 2006; Bozek et al. 2011). Although much is known about Walleye life history including spatial ecology (Bozek et al. 2011), as with many species, movement patterns and spatial ecology can have substantial variation between waterbodies and regions (Bozek et al. 2011). Research on Walleye movement suggests that movement can vary seasonally and with changing environmental conditions (Paragamian 1989; Williams 2001; DePhillip et al. 2005; Palmer et al. 2005; Hanson 2006; Bozek et al. 2011). Most studies on Walleye distribution and habitat use have focused on activity during spawning with less focus on non-spawning periods (Paragamian 1989; DePhillip et al. 2005; Palmer et al. 2005; Hanson 2006; Bozek et al. 2011). Although Walleye movement has been extensively studied in several regions such as the Great Lakes and the Midwest, little research has been conducted in Appalachian reservoirs (Williams 2001; Palmer et al. 2005). Additionally, a substantial portion of research on Walleye spatial ecology has employed manual tracking techniques. Recently, researchers have used continuous acoustic monitoring of Walleyes with stationary acoustic receivers (Hanson 2006; Phillips 2014; Hayden et al. 2014; Peat et al. 2015; Raby et al. 2018).

Cheat Lake is a hydropower reservoir in northern West Virginia that historically supported Walleye but has been impacted by acidification. For over a century, Cheat Lake was severely impacted by acid mine drainage from abandoned mine lands (Core 1959; Welsh and Perry 1997; Freund and Petty 2007; Merovich et al. 2007). As a result, Walleyes were reportedly extirpated from the reservoir in the late 1940's (Core 1959). Abatement of acid mine drainage pollution, beginning in the 1980's, has led to improved water quality in the reservoir and throughout the watershed (McClurg et al. 2007). In response to improved water quality, the

WVDNR began stocking Walleyes in 1999 and have continued on a bi-annual basis. Given the success of stockings and recent evidence of natural reproduction, more information on the life history of Walleyes in Cheat Lake, including movements and distribution, would be beneficial to the future management of the population. Information gained on both spawning and non-spawning seasonal locations and movements would further enhance management opportunities of the fishery. Therefore, there is a need for research investigating seasonal distribution and space use patterns of Walleyes within Cheat Lake. With knowledge of seasonal distribution and other spatial behavior, managers can better predict potential impacts to the population by environmental conditions and fishing pressure. Increased knowledge of Walleye distribution, home range, and residency would provide beneficial information to both managers and anglers.

The goal of this study was to determine the seasonal home and core range, lake residency, and seasonal distribution of Walleyes in a West Virginia hydropower reservoir. Specifically, one objective was to determine what reservoir areas were utilized, and if distributions changed temporally or differed between males and females. Additionally, we sought to determine residency of Cheat Lake Walleyes, how Walleyes may emigrate from the system, and if there were temporal or sex based differences in residency.

## Methods

### *Study Area*

Cheat Lake, formed in 1926, is a hydropower reservoir on the lower Cheat River, northern West Virginia. The reservoir has a surface area of 700 ha, is approximately 21 km in length and has a maximum depth of 24 m near its dam. The reservoir serves the needs of a hydroelectric generating facility at its dam. The reservoir experiences daily and seasonal water level fluctuations due to hydropower operations. Fluctuations are restricted to 0.6 m from May –

October and are at their maximum during November – March when levels can fluctuate 3.9 m. Fluctuations are restricted to 2.1 m during April in an attempt to protect spawning habitat and activities of Walleye and Yellow Perch.

For this study, we designated three spatial zones of Cheat Lake for comparisons of Walleye movements and distribution: the riverine zone, middle main lake zone, and lower main lake zone (including embayments) (Figure 4.1). Additionally, we recognized the Cheat River upstream of the reservoir as a separate zone (Figure 4.1). Separation of these zones was based on various factors including reservoir morphology, bathymetry, and water chemistry differences. Specifically, based on morphology, there is a distinct morphological difference between the riverine zone, middle lake zone, and lower lake zone. The riverine zone is relatively narrow in cross section, whereas the middle and lower lake zones are typically 2.5–3 times the width of the riverine zone (Figure 4.1). There is also a distinct difference in hydrological characteristics between the three zones. The riverine zone is heavily influenced by the incoming Cheat River in terms of river current. In contrast, the middle and lower lake zones are much more lacustrine in character as river current is spread out. This is apparent by the typical pattern of overwinter ice formation in the middle and lower lake zones but absence of ice in the riverine zone. Additionally, throughout most of the middle and lower lake zones, average depths are greater than that occurring within the riverine zone. The lower lake zone and middle lake zone also differed in characteristics. Specifically, the middle lake zone is more of a transitional area between the riverine habitat of the riverine zone and the lacustrine habitat of the lower lake zone. The middle lake zone typically has bathymetric and morphological characteristics intermediate of the riverine and lower lake zones.

*Fish Collection and Tagging*

Fifty-two Walleyes (30 males, 20 females, 2 undetermined, 432–708 mm TL) were collected and implanted with acoustic transmitters in the months of October–February, in 2011, 2012, and 2013. Walleyes were collected using boat electrofishing and gill nets from all 3 reservoir zones. Prior to transmitter implantation, each Walleye was measured for total length (mm) and weighed (g). After anesthetization (MS-222, tricaine methanesulfonate, 100 mg/L), acoustic transmitters (Sonotronics CTT-83-3-I) were surgically-implanted into the abdominal cavity of each Walleye (Hart and Summerfelt 1975). Acoustic transmitters were 62 mm in length,16 mm in diameter, weighed 10 g in water and had an estimated battery life of 3 years. Each fish was tagged with a numerically coded external t-bar anchor tag. Each anchor tag displayed contact information in the event of angler caught fish. Additional information was included on each tag recommending the release of the fish due to the 21-day hold time of MS-222. Fish were placed in a V-shaped trough during surgery, ventral side up, and the gills were continuously irrigated with water. Surgical instruments were sterilized prior to surgery and betadine was applied to the incision site as an antiseptic. To insert the transmitter, an incision of approximately 20–30 mm was made and 3–4 sutures of non-absorbable monofilament were used to close the incision (Ethicon). Surgical procedures lasted less than 7 minutes. After surgery, fish were placed in a livewell to recuperate and were monitored until swimming upright and behaving normally (usually a period of 5–10 minutes). To reduce tag-induced behavior, transmitter weight was never more than 2% of the fish weight (Winter 1996). We also included a recovery period of 4 weeks prior to data collection to monitor for abnormal behavior associated with gear-induced and post-surgery stress or injury (Gilroy et al. 2010). When possible Walleyes were sexed by examination of the gonads through the surgical incision or by expulsion of milt for males. Some Walleyes that were initially difficult to sex were later recaptured via fish surveys or anglers and sex was verified.

*Telemetry*

Movements and locations of tagged Walleyes were monitored from January 2012–April 2015. Some manual tracking of Walleyes was conducted to determine fine scale range and distribution. However, tagged Walleyes were predominantly monitored year-round using an array of stationary receivers (Sonotronics omni-directional submersible receivers) deployed throughout Cheat Lake (Figure 4.1). An attempt was made to position receivers relatively equidistant from each other to maximize effective coverage. Receivers were either attached to buoys or tethered to the shoreline via root systems. Receivers were attached to buoys or the shoreline using 9.5 mm steel cable and were anchored in place using two, 20 x 20 cm cinder blocks. Receivers attached to the shoreline were dropped approximately 20–30 m away from and perpendicular to the shoreline. At most, 10 acoustic receivers were active within the reservoir, with an additional receiver placed approximately 1 km upstream of Cheat Lake (upstream of 1$^{st}$ riffle/run complex). The receiver located 12 km upstream of the dam was added in November 2012. The two receivers located within the large embayments near the dam were lost in December 2013. The mean distance between each receiver was approximately 2.4 rkm. Tag detection range of acoustic receivers can be influenced by thermal stratification, acoustic noise (bridges) and sinuosity (Shroyer and Logsdon 2009). Tag detection range varied seasonally in Cheat lake due to thermal stratification. Specifically, thermal stratification reduces the effective range of receivers (Shroyer and Logsdon 2009). Range detection tests determined that the average detection range of acoustic receivers during periods of thermal stratification was 200-500 m. During periods without stratification, range of receivers was between 400-900m.

### ***Data Analysis***

Telemetry data were retrieved from stationary receivers. Data were processed using Sonotronics SURsoftDPC software, and exported to Microsoft Excel for further data processing and analysis. Acoustic telemetry data can produce false detections due to background noise (sonar units, other disturbances) and multiple tagged fish close to a receiver at once (Pincock 2011). Possible false detections were eliminated from the dataset by omitting single detections from individual fish within a 24 hour period (Harasti et al. 2015). Additionally, records of individual fish occurring in multiple locations simultaneously (< 0.01 % of detections) were eliminated from the dataset. Due to the large number of detections per individual fish that often include hours or days of continuous relocations at the same receiver, data were transformed into a manageable format for analysis. Data were transformed to reflect arrival and departure dates/times and direction of travel for individual fish for each receiver (Rosenblatt and Heithaus 2011).

Overall and temporal distribution and range of tagged Walleyes were summarized from processed telemetry data. Due to the potential bias of using number of detections at a receiver from unequal detection range of receivers and seasonal changes in detectability, fish locations were instead summarized by the amount of time each fish spent at a receiver (Walsh et al. 2012; Ramsden et al. 2016). Specifically, the number of overall days each fish spent at each receiver was determined (Ramsden et al. 2016). Calculations of overall days spent near a receiver were transformed for each individual into percent time spent near a specific receiver or percent time spent in a lake zone. Tagged fish were determined to be in the area of a receiver when two or more consecutive detections were recorded within an hour (Walsh et al. 2012). If fish were absent for more than one hour then location was determined to be averaged over the location prior to and after the absence (Cowley et al. 2008). Calculation of percent time spent near a receiver allowed us to determine proportional use of lake zones by individual fish and also proportional use of lake zones by month for all fish. When referencing distribution seasonally, we defined seasons as the following: winter (December–February), spring (March–May), summer (June–August), and fall (September–November). Proportional use of receivers or lake zones were examined for differences across months. Comparisons were also made to determine if there were differences in proportional use of receivers or lake zones by fish sex.

Due to the linear set up of our array system and coarse detail of locations due to relocation data from receivers, we did not utilize traditional home range calculation techniques (Vokoun 2003; Walsh et al. 2012). Instead, we adopted the approach used by Walsh et al. (2012) by calculating probability intervals using Pareto cumulative frequency density plots. This method calculates a utilization distribution that is based on the probability of an individual fish using a particular area (Vokoun 2003; Walsh et al. 2012). As described by Walsh et al. (2012), receiver area boundaries were designated as mid-points between receivers. Sections that encompassed 50% of the receiver areas used by a fish were considered the core-use area (Walsh et al. 2012). Similarly, sections that encompassed 95% of the receiver areas used by a fish were considered the home range of the fish (Walsh et al. 2012). Home range length for individual fish was described as the distance between the furthest downstream and furthest upstream areas encompassed in the home range of a fish (Walsh et al. 2012).

We examined spatial distribution of Walleyes in several ways utilizing core range calculations. Overall core range was calculated for each individual. Number of overall core use areas was calculated and analyzed using a Kruskal-Wallis test to determine if there were sex-based differences ($\alpha = 0.05$). We also used a Kruskal-Wallis test to determine if there were sex-based differences in lake zone occupied in the overall core use areas ($\alpha = 0.05$). Specifically, Walleye core range was labeled as either including the riverine zone and/or Cheat River or not including these zones. We also calculated monthly core range for each Walleye. Using these calculations we determined the frequency that receiver areas were included in core use areas across months. Using monthly core range calculations, the lake zone encompassed by the core use area was determined for each month. Additionally, we calculated changes in core range shifts. During months when tagged Walleyes shifted lake zones in core range (e.g., core range shift from the middle main lake to riverine zone), a "1" was assigned for that month. If no shift occurred then a "0" was assigned. This binary setup allowed us to determine what months had the highest frequency of core range shifts among tagged Walleyes. Repeated measures binomial logistic regression (package "lme4" in program R, Bates et al. 2015) was used to determine if there was a significant effect ($\alpha = 0.05$) of sex and/or month on core range shifts.

We also evaluated changes in monthly Walleye movement by comparing linear range expansion and contraction. Following Topping et al. (2006), we took the number of receivers by which individual fish were detected each month and calculated a yearly mean for number or receivers visited. To get an estimate of monthly range deviations, we took the yearly mean for each fish and subtracted it from the number of receivers fish visited each month (Topping et al. 2006). Positive deviations from the mean number of receivers visited indicated range expansion, while negative deviations indicated range contraction (Topping et al. 2006). A linear mixed effects model (package "lme4" in program R, Bates et al. 2015) was used to test for significant effects of month and/or sex ($\alpha = 0.05$) in monthly range deviations (Topping et al. 2006).

Lake residency of tagged fish in our study was affected by both emigration downstream of the lake (via dam spillway or turbine passage) or emigration upstream of the lake into Cheat River. Downstream movement via the dam spillway or turbine passage resulted in permanent emigration from the lake (and possibly mortality in some instances), whereas upstream movement into Cheat River allowed for later immigration back into the lake. We evaluated potential environmental factors (river discharge, lake elevation, water temperature) and temporal patterns associated with permanent emigration over or through the dam. Due to the relatively small number of fish that escaped via the dam, we did not conduct statistical analysis on these movements, but simply described associated environmental conditions and temporal patterns through simple summary statistics (e.g., mean, standard errors, etc.) or with a graphical approach. We also calculated a residency index for Walleyes. Residency index was calculated as the number of days fish were present within the lake divided by the total number of days the fish was at liberty. Calculation of this index provided an indication of what proportion of time fish remained in the lake boundaries vs time spent upstream in Cheat River. Both an overall residency index (including the entire tagged life of a fish) and a monthly residency index were calculated. We tested for sex based differences in overall residency of tagged Walleyes using a Kruskal-Wallis test ($\alpha$ = 0.05). We also tested for effects of month and/or sex on differences in residency using a linear mixed effects model ($\alpha$ = 0.05).

Environmental data, referenced for comparisons to telemetry data, included water temperature (˚C), lake elevation, and river discharge data acquired from the U.S. Geological Survey Water Watch website (http://water.usgs.gov/waterwatch). Additionally, water temperature and river discharge data were taken from the Albright gauging station on the Cheat River. The Albright gauging station is approximately 24 rkm upstream from the head of Cheat Lake. Lake elevation data were taken from a monitoring gauge at the Cheat Lake hydrostation.

## Results

From January 2012–April 2015 a total of 40 Walleyes (19 males; 19 females; 2 unknown) provided data on seasonal distribution and range (Table 4.2; Table 4.3). Three of 19 females were immature during part of their monitoring period and six of the 19 females were believed to be immature during their entire monitoring period. The number of fish monitored per year included 6 individuals in 2012, 31 individuals in 2013, 20 individuals in 2014, and 15 individuals in 2015. Twelve of the fish originally tagged did not provide data on seasonal distributions due to either mortality, emigration over the dam within 30 days of tagging or transmitter failure. Fish that were tagged in winter of 2014 did not provide summer-winter movement data as acoustic receivers were removed from the reservoir the following spring.

A total of 2,769,936 detections were recorded for 40 acoustically-tagged Walleyes (Table 4.2). The most detections for an individual fish was 188,272 (fish #80; Table 4.2). The mean number of detections (averaged over all fish) was 69,248 (SE = 7461). A total of 1,216 days were monitored for fish movement during the monitoring period. The mean number of days that fish were monitored was 589 days (SE = 45.3), and the most days monitored for an individual fish was 919 days for fish #40 (Table 4.2). Temporal distribution of Walleyes showed substantial individual variation, but proportional use of lake zones was similar for many individuals (Table 4.1). Distribution often varied by month or season for individuals. Although Walleyes used all lake zones, the middle main lake zone was used most frequently overall by both male and female Walleyes (females: mean = 71.6%, SE = 5.80%; males: mean = 50.7%, SE = 5.14%; Table 4.1; Figure 4.5 & 4.6). The lower main lake zone was the overall least used area for males (mean = 5.09%, SE = 2.61%; Table 4.1; Figure 4.5), while the Cheat River was the overall least used area for females (mean = 4.96%, SE = 2.44%; Table 4.1; Figure 4.5). The riverine zone and Cheat River were used substantially by males and accounted for an overall average of 30.7% (SE = 4.58%) and 13.4% (SE = 3.65%) of time, and for a combined overall mean of 44.2% (SE = 5.45%; Table 4.1; Figure 4.5). For males, the riverine zone and Cheat River were used most heavily during spring and summer (March–September, mean = 72.0%), and use decreased substantially in fall and winter (October–February, mean = 14.5%) (Figure 4.5). For females, the riverine zone and Cheat River were primarily used in spring (March–April, mean = 35.2%,), and use was substantially lower in other months (May–February, mean = 9.0%) (Figure 4.6). In contrast to the riverine zone and Cheat River, males primarily used the middle main lake zone in fall and winter (October–February, mean = 80.6%,), while use of this zone decreased from March–September (mean = 21.8%) (Figure 4.5). Females utilized the middle main lake zone heavily during all months, but use was particularly high from May–February (mean = 73.9%), and was lower in March and April (mean = 56.8%) (Figure 4.6). Use of the lower main lake zone was comparatively low for both males and females during all months, but females did utilize this zone more frequently than the riverine zone and Cheat River from June–February (Figures 4.5 & 4.6).

Core, home, and total linear range of tagged Walleyes varied across individuals, although similarities in space use patterns were apparent in different groups of tagged fish. Walleyes could be grouped by number of overall core areas, including those individuals that occupied one core use area, and those that occupied two separate core use areas (Table 4.2). Specifically, 60% (24 fish) of tagged Walleyes occupied one overall core use area, whereas 40% (16 fish) occupied two overall separate core use areas (Table 4.2). There was a significant difference in the number of core use areas between male and female Walleyes (Kruskal-Wallis: d.f. = 1, $H = 7.05$, p value = 0.008). Specifically, most females (84.2%) only had one core use area, whereas most males (57.9%) had two core use areas (Table 4.2). Most Walleyes had a core range encompassing or including the middle main lake zone (90% of fish or 36 individuals; Table 4.2; Figure 4.2). The riverine zone and Cheat River were included in the core use areas by fewer Walleyes (20% or 8 fish and 15% or 6 fish, respectively; Table 4.2; Figures 4.3 & 4.4). The lower main lake was included in the core range by the fewest proportion of fish (10%, 4 fish Table 4.2). Additionally, inclusion of the riverine and/or Cheat River zones in Walleye core use areas significantly differed between sexes (Kruskal-Wallis: d.f. = 1, $H = 11.86$, p value $< 0.001$). Specifically, only one female (5.3% of females) utilized riverine habitats as part of its core use area, whereas, 11 males (57.9%) utilized riverine habitats as part of their core range. Home range of tagged Walleyes also varied individually. Some Walleyes utilized nearly the entire lake as part of their overall home range (16.4 km) while one fish had the smallest overall home range that only included two receivers (2.1 km). Total linear range of Walleyes likewise varied individually. The largest linear range encompassed nearly the entire reservoir and the lower Cheat River (19.6 km), while the smallest linear range only included three receivers (3.7 km). The mean total linear range for Walleyes was approximately 14.3 km (SE = 0.75).

Residency of tagged Walleyes varied individually, with significant sex-based differences. Overall residency of tagged Walleyes also varied, with some tagged fish never leaving the reservoir, while others temporarily exited the reservoir by swimming upstream into the Cheat River. Overall, 21 of the 40 tracked Walleyes (52.5 % of tagged fish) at some point exited the reservoir via the Cheat River resulting in a residency index of less than 1 (Table 4.2). There was a significant difference in residency between male and female Walleyes (Kruskal Wallis: d.f. = 1, H = 4.48, p value = 0.03; Figure 4.9). Male Walleyes were more likely leave the lake for Cheat River (mean residency index = 0.81, SE = 0.05) and have a lower residency than female Walleyes (mean residency index = 0.95, SE = 0.01; Figure 4.9). Specifically, male Walleyes spent an average of 58 days per year (SE = 14.72, range = 0 – 160 days per year) in Cheat River, while females spent an average of 15 days per year (SE = 9.75, range = 0 – 157 days per year) in the river.

In addition to overall space use patterns, examination of monthly space use patterns provided insight into Walleye movements and distribution. Examination of monthly core range shifts, residence time, and linear range change, all revealed similar patterns in Walleye distribution and space use in Cheat Lake. Logistic regression results suggested that core range shifts differed significantly across months and by sex (Table 4.6; Figure 4.7). Specifically, logistic regression results suggested that Walleye range shifts were significantly different in the months of March, April, May, October, and November, and that male range shifts were significantly different that female range shifts ($p < 0.05$; Table 4.6). Male Walleyes, on average, experienced more core range shifts (monthly mean = 5.2, SE = 1.1) than females (monthly mean = 3.5, SE = 0.71). The largest peak in core range shifts occurred in spring (March-May) and fall (October-November) (Figure 4.7). The monthly mean number of core range shifts by lake zone was 8.7 (SE = 1.6), whereas the mean number of core range shifts were greater than the mean from March – May and October–November (Figure 4.7). The highest number of average core range shifts was in March (19 individuals with core range shifts; Figure 4.7). The middle main lake zone, on average, occurred most frequently in the monthly core ranges of tagged Walleyes (Tables 4.4 & 4.5). However, in March and April, the riverine zone occurred most frequently, on average, in the core ranges of tagged Walleyes (Tables 4.4 & 4.5). Additionally, when combining use of the riverine zone and Cheat River, there was a small peak in use of these areas in the month of July (Table 4.4). In July, the riverine zone and Cheat River combined occurred more frequently than the middle main lake zone in the core ranges of tagged Walleyes (Table 4.4).

Monthly residency index also revealed patterns in Walleye distribution. Based on the linear mixed model analysis, residency index significantly differed across months ($F = 7.57$; df = 11, 330; $p < 0.001$) and between males and females ($F = 5.77$; df = 1, 29; $p = 0.02$). Specifically, males were more likely to leave Cheat Lake (and have a lower residency index) than females (Figure 4.9). April had the lowest mean residency index of all months (mean for both sexes combined = 0.75, male mean = 0.60, female mean = 0.88), due to more Walleyes leaving the lake for the Cheat River (Figure 4.9). The monthly residency indices from April–September were significantly low compared to other months, due to increased use of Cheat River during this time period (Figure 4.9). January had the highest residency index (mean RI = 1.0), as no Walleyes utilized Cheat River during this month (Figure 4.9).

The monthly change in receiver use (i.e., linear range) of tagged Walleyes was consistent with those of monthly core range and residency index. Linear mixed model analysis suggested that linear range change significantly differed across months ($F = 2.83$; $df = 11, 330$; $p < 0.01$) but was not significantly different between males and females ($F = 0.43$; $df = 1, 29$, $p = 0.52$). The only months with evidence for mean linear range expansion were February–April and October (Figure 4.8). The mean deviation in linear range for these months was > 0, indicating an expansion of linear range and increased movement for tagged Walleyes during these months. However, linear range expansion was significantly different only during the month of March ($p < 0.001$). Nevertheless, this metric provides an indication of increased movement during spring and fall months.

A total of 12 individuals (23.1% of tagged Walleyes) passed over or through the dam during the study. Most dam passage events occurred in November or December (75%). Four individuals were caught by anglers in the tailwater pool shortly after passing over the dam. Two individuals (March and December) likely passed through the dam turbines as lake elevation was decreasing and hydropower generation was occurring. These fish were considered as likely deceased from the passage event as the transmitters were continuously detected near the turbine outflow for several months without movement. No other tagged fish that exited via the dam were continuously detected in the tailwater, potentially indicating survival. The ten fish that potentially survived passage of the dam (including the four caught by anglers) passed during high water events (mean lake elevation 869.8 ft elevation ± 0.122 standard error; river discharge 12,168 cfs ± 2186.2) when lake elevation was increasing (mean daily lake elevation increase 1.6 ft. ± 0.55 standard error). In contrast, the two fish that likely died during passage, passed during comparatively lower water periods (862.9 ft. elevation ± 2.135; river discharge 2675 cfs ± 5) when lake elevation was decreasing from hydropower operations (mean daily lake elevation decrease -1.8 ft. ± 1.475 standard error).

## Discussion

Walleyes often demonstrated range shifts and movement patterns during periods associated with spawning, post-spawn/summer, and fall/winter. Most Walleyes made upstream movements and range shifts from lake to riverine environments in conjunction with spawning season. After spawning, a portion of the tagged individuals, largely females, migrated back to main lake areas, while many males remained in riverine habitats. Some individuals displayed shifts in range toward riverine habitats during peak summer, possibly in relation to increasing water temperatures and declining oxygen conditions in the main lake. By fall, most individuals remaining in riverine habitats made return trips and range shifts to the main lake where overwintering occurred. Distribution and spatial patterns demonstrated by Cheat Lake Walleyes could have important implications for future management and recreational angling of this emerging fishery.

Examining overall Walleye distribution patterns over the calendar year, it appeared that tracked fish largely favored middle main lake habitats where depths and water quality characteristics (dissolved oxygen, water temperature, flow, etc.) were intermediate compared to upstream and downstream habitats. On average, male Cheat Lake Walleyes spent over 50% of their time and females spent over 71% of their time in the middle main lake zone. Other studies have reported Walleyes primarily utilizing lacustrine reservoir habitats during non-spawning periods (Williams 2001; Palmer et al. 2005, Hanson 2006). Bathymetry, water temperature, dissolved oxygen, and habitat could be described as intermediate compared to the lower main lake zone and the riverine zone. The middle main lake zone has shallow flats juxtaposed next to deep water areas, two large coves, and the most abundant and diverse forage of all areas of the lake. Walleyes have been reported to select for shallow flats and coves to forage on at night (Swenson and Smith 1976; Fitz and Holbrook 1978; Ickes et al. 1999; Haxton et al. 2015). This habitat is most prevalent in the middle main lake zone. Although the middle main lake zone does stratify, stratification can be weaker compared to the lower main lake zone. The middle main lake zone has an abundance of fishes common to Walleye diets, including Yellow Perch, Gizzard Shad, Emerald Shiner, Logperch, Golden Redhorse, and sunfish species (see Chapter 2). In contrast, the lower main lake and riverine zones do not support the combination of abundance and diversity of forage opportunities. Additionally, the lower main lake zone, although providing deep water with cool summer temperatures, tends to strongly stratify. It could be difficult for Walleyes to locate preferred water temperatures with suitable dissolved oxygen. The lower main lake also has sharply sloped banks, leading to limited littoral zone areas on which to forage. Therefore, it is possible the heavy use of the middle main lake zone is tied to foraging opportunities, habitat, or a combination thereof which has been suggested in previous studies on Walleye distribution (DePhilip et al. 2005; Hanson 2006; Wang et al. 2007; Raby et al. 2018).

Core and home range size of tracked fish were similar throughout the year, although we documented temporal shifts in areas used by Walleyes. There was individual variation in size of home and core range with some individuals occupying relatively small areas (< 5 km) and other individuals occupying the entire reservoir (> 19 km). Other studies have noted a wide range in individual range variation (Williams 2001; Palmer et al. 2005; Golding et al. 2007; Clark-Kolaks 2008; Phillips 2014; Kirby et al. 2017). Total ranges of Walleyes in Cheat Lake were small compared to what has been reported in some other studies when considering distance traveled (e.g., river kilometers) (DePhilip et al. 2005; Palmer et al. 2005; Phillips 2014). However, this is largely due to the small size of Cheat Lake (20.9 rkm) and limited monitoring area of Cheat River compared to other water bodies where telemetry studies have taken place. Several Walleyes occupied the entirety of Cheat Lake and also utilized some of the upstream Cheat River. These fish had total linear ranges of at least 19.6 rkm based on the distance between the Cheat River receiver and the most downstream receiver in Cheat Lake. However, due to a lack of receiver coverage we are unsure how far upstream fish traveled into the Cheat River, so it is possible these fish had much larger linear ranges than realized. When considering proportion of lake area occupied, Walleyes in Cheat Lake had similar total ranges as what has been reported in other studies, with some Walleyes only occupying a very small percentage of the reservoir and other Walleyes utilizing the entire reservoir (Williams 2001; DePhillip et al. 2005; Palmer et al. 2005; Hanson 2006; Foust and Haynes 2007; Clark-Kolaks 2008; Kirby et al. 2017). As previously eluded to, the middle main lake zone was most frequently included in core use areas of tracked fish. A total of 90% of tracked fish utilized the middle main lake zone as part of their overall core range, reinforcing the importance of this area to Cheat Lake Walleyes. Walleyes differed in that individual fish either occupied one or two overall core use zones. This suggests that fish with only one core use zone had a more overall restricted high use range, while fish with two core use zones exhibited more plasticity or temporal variations in areas of high use. Other studies have only eluded to multiple core use areas of Walleyes via description of temporal changes in range and distribution (DePhilip et al. 2005; Palmer et al. 2005; Hanson 2006; Raby et al. 2018), but have not specifically quantified them, so comparisons with other populations are difficult.

Walleyes exhibited temporal variations in core ranges and use of lake zone. In spring months and to a lesser extent in mid-summer, fish shifted core use areas from the middle main lake to the riverine zone and Cheat River. Spring month range shifts were most likely a factor of pre-spawning and spawning activity. These spawning related range shifts are typical of what occurs in other systems (Ickes et al. 1999; DePhilip et al. 2005; Palmer et al. 2005; Hanson 2006; Phillips 2014). The small peak in range shifts evident in mid-summer (July) could potentially be related to challenging physicochemical conditions with the main lake areas during summer months. Specifically, water temperatures were highest in July and dissolved oxygen concentrations were also strongly stratified during this time period (WVDNR unpublished data).

This could result in an oxygen-temperature squeeze (Coutant 1985; Williams 2001; Clark-Kolaks 2008; Bozek et al. 2011) forcing some Walleyes to make range shifts in search of cooler, more oxygenated water which is most likely to be found near the inflow of Cheat River. Movements in search of optimum water temperature conditions have been suggested in other studies (Ickes et al. 1999; DePhilip et al. 2005; Wang et al. 2007; Hayden et al. 2014; Raby et al. 2018). However, only a small number of Walleyes made this mid-summer habitat shift, indicating that other main lake residents chose to remain in stratified main lake habitats. Cheat Lake typically experiences fall turnover in September (WVDNR unpublished data) which is also when tagged fish began to increase use of the middle lake zone. Once water temperatures cooled and fall months arrived, nearly all Walleyes shifted core use areas again to occupying primarily the middle main lake zone. Use of the middle lake zone peaked during late fall/early winter. Walleyes may retreat to the main lake zone during this period to locate deeper water or concentrated prey (Paragamian 1989; DePhillip et al. 2005; Hanson 2006). Convergence of Walleyes into deeper waters in the fall has been commonly reported in other studies (Paragamian 1989; Williams 2001; DePhilip et al. 2005; Potter et al. 2009).

In general, there were two groups of Walleyes in our study: lake resident fish, that spent most their time in main lake habitats, and riverine resident fish that spent a substantial portion of their time in riverine habitats in addition to overwintering in main lake habitats. Lake resident fish typically occupied main lake core ranges during all time periods except for months associated with spawning. Riverine resident fish occupied riverine core ranges during all time periods except fall and winter, in which most of these fish switched to occupying main lake habitats. Riverine resident fish also were more likely to emigrate from Cheat Lake via the Cheat River upstream, resulting in lower residency indices for these fish. Although both males and females were often lake resident fish, riverine resident fish were much more likely to be males. Other Walleye movement studies have reported a similar segregation of Walleyes occupying lacustrine or riverine environments (Williams 2001; DePhilip et al. 2005; Palmer et al. 2005; Wang et al. 2007; Hayden et al. 2014). In most of these studies, differences in overall distribution were often tied to variations in post-spawning movements between males and females, or genetically induced behavior (DePhilip et al. 2005; Palmer et al. 2005; Hayden et al. 2014). However, many studies have not quantified core and home ranges for individuals, but instead have qualitatively described seasonal movements. Additionally, in most of these studies, fish had left spawning areas by late spring (Ickes et al. 1999; Palmer et al. 2005; Hanson 2006; Hayden et al. 2014; Raby et al. 2017). In our study, it was not uncommon for fish to remain near spawning areas until fall. DePhilip et al. (2005) did have similar results to our study in the Au Sable River, Michigan. In their study, some Walleyes did not outmigrate from spawning areas to the downstream reservoir until fall. DePhilip et al. (2005) postulated that some Walleyes delayed return to the reservoir to take advantage of optimal foraging conditions. Palmer et al. (2005) found that lake resident fish spawned in riverine habitats but subsequently returned to main lake habitats, while river resident fish spawned and remained in riverine habitats. Differences in their study were thought to be the result of genetic differentiation (Palmer et al. 2005). In our study, nearly all individuals occupied the main lake at some point during a given year (almost always to overwinter) but differences existed in ranges occupied in post-spawn and summer periods.

Sex-based differences in distribution and movement patterns were apparent in our study. Other studies have noted the apparent link between Walleye sex and seasonal distribution (DePhilip et al. 2005; Wang et al. 2007; Hayden et al. 2014; Raby et al. 2018). In particular, other studies have reported a dichotomy in post-spawn distributions between males and females (DePhilip et al. 2005; Wang et al. 2007; Hayden et al. 2014; Raby et al. 2018). Several theories have been posited to why males and females segregate. Other researchers have suggested theories related to maximizing spawning success for males, occupation of preferred water temperatures, and optimal foraging theory (DePhilip et al. 2005; Wang et la. 2007; Hayden et al. 2014; Raby et al. 2018).

It is possible that sex-based differences in distribution in our study were related to differences in spawning behavior between males and females. Some authors have suggested that male Walleyes extend time spent on spawning grounds to maximize their potential spawning attempts with as many females as possible (Hayden et al. 2014; Raby et al. 2018). Males often spawn with multiple females whereas females typically deposit all of their eggs in a short timeframe (Colby et al. 1979). By extending time spent on spawning grounds, males may increase their interaction with females and increase their spawning attempts (Hayden et al. 2014; Raby et al. 2018). However, this theory does not explain the residence of males past the month of April in riverine habitats.

Another possible explanation for sex-based differences in distribution is related to variations in habitat needs between males and females. Other researchers have suggested that females are more likely to search out optimal habitat (e.g., water temperature) conditions compared to males after spawning to maximize their energy intake (Wang et al. 2007; Raby et al. 2018). In many waters, as surface water temperatures warm, deep waters in main lake areas could provide thermal refugia for female Walleyes, potentially optimizing growth potential and body condition. In Cheat Lake, deeper main lake areas do offer cool water temperatures compared to the uniform temperatures found throughout the riverine zone. However, in Cheat Lake, the riverine zone still consistently offers Walleyes summertime water temperatures within their preferred range. Additionally, during summer, stratification of main lake areas negates the ability to find cool waters as oxygen levels are often depleted. In summer, some females displayed a propensity to make forays from the main lake back into the riverine zone. Potentially, these fish were searching for cooler, more oxygenated water that the incoming Cheat River provides during summer periods. However, only a small number of females displayed this behavior, suggesting other main lake residents were able to find suitable habitat without making movements into the riverine zone.

Researchers have also suggested that some Walleyes (especially females) migrate to areas after spawning that offer optimal foraging opportunities in terms of preferred prey (DePhilip et al. 2005; Wang et al. 2007; Bowlby and Hoyle 2011; Hayden et al. 2014; Raby et al. 2018). Of all the reasons presented, this seems the most likely for Cheat Lake Walleyes. Although the riverine zone supports prey fish for Walleyes, a higher proportion of these fish will be smaller shiner species (e.g., Mimic Shiner, Emerald Shiner, etc.), Logperch, and riverine centrarchids (e.g., Smallmouth Bass, Rock Bass). In contrast, the main lake offers a greater diversity of prey fish and a greater size spectrum of potential prey. Specifically, the middle main lake supports a strong population of Yellow Perch, and Cheat Lake Walleyes have demonstrated a strong propensity to prey on Yellow Perch (see Chapter 2).

Most Walleyes increased their use of upstream riverine habitats and the incoming Cheat River during spring. Range shifts during spring months provided evidence that Walleyes used the headwaters of Cheat Lake and the Cheat River for spawning. Given Cheat Lake is an ecosystem recovering from decades of acidification, identification of available spawning habitat for a once extirpated species such as the Walleye is important. Cheat Lake experiences seasonal changes in lake level fluctuations which can impact Walleye spawning (Johnson 1961; Priegel 1970; Chevalier 1977). Lake area utilized for spawning was a relatively small area (approximately 1 rkm) just downstream of the incoming Cheat River. This limited spawning area creates an inherent risk of disruption to spawning activity. Poorly timed lake level decreases in spring could lead to spawning failure for fish utilizing this area. Some Walleyes are evidently utilizing the Cheat River to spawn and as summer habitat. These Walleyes are protected from lake level fluctuations, but if larval Walleyes subsequently drift downstream to the main lake, they would still be susceptible to changing water levels given their poor swimming ability

(Walburg 1971). Additionally, should acidification issues arise again in the future, this area would be the first to receive acidic water from upstream prior to it having a chance to dilute in the larger body of the main lake. Acidic conditions are not conducive to successful Walleye reproduction (Hulsman et al. 1983; Rahel and Magnuson 1983), so protection of suitable water quality especially around spawning habitat is critical. Evidence of spawning being restricted to the upper portion of the lake should improve the ability of researchers to monitor the impacts of lake level fluctuations on spawning activity in future years. However, this seasonal clustering of adult Walleyes also potentially increases their susceptibility to angling (Palmer et al. 2005). The use of Cheat River for spawning and for summer habitat lends some evidence that a portion of the population may be protected from lake level fluctuations and angling pressure.

Residency indices of tagged Walleyes provided information on frequency of fish temporarily leaving the reservoir for the upstream Cheat River. Overall, over 50% of tagged Walleyes at some point temporarily exited the reservoir for the river upstream. When examining residency of tagged Walleyes monthly, clear patterns of temporal emigration from the reservoir dependent on time of year are evident. The heaviest use of the Cheat River occurred in April. This is likely due to Walleyes leaving the reservoir to spawn in the Cheat River upstream. Although female Walleyes typically returned to utilizing primarily main lake habitats in summer with occasional forays into upstream riverine habitats, a large proportion of males continued to utilize upstream riverine habitats throughout the summer until fall. Some Walleyes (primarily males) continued to periodically utilize the Cheat River upstream, while others continued to occupy the Cheat River until fall. It is unknown why some fish choose to remain in Cheat River or utilize it frequently compared to others. Walleyes remaining in the river may simply be choosing to limit post-spawn movement and instead focus on immediately foraging upon available prey in the river (DePhilip et al. 2005).

The dichotomy in habitat use between males and females could affect management strategies and angling pressure (Palmer et al. 2005; Wang et al. 2007; Hayden et al. 2014). Fisheries managers should be aware that fishing pressure may not be equivalent between males and females. Specifically, female Walleyes in Cheat Lake may experience higher susceptibility to angling given their closer proximity to the angler access areas in the main lake. Anecdotal observations suggest that most angling occurs in Cheat Lake from May–October, when the reservoir fluctuations are restricted for recreational activity. This coincides with the time period that female Walleyes have largely returned to utilizing main lake habitats. An angler creel survey and research into the effort and harvest habits of Cheat Lake anglers would be beneficial for future management.

A substantial proportion of tagged Walleyes (19.2%) passed over or through the dam during the study. Most Walleyes passed over the dam during high water events in November and December. However, two Walleyes likely passed through the turbines leading to mortality of at least one fish. Research is limited regarding dam passage of Walleyes in reservoir systems. Jernejcic (1986) found substantial movement of Walleyes through the dam on Tygart Lake, WV. Most of these fish were juveniles (age-0), indicating that younger fish were more inclined to bypass the dam than larger, older individuals (Jernejcic 1986). Additionally, Jernejcic (1986) found evidence of some mortality of Walleyes as a result of dam passage. Weber et al. (2013) found similar results with regards to dam passage. In their study, tagged Walleyes > 300 mm were released into Rathbun Lake, IA and the tailwaters were monitored for tagged fish (Weber et al. 2013). Fish passage through the dam increased with increasing discharged and decreasing fish length, indicating most fish passing through were small individuals doing so at high discharge events (Weber et al. 2013). In our study, Walleyes passing through the dam were all larger individuals due to the size restrictions associated with implanting acoustic transmitters. Walleyes also primarily passed the dam during high water events, but two individuals passed during drawdown events and likely perished as a result. It is unknown how common these passage events are for Walleyes in Cheat Lake. Weber et al. (2013) suggested that fisheries managers should stock Walleyes at the largest size possible and as far away from the dam as possible. Very small Walleyes (i.e., fry, small fingerlings) may have limited ability to avoid bypassing the dam given their limited swimming ability. Additionally, by stocking Walleyes close to the dam, individuals may be more likely to exit the reservoir (Weber et al. 2013). Walleyes have traditionally been stocked relatively close to the dam in Cheat Lake, so fisheries managers should consider releasing fish at locations further away from the dam.

**Management Implications**

Knowledge of the spatial ecology of sportfish, especially top predators such as Walleyes, can be important for effective management of fisheries. Walleyes are top predators that can structure ecosystems (Craig 2000; Quist et al. 2003; Bozek et al. 2011; Pothoven et al. 2016) and are also an economically important species (Craig 2000; Bozek et al. 2011; Hayden et al. 2014; Kirby et al. 2017). Therefore, effective management of this species can have wide ranging consequences. Space use patterns of Walleyes have implications for both fisheries management and angling exploitation. Results from this study provide valuable information on the temporal distribution, core and home range areas, and lake residency of Walleyes in Cheat Lake. Given Walleyes were once extirpated from Cheat Lake due to acid mine drainage but have since been reestablished, knowledge of the distribution and space use of this Walleye population is important for future management.

Understanding seasonal movements and distributions can improve the management of Walleye populations (Williams 2001; Rasmussen et al. 2002; Palmer et al. 2005; Hanson 2006). Specifically, this information would be useful from a management perspective as knowing when and where congregations of Walleyes will occur seasonally could help direct survey efforts and potentially improve angler success rates (Williams 2001; Palmer et al. 2005). This study demonstrated seasonal patterns and sex-based differences in Walleye distribution in Cheat Lake. Specifically, male Walleyes spent greater periods of time utilizing upstream riverine habitats and the Cheat River, while females spent more time utilizing main lake habitats downstream. In spring, most adult Walleyes congregated near the headwaters of Cheat Lake and some left the lake to spawn in Cheat River. These springtime congregations are important for fisheries managers, as they offer an opportunity to collect adult Walleyes for broodstock purposes, or conduct further monitoring and research on the spawning population. Additionally, these congregations could have significant implications should anglers begin to capitalize on this pattern. Other studies have shown that a substantial portion of harvest can occur on Walleyes congregating in small areas to spawn (Palmer et al. 2005). Fisheries managers should monitor the angling impact of these spawning congregations in Cheat Lake to ensure overharvest does not occur. Additionally, the tendency for female Walleyes to utilize downstream main lake habitats in the summer could also have important management implications. Stock assessment surveys should take into account the sex-based segregation of Walleyes within Cheat Lake during these time periods. Additionally, consideration should be given to the potential impact of angler harvest on female Walleyes during summer periods. It is possible, given proximity to access sites, that anglers primarily harvest female fish during summer in Cheat Lake. Creel survey and angler effort research should be conducted on Cheat Lake to determine the potential impacts of these seasonal, sex-based distributions. Overall, results from this study provide fisheries managers with valuable information that will be beneficial in the future management of this reestablished fishery. Information gained will help guide future monitoring and research, and aide in directing future management actions to maintain and potentially improve this fishery.

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**Table 4.1**. Overall proportional use (%) of lake zones by male and female Walleyes in Cheat Lake.

| | Males | | Females | |
|---|---|---|---|---|
| **Lake Zone** | **Mean %** | **SE** | **Mean %** | **SE** |
| **Lower** | 5.09 | 2.61 | 14.26 | 5.27 |
| **Middle** | 50.74 | 5.14 | 71.60 | 5.80 |
| **Riverine** | 30.73 | 4.58 | 9.18 | 1.90 |
| **Cheat River** | 13.44 | 3.65 | 4.96 | 2.44 |

**Table 4.2.** Summary of individual Cheat Lake Walleye telemetry histories. RI = residency index. Zone abbreviations: L=lower main lake, M=middle main lake, R=riverine zone, C=Cheat River

| ID | Sex | Total Length (mm) | Tag detections | Days Monitored | RI | No. Core Areas | Core Zone | Home Range Zone |
|---|---|---|---|---|---|---|---|---|
| 87 | F | 449 | 65,013 | 504 | 1.00 | 1 | M | L-M |
| 57 | F | 459 | 52,193 | 527 | 1.00 | 1 | M | M |
| 88 | F | 465 | 156,416 | 907 | 0.93 | 1 | M | L-M-R-C |
| 33 | F | 466 | 126,026 | 907 | 1.00 | 1 | M | M |
| 60 | F | 476 | 79,394 | 555 | 1.00 | 1 | M | L-M |
| 84 | F | 480 | 123,248 | 907 | 1.00 | 1 | E | L-M-R |
| 55 | F | 485 | 91,428 | 868 | 1.00 | 1 | M | L-M-R |
| 83 | F | 499 | 16,500 | 528 | 0.57 | 2 | M-C | M-R-C |
| 41 | F | 516 | 181,523 | 874 | 0.99 | 1 | M | M |
| 96 | F | 518 | 38,921 | 907 | 0.81 | 2 | L-M | L-M-R-C |
| 79 | F | 542 | 59,752 | 662 | 1.00 | 1 | M | L-M |
| 59 | F | 559 | 114,804 | 907 | 1.00 | 1 | M | M-R |
| 185 | F | 568 | 98,932 | 542 | 1.00 | 1 | M | M |
| 85 | F | 570 | 40,697 | 358 | 1.00 | 1 | M | M |
| 190 | F | 580 | 67,026 | 493 | 1.00 | 2 | L-M | L-M-R |
| 53 | F | 600 | 109,467 | 403 | 1.00 | 1 | M | L-M-R |
| 157 | F | 617 | 4,168 | 131 | 0.86 | 1 | M | M-R-C |
| 179 | F | 652 | 24,320 | 196 | 0.91 | 1 | M | L-M-R-C |
| 52 | F | 708 | 113,147 | 883 | 0.98 | 1 | M | M-R |
| 58 | M | 430 | 71,744 | 428 | 0.63 | 2 | M-C | M-R-C |
| 89 | M | 430 | 35,368 | 697 | 0.79 | 2 | M-R | M-R-C |
| 38 | M | 432 | 15,713 | 51 | 1.00 | 1 | M | M-R |
| 51 | M | 435 | 28,906 | 258 | 1.00 | 1 | M | M-R |
| 39 | M | 437 | 62,214 | 777 | 0.80 | 2 | M-R | M-R-C |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| 90 | M | 440 | 23,483 | 358 | 1.00 | 1 | M | L-M-R |
| 42 | M | 443 | 52,491 | 69 | 1.00 | 2 | M-R | M-R |
| 35 | M | 446 | 55,040 | 829 | 1.00 | 1 | R | M-R |
| 93 | M | 450 | 11,072 | 301 | 0.98 | 2 | L-M | L-M-R |
| 86 | M | 452 | 132,350 | 907 | 0.92 | 1 | M | L-M-R-C |
| 40 | M | 459 | 73,191 | 919 | 0.80 | 2 | M-R | M-R-C |
| 43 | M | 467 | 114,870 | 747 | 0.84 | 2 | M-R | M-R-C |
| 50 | M | 475 | 86,944 | 801 | 0.56 | 2 | M-C | M-R-C |
| 98 | M | 487 | 50,550 | 639 | 0.62 | 2 | M-C | M-R-C |
| 193 | M | 487 | 16,890 | 546 | 0.59 | 2 | M-C | L-M-R-C |
| 80 | M | 495 | 188,272 | 907 | 0.96 | 1 | M | M-R-C |
| 94 | M | 500 | 39,589 | 651 | 0.96 | 2 | M-R | M-R-C |
| 82 | M | 505 | 70,594 | 651 | 0.99 | 1 | M | M-R |
| 189 | M | 556 | 41,557 | 71 | 1.00 | 1 | M | M-R |
| 44 | U | 476 | 21,991 | 854 | 0.73 | 2 | R-C | M-R-C |
| 151 | U | 490 | 14,132 | 46 | 1.00 | 2 | L-L | L-M |

**Table 4.3.** Average overall proportional use (with standard errors in parentheses) of lake zones by tagged Walleyes from 2012–2015.

| ID | Sex | Monitoring Period | Lower | Middle | Riverine | Cheat River |
|---|---|---|---|---|---|---|
| 33 | F | 2013–2015 | 0.00% (0) | 99.01% (9.81) | 0.99% (0.13) | 0.00% (0) |
| 41 | F | 2012–2014 | 0.11% (0.07) | 95.42% (7.41) | 3.55% (0.45) | 0.92% (0.99) |
| 52 | F | 2012–2014 | 0.57% (0.27) | 69.31% (7.12) | 28.20% (2.16) | 1.93% (1.41) |
| 53 | F | 2013 | 6.45% (1.18) | 76.18% (9.01) | 17.37% (2.83) | 0.00% (0) |
| 55 | F | 2013–2015 | 4.38% (0.93) | 88.02% (7.09) | 7.26% (1.36) | 0.35% (0.21) |
| 57 | F | 2013 | 0.00% (0) | 100.00% (8.91) | 0.00% (0) | 0.00% (0) |
| 59 | F | 2013–2015 | 0.44% (0.21) | 86.99% (9.42) | 12.13% (1.73) | 0.44% (0.29) |
| 60 | F | 2013 | 20.36% (2.26) | 79.64% (7.22) | 0.00% (0) | 0.00% (0) |
| 79 | F | 2013–2014 | 16.01% (3.63) | 81.42% (8.29) | 2.57% (0.58) | 0.00% (0) |
| 83 | F | 2013–2014 | 0.00% (0) | 40.72% (6.61) | 16.29% (2.14) | 42.99% (13.77) |
| 84 | F | 2013–2015 | 90.41% (7.68) | 3.97% (0.89) | 5.62% (0.79) | 0.00% (0) |
| 85 | F | 2013 | 0.00% (0) | 94.97% (9.28) | 5.03% (0.69) | 0.00% (0) |
| 87 | F | 2013 | 49.60% (7.28) | 50.40% (6.77) | 0.00% (0) | 0.00% (0) |
| 88 | F | 2013–2015 | 9.37% (2.43) | 65.60% (6.80) | 18.52% (2.22) | 6.50% (3.59) |
| 96 | F | 2013–2015 | 28.45% (5.37) | 36.05% (5.97) | 16.76% (1.88) | 18.74% (9.36) |
| 157 | F | 2014–2015 | 2.29% (1.07) | 65.65% (13.58) | 18.32% (3.51) | 13.74% (14.4) |

| | | | | | | |
|---|---|---|---|---|---|---|
| 179 | F | 2014–2015 | 11.22% (2.44) | 65.82% (9.91) | 14.29% (2.27) | 8.67% (6.61) |
| 185 | F | 2014–2015 | 0.00% (0) | 98.52% (8.75) | 1.48% (0.20) | 0.00% (0) |
| 190 | F | 2014–2015 | 31.24% (4.54) | 62.68% (5.96) | 6.09% (0.98) | 0.00% (0) |
| 35 | M | 2012–2014 | 0.00% (0) | 41.74% (6.16) | 58.26% (5.70) | 0.00% (0) |
| 38 | M | 2012 | 0.00% (0) | 92.16% (20.58) | 7.84% (2.26) | 0.00% (0) |
| 39 | M | 2013–2014 | 0.00% (0) | 33.98% (5.60) | 45.56% (3.77) | 20.46% (8.15) |
| 40 | M | 2012–2014 | 0.65% (0.28) | 27.09% (6.20) | 52.45% (3.72) | 19.80% (7.93) |
| 42 | M | 2012 | 0.00% (0) | 46.38% (19.09) | 53.62% (10.20) | 0.00% (0) |
| 43 | M | 2012–2013 | 1.61% (0.52) | 25.70% (4.92) | 57.03% (3.64) | 15.66% (6.52) |
| 50 | M | 2012–2014 | 0.00% (0) | 38.95% (7.22) | 17.23% (2.30) | 43.82% (13.18) |
| 51 | M | 2013 | 0.39% (0.19) | 81.78% (8.30) | 17.83% (3.71) | 0.00% (13.18) |
| 58 | M | 2013 | 0.00% (0) | 46.73% (7.30) | 16.36% (3.41) | 36.92% (14.54) |
| 80 | M | 2013–2015 | 0.22% (0.10) | 82.03% (9.80) | 13.56% (2.07) | 4.19% (3.10) |
| 82 | M | 2013–2014 | 1.69% (0.45) | 54.38% (6.95) | 42.86% (3.27) | 1.08% (0.83) |
| 86 | M | 2013–2015 | 7.50% (1.00) | 77.18% (8.59) | 7.06% (1.23) | 8.27% (4.91) |
| 89 | M | 2013–2014 | 0.00% (0) | 26.69% (5.64) | 52.80% (2.97) | 20.52% (7.38) |
| 90 | M | 2013 | 17.32% (4.02) | 72.63% (9.24) | 10.06% (2.16) | 0.00% (0) |
| 93 | M | 2013 | 44.85% (9.19) | 34.88% (7.66) | 18.60% (3.50) | 1.66% (1.13) |
| 94 | M | 2013–2014 | 1.38% (0.35) | 37.94% (7.05) | 56.53% (4.04) | 4.15% (1.55) |
| 98 | M | 2013–2014 | 0.00% (0) | 33.49% (6.26) | 28.95% (3.49) | 37.56% (12.88) |
| 189 | M | 2014–2015 | 0.00% (0) | 78.87% (15.64) | 21.13% (5.06) | 0.00% (0) |
| 193 | M | 2014–2015 | 21.06% (3.41) | 31.50% (5.38) | 6.23% (0.97) | 41.21% (14.00) |
| 44 | U | 2013–2015 | 0.00% (0) | 21.31% (3.41) | 51.52% (3.49) | 27.17% (6.87) |
| 151 | U | 2014 | 82.61% (8.99) | 17.39% (6.67) | 0.00% (0) | 0.00% (0) |

**Table 4.4.** Mean proportional occurrence of lake zones in monthly core use areas occupied by Walleyes in Cheat Lake.

| Zone | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Lower** | 4.88 | 2.22 | 2.27 | 6.98 | 17.95 | 13.16 | 11.90 | 11.11 | 8.11 | 15.00 | 12.50 | 9.76 |
| **Middle** | 92.68 | 80.00 | 29.55 | 30.23 | 43.59 | 44.74 | 40.48 | 47.22 | 48.65 | 60.00 | 85.00 | 87.80 |
| **Riverine** | 2.44 | 17.78 | 59.09 | 34.88 | 15.38 | 23.68 | 30.95 | 22.22 | 24.32 | 20.00 | 2.50 | 2.44 |
| **Cheat River** | 0.00 | 0.00 | 9.09 | 27.91 | 23.08 | 18.42 | 16.67 | 19.44 | 18.92 | 5.00 | 0.00 | 0.00 |

**Table 4.5.** Monthly core use area lake zones occupied by Walleyes in Cheat Lake (L = lower main lake zone, M = middle main lake zone, R = riverine zone, and C = Cheat River).

| ID | Sex | Jan. | Feb. | Mar. | Apr. | May | Jun. | Jul. | Aug. | Sep. | Oct. | Nov. | Dec. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **33** | **F** | M | M | M | M | M | M | M | M | M | M | M | M |
| **41** | **F** | M | M | M | M | M | M | M | M | M | M | M | M |
| **52** | **F** | M | M | R | M-R | M | M | R | M | M | M | M | M |
| **53** | **F** | M | M | R | M | M | M | M-R | R | M | M | M | M |
| **55** | **F** | M | M | M | M | M-R | M | M | M | M | M | M | M |
| **57** | **F** | M | M | M | M | M | M | M | M | M | M | M | M |
| **59** | **F** | M | M | R | M | M | M | M | M | M | M | M | M |
| **60** | **F** | M | M | M | M | L-M | M | L-M | M | M | M | M | M |
| **79** | **F** | M | M | M | M | M | M | M | M | M | L | M | M |
| **83** | **F** | M | M | R | C | C | C | C | C | C | C | M | M |
| **84** | **F** | L | L | L | L-R | L | L | L | L | L | L | L | L |
| **85** | **F** | M | M | M | M | M | M | M | M | M | M | M | M |
| **87** | **F** | M | M | M | M | L-M | L | L | L | L | L | L-M | M |
| **88** | **F** | M | M | R | R-C | M | M | M | M | M | L-M | M | M |
| **96** | **F** | M | M | R | C | C | L | L | L | L | L | M | M |
| **157** | **F** | M | M | R | C | . | . | . | . | . | . | . | M |
| **179** | **F** | M | M | M-R | R-C | . | . | . | . | . | M | M | M |
| **185** | **F** | M | M | M | M | M | M | M | M | M | M | M | M |
| **190** | **F** | L-M | M | M | L | L | M | M | M | M | M | M | L-M |
| **35** | **M** | M | M | R | R | R | R | R | R | M-R | M | M | M |
| **38** | **M** | M | M | M | . | . | . | . | . | . | . | . | . |
| **39** | **M** | M | R | R | R | R | R | C | C | C | M-R | M | M |
| **40** | **M** | M | M | C | C | R | R | R | R | R | M-R | M | M |
| **42** | **M** | M | M | R | . | . | . | . | . | . | . | . | . |
| **43** | **M** | M | M-R | R | R | C | R | R | R | R-C | M-R | M | M-R |
| **50** | **M** | M | M | R-C | C | C | C | C | C | R | M | M | M |
| **51** | **M** | M | M | R | R | M | M | M | . | . | . | M | M |
| **58** | **M** | M | M | M-R | R | C | C | C | C | C | R | M | M |
| **80** | **M** | M | M | R | M-C | M | M | M | M | M | M | M | M |
| **82** | **M** | M | M | R | R | M | M | R | M-R | R | M-R | M | M |
| **86** | **M** | M | M | R-C | C | M | M | M | M | M | M | M | M |
| **89** | **M** | M | M-R | R | C | C | R-C | R | R | R | R | M | M |
| **90** | **M** | M | M | R | R | L | L | M | M | M | M | M | M |
| **93** | **M** | M | M-R | R | L-R | L | L | L | L | . | . | M | M |
| **94** | **M** | M | M | R | R | R | R | R | R | M | M | M | M |
| **98** | **M** | M | M | R | R | C | C | C | C | C | R | M | M |
| **189** | **M** | M | M-R | . | . | . | . | . | . | . | . | . | M |
| **44** | **U** | M-R | R | R | R-C | R-C | R-C | R-C | C | R-C | C | M-R | M |

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **151** | **U** | . | . | . | . | . | . | . | . | . | . | L | L |
| **193** | **M** | M | M | R-C | C | C | C | C | C | C | M | L-M | L-M |

**Table 4.6.** Results of generalized linear mixed model analysis of monthly core range shifts in Walleyes in Cheat Lake, WV. Sex (female) and Month (January) are used as the baseline for the estimation of the categorical variables sex and month, and therefore, do not appear in the model summary. Asterisk * indicates statistical significance ($\alpha < 0.05$).

| | Estimate | SE | z value | p value | |
|---|---|---|---|---|---|
| **Intercept** | -3.462 | 0.7949 | -4.355 | <0.001 | * |
| **Sex (male)** | 1.0631 | 0.3756 | 2.831 | 0.00465 | * |
| **Month (February)** | 0.8095 | 0.9269 | 0.873 | 0.3825 | |
| **Month (March)** | 3.5147 | 0.8566 | 4.103 | <0.001 | * |
| **Month (April)** | 2.748 | 0.8456 | 3.25 | 0.00116 | * |
| **Month (May)** | 2.7486 | 0.8456 | 3.25 | 0.00115 | * |
| **Month (June)** | 1.5592 | 0.8711 | 1.79 | 0.07348 | |
| **Month (July)** | 1.5551 | 0.8713 | 1.785 | 0.0743 | |
| **Month (August)** | 0.8106 | 0.9268 | 0.875 | 0.38177 | |
| **Month (September)** | 1.3384 | 0.8834 | 1.515 | 0.12975 | |
| **Month (October)** | 2.2768 | 0.8488 | 2.682 | 0.00731 | * |
| **Month (November)** | 2.5961 | 0.8458 | 3.069 | 0.00214 | * |
| **Month (December)** | 0.4522 | 0.9711 | 0.466 | 0.64148 | |

**Figure 4.1.** Acoustic telemetry receiver locations and associated lake zones in Cheat Lake, WV.

**Figure 4.2.** Typical core range for Walleyes occupying the middle main lake zone of Cheat Lake, WV.

**Figure 4.3**. Typical core range for Walleyes occupying the riverine zone of Cheat Lake, WV.

**Figure 4.4.** Typical core range for Walleyes occupying the Cheat River, upstream of Cheat Lake, WV.

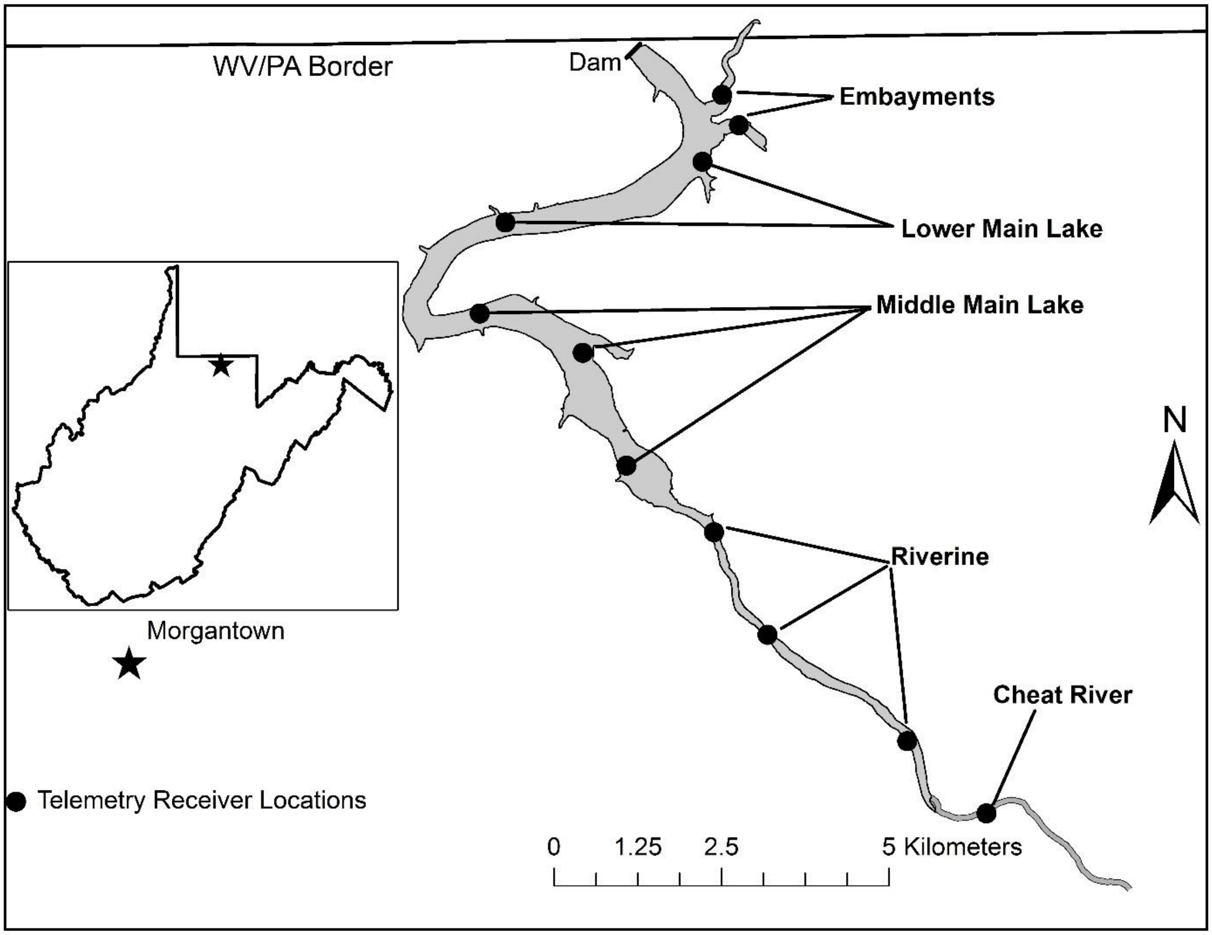
**Figure 4.5.** Mean proportional monthly lake zone use by male Walleyes in Cheat Lake, WV. Error bars are ± standard error.

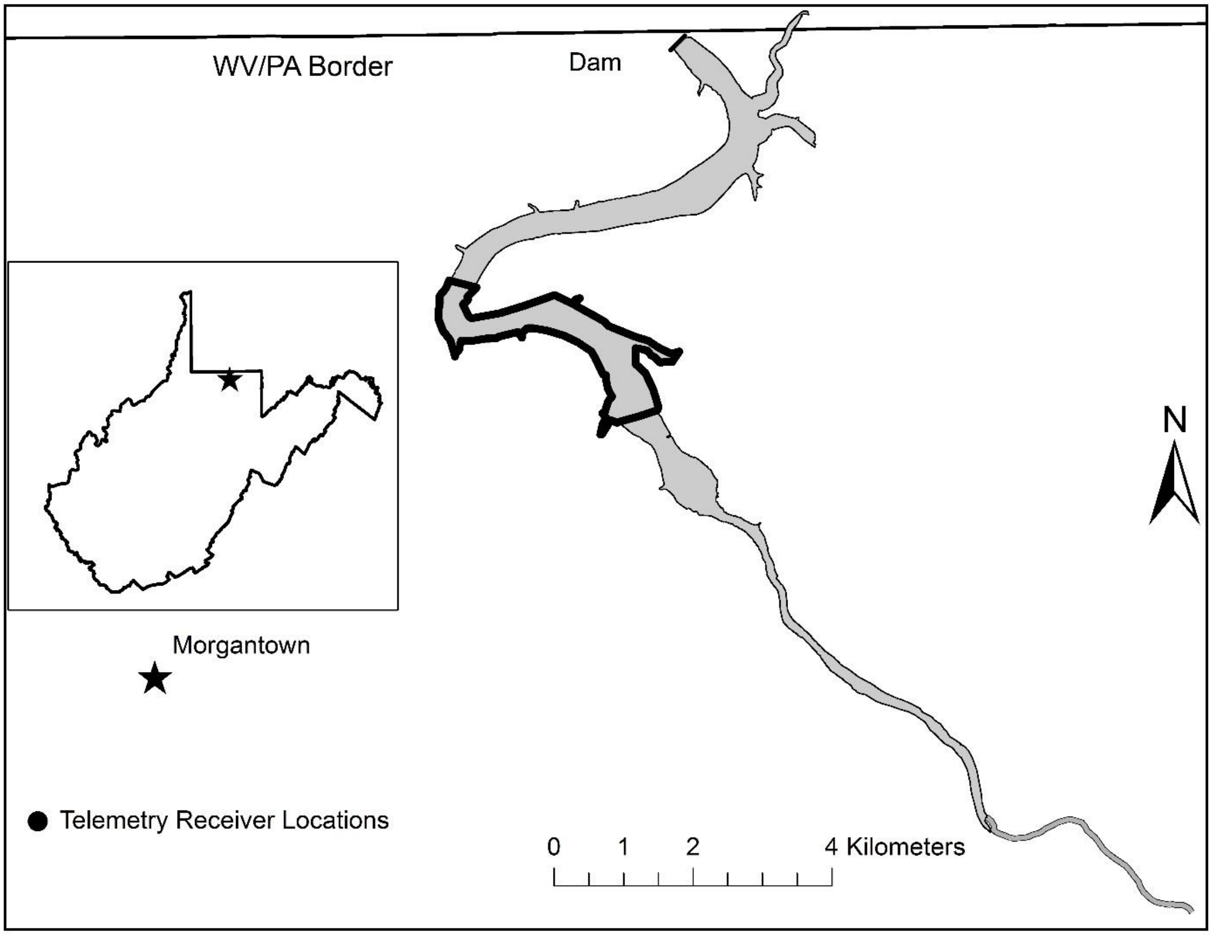
**Figure 4.6.** Mean proportional monthly lake zone use by female Walleyes in Cheat Lake, WV. Error bars are ± standard error.

**Figure 4.7.** Mean proportion of monthly core range shifts by male and female Walleyes in Cheat Lake, WV

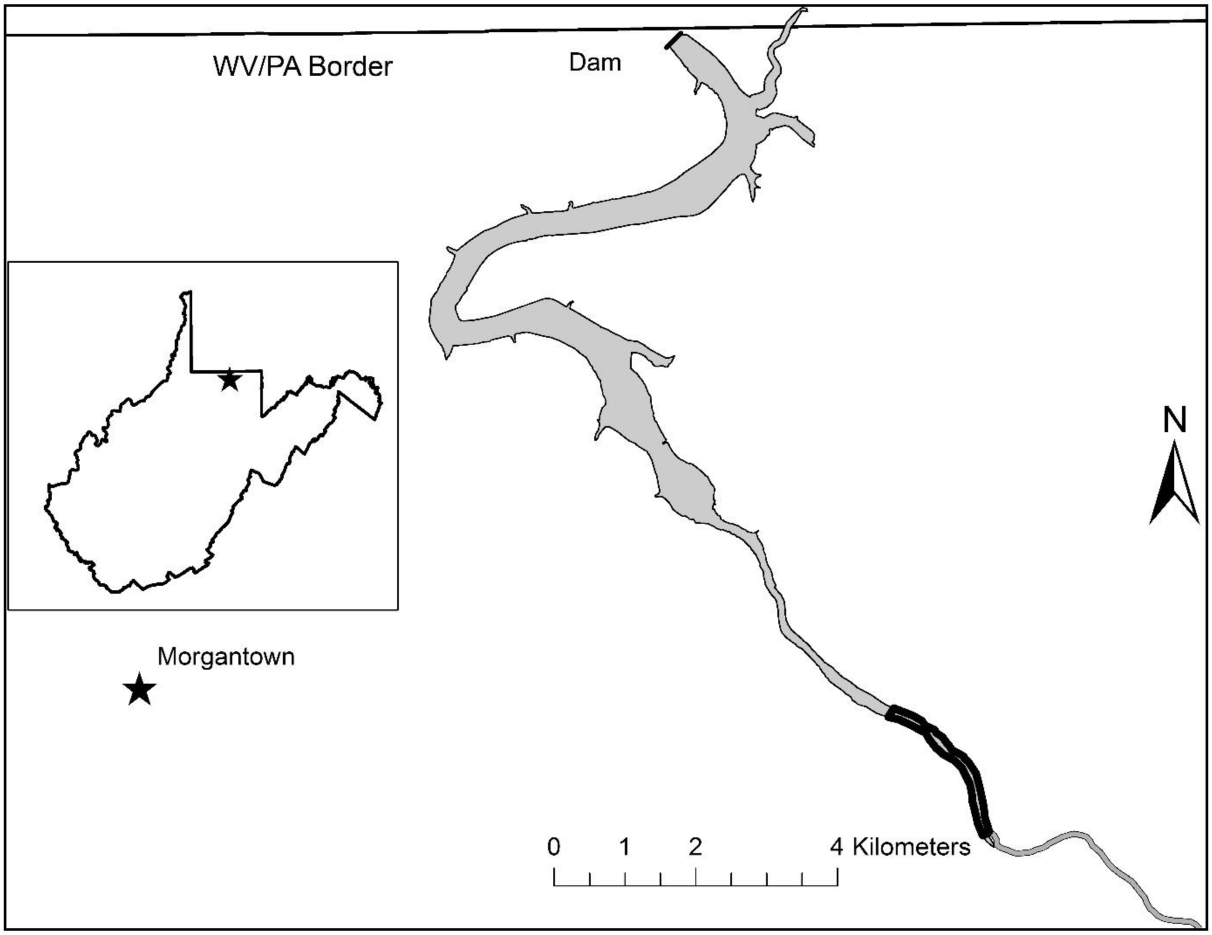
**Figure 4.8.** Mean monthly deviation in receiver use (linear range) by Walleyes in Cheat Lake, WV. Error bars are ± standard error.

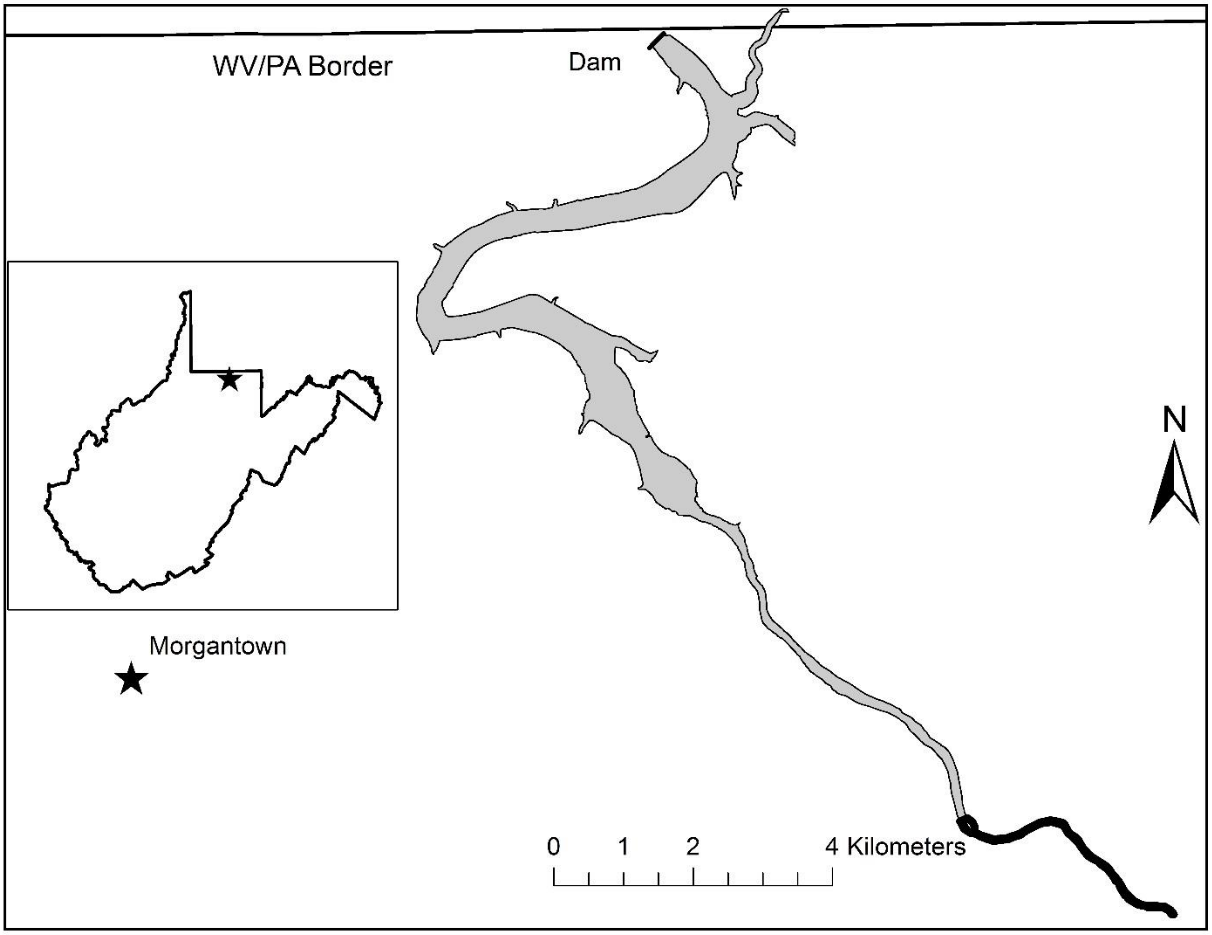
**Figure 4.9.** Mean monthly deviation in residency index by male and female Walleyes in Cheat Lake, WV. Error bars are ± standard error.


WV/PA Border
Dam
Embayments
Lower Main Lake
Middle Main Lake
Riverine
Cheat River
Morgantown
Telemetry Receiver Locations
0
1.25
2.5
5 Kilometers
N

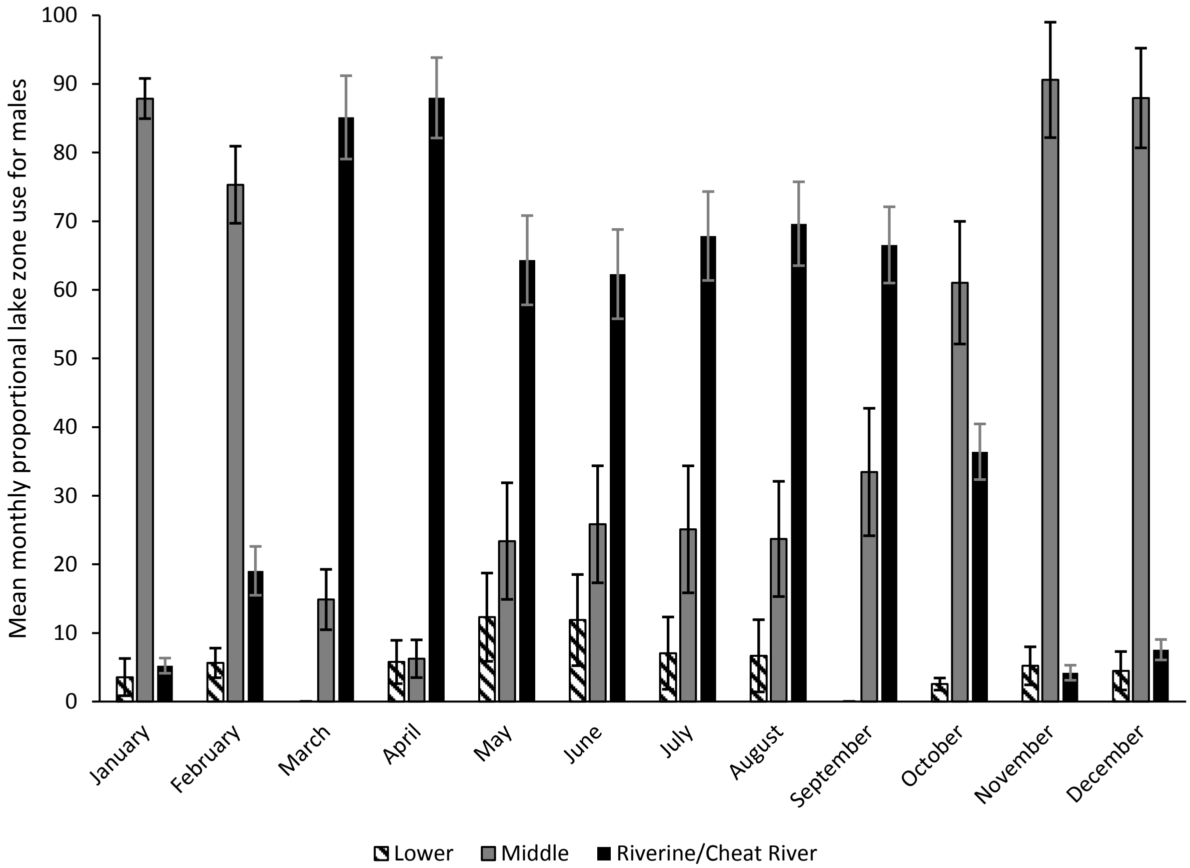


WV/PA Border
Dam
N
Morgantown
Telemetry Receiver Locations
0
1
2
4 Kilometers

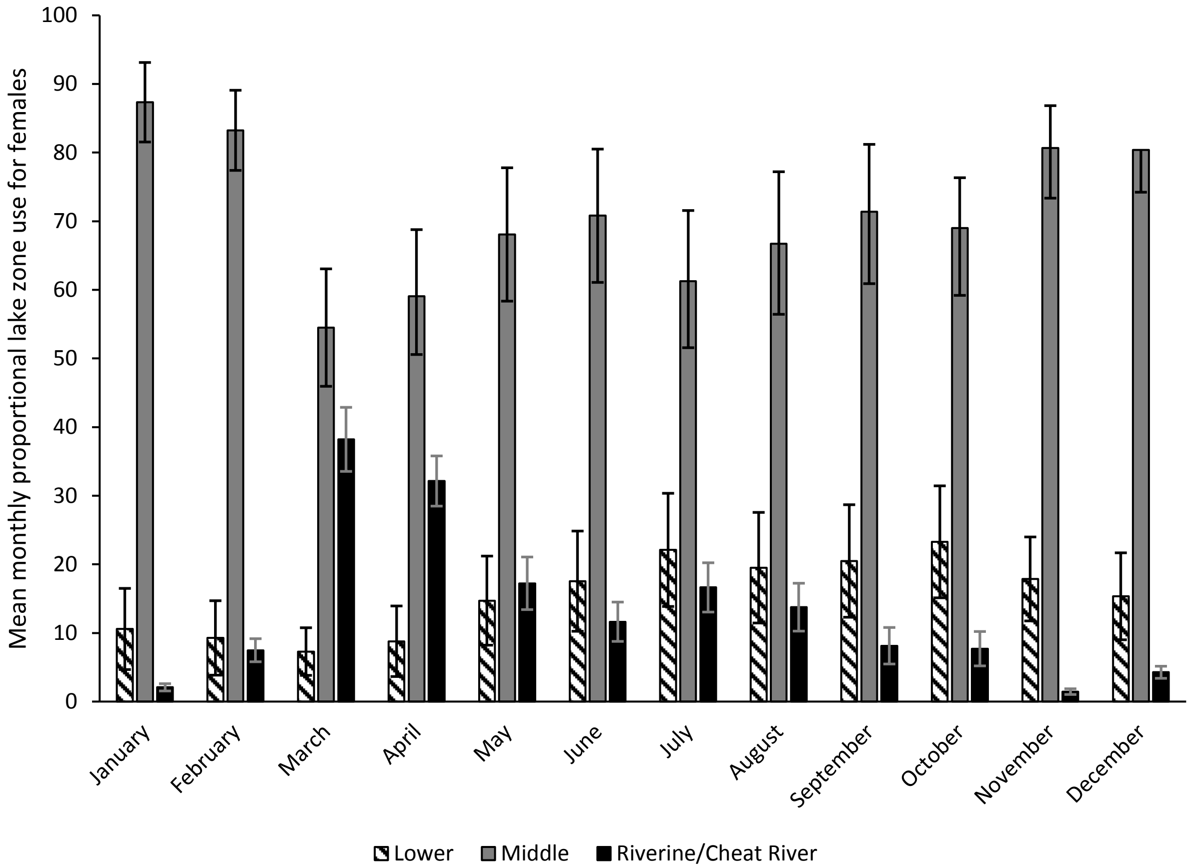

WV/PA Border
Dam
N
Morgantown
0 1 2 4 Kilometers



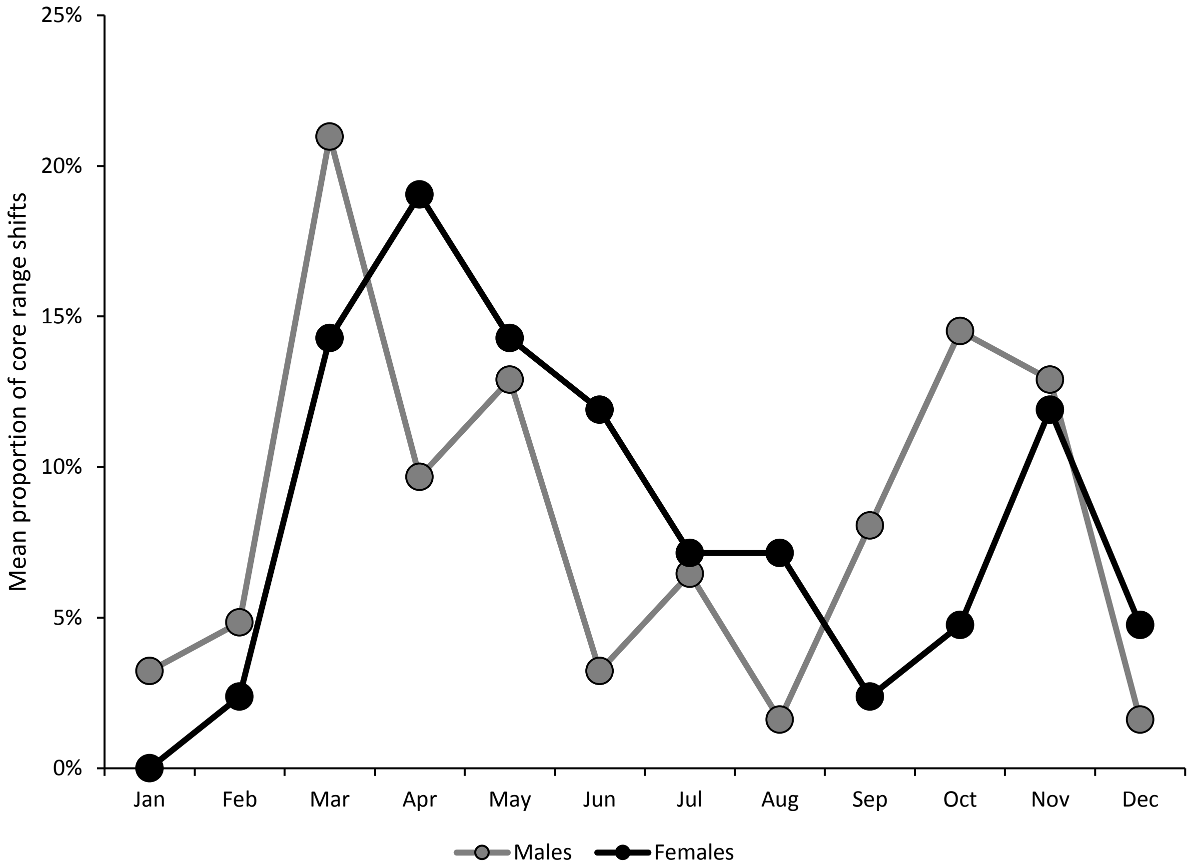
WV/PA Border
Dam
N
Morgantown
0 1 2 4 Kilometers

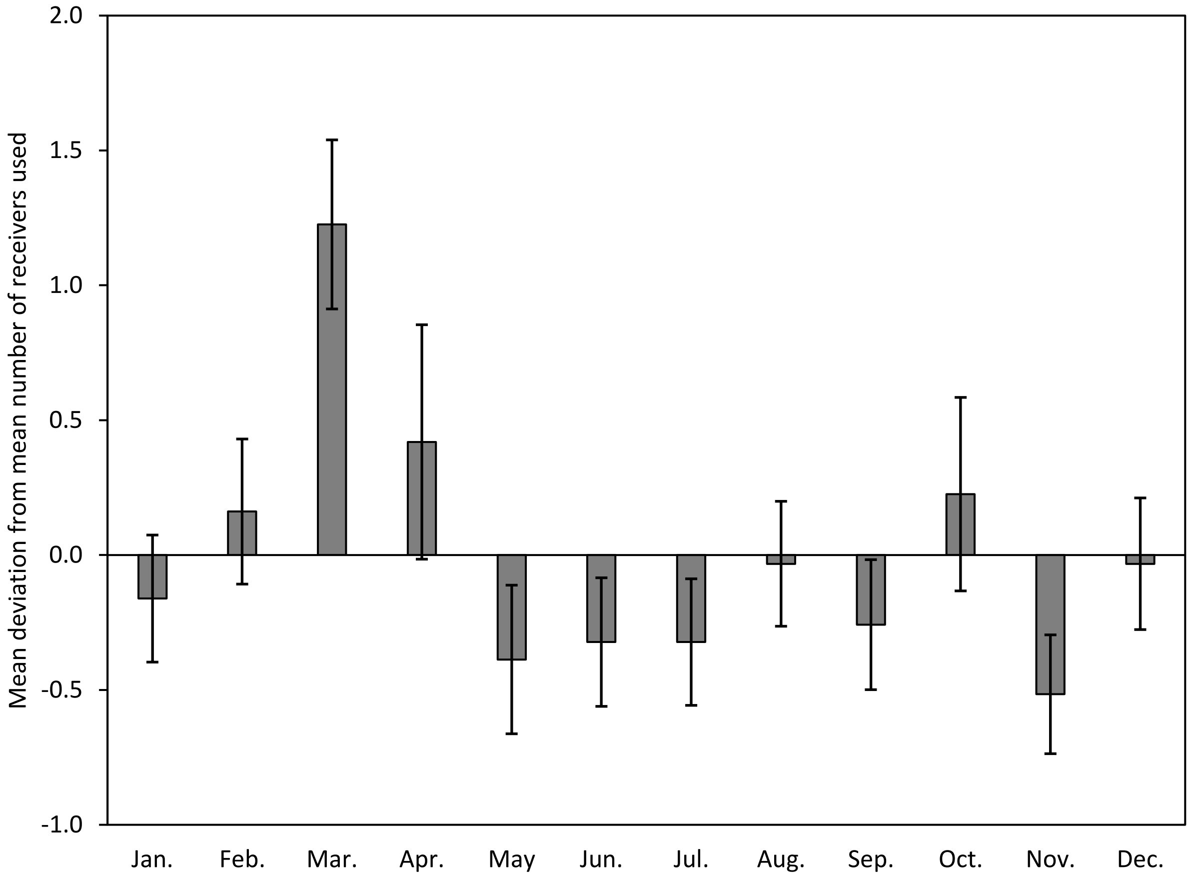


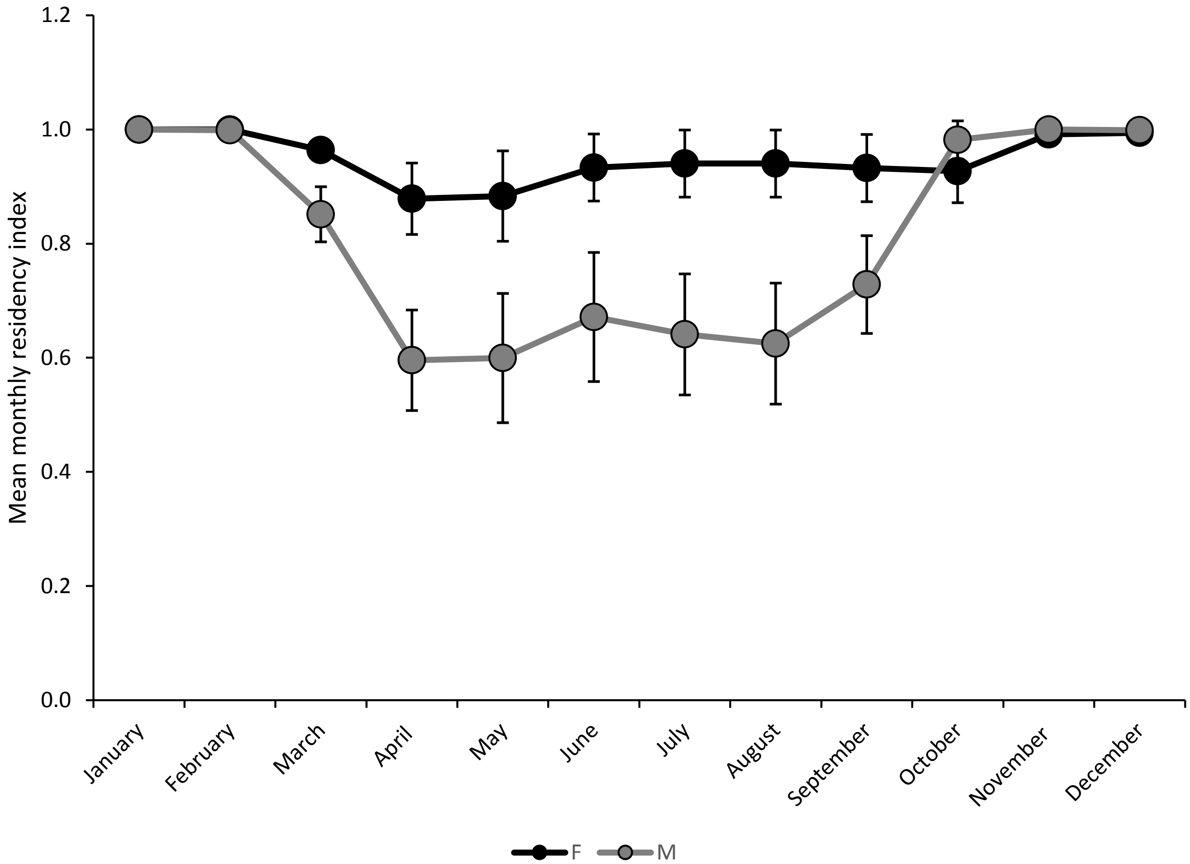
Mean monthly proportional lake zone use for males
100
90
80
70
60
50
40
30
20
10
0
January
February
March
April
May
June
July
August
September
October
November
December
Lower
Middle
Riverine/Cheat River



Mean monthly proportional lake zone use for females
100
90
80
70
60
50
40
30
20
10
0
January
February
March
April
May
June
July
August
September
October
November
December
Lower
Middle
Riverine/Cheat River


25%
20%
15%
10%
5%
0%
Mean proportion of core range shifts
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
Males
Females


2.0
1.5
1.0
0.5
0.0
-0.5
-1.0
Mean deviation from mean number of receivers used
Jan.
Feb.
Mar.
Apr.
May
Jun.
Jul.
Aug.
Sep.
Oct.
Nov.
Dec.



Mean monthly residency index
1.2
1.0
0.8
0.6
0.4
0.2
0.0
January
February
March
April
May
June
July
August
September
October
November
December
F
M

# Chapter 5 - Environmental correlates of large scale seasonal movements of Walleyes in a hydropower reservoir


### *Abstract*

Walleyes were recently reestablished in Cheat Lake, WV in response to water quality improvements after years of impairment from acid mine drainage. As part of the reintroduction effort, Walleye stockings have regularly occurred since 1999. Although stockings have been conducted, a naturally reproducing population is ultimately desired. To better understand the spawning habits and seasonal movement patterns within the lake, a telemetry study was initiated. From 2012–2015, 50 Walleyes were tagged with acoustic transmitters to determine seasonal movements and spawning locations. Binomial logistic regression was used to determine what environmental variables best predict large scale seasonal movements during pre-spawn, post-spawn and non-spawn time periods. Using an information theoretic approach, the best approximating models composed of environmental variables were identified for each time period of interest. Walleyes made pre-spawn upstream migrations in late winter/early spring to spawning areas during periods of elevated water temperatures (75 % of migrations occurred at water temperatures > 4.1 ˚C). Male Walleyes were more likely to make upstream pre-spawn migrations earlier than females. Walleyes spawned in shallow, riffle-run habitat in the headwaters of Cheat Lake. Post-spawning migrations were most influenced by season and fish sex. Most females (83%) made post-spawn migrations to the main lake in spring, while most males (61%) made post-spawn migrations in fall. During non-spawning periods (May – December) large movements (> 4 km) were primarily influenced by river discharge and to a lesser extent water temperature. Most Walleyes made large non-spawning movements from the main lake zone to the riverine zone. Results from the study suggest that water temperature and river flow are important environmental predictors of Cheat Lake Walleye movements.  However,

the importance of water temperature and river discharge in predicting large scale movements can vary seasonally and with fish sex. Knowledge of spawning locations and seasonal movement patterns could be beneficial for management of this recovering population.

## Introduction

An understanding of seasonal movements and spawning locations is critical for the management and conservation of fishes (Landsman et al. 2011). Advances in fish tracking via telemetry give researchers the ability to better understand fish movements, habitat use, and behavior (Lucas and Baras 2000; Rutz and Hayes 2009; Landsman et al. 2011). The Walleye is considered a highly mobile species, where individuals make frequent and long range movements associated with spawning, foraging, and overwintering (Paragamian 1989; DePhillip et al. 2005; Hanson 2006; Bozek et al. 2011). Habitat usage by Walleyes is often complex involving daily and seasonal habitat shifts (Bozek et al. 2011). Several studies have examined Walleye movements and habitat use via mark-recapture methods and telemetry (Eschemeyer and Crowe 1955; Crowe 1962; Paramagian 1989; DePhillip et al. 2005; Palmer et al. 2005; Hanson 2006; Hayden et al. 2014). Past studies have focused mostly on Walleye movements in rivers, natural lakes, or flood control reservoirs within northern or midwestern states (Holt et al. 1977; Paramagian 1989; Williams 2001; DePhillip et al. 2005; Hanson 2006; Bozek et al. 2011).

Among water bodies, Walleyes can be highly variable in patterns of movement and habitat use (Bozek et al. 2011). Seasonal movements of Walleyes have been correlated with various environmental factors (Paragamian 1989; Williams 2001; DePhillip et al. 2005; Palmer et al. 2005; Hanson 2006; Bozek et al. 2011). Walleyes exhibit more frequent and larger seasonal movements during late winter and early spring in relation to spawning activity (Paragamian 1989; DePhillip et al. 2005; Palmer et al. 2005; Hanson 2006; Bozek et al. 2011).

Frequent environmental variables associated with increased spawning movements include water temperature and river discharge (Paragamian 1989; Palmer et al. 2005; Bozek et al. 2011). Despite numerous studies investigating an array of possible environmental influences on Walleye movement, limited research has been done investigating Walleye movements in Appalachian reservoirs (Williams 2001; Palmer et al. 2005). Additionally, most studies on Walleye movements have employed manual tracking techniques, primarily with radio telemetry. Only recently have researchers began to utilize continuous acoustic monitoring of Walleye movements through use of stationary acoustic receivers (Hanson 2006; Phillips 2014; Pritt et al. 2013; Hayden et al. 2014). Use of continuous acoustic monitoring could provide improved accuracy of movement patterns and aid in making more effective management decisions.

Cheat Lake, WV is a hydropower reservoir in northern West Virginia that supports a rebounding Walleye fishery that was originally extirpated due to acid mine drainage within the watershed (Core 1959; WVDNR, unpublished data). Water quality remediation and stocking efforts have reestablished a Walleye fishery within the reservoir (see Chapter 3). Although Walleyes have been reestablished within the reservoir, natural reproduction has been limited and little is known about the movement patterns and spawning locations of Walleyes in Cheat Lake. Cheat Lake also experiences seasonally varying fluctuations in water levels as a result of hydropower operations and it is unknown how these fluctuations may impact Walleye spawning and other seasonal movements. Water level fluctuations influence movements and can limit reproductive success of some fish species (Rogers and Bergerson 1995; Jones and Rogers 1998; Paukert and Fisher 2000; Paukert and Fisher 2001), including Walleyes during spawning periods (Johnson 1961; Priegel 1970; Bozek et al. 2011; Martin et al. 2012). Information regarding spawning location of Walleyes, environmental cues for spawning migration, and timing of spawning in relation to water levels are important for the future management of the Cheat Lake Walleye fishery. In addition, information gained on other seasonal movements would further enhance management opportunities for the fishery. Consequently, there is a management driven need for research investigating seasonal movements of Walleyes within Cheat Lake, and the potential influence of environmental factors. With knowledge of migration cues and seasonal movements, managers can better predict potential impacts to the population by environmental conditions and fishing pressure.

The goal of this study was to evaluate seasonal movement patterns of Walleyes within Cheat Lake in relation to environmental covariates. During the pre-spawn period, our objective was to determine important environmental cues associated with initiation of upstream migration towards spawning grounds. We were also interested in determining spawning locations and how changing lake elevation may impact spawning at these locations. During the post-spawn period, our objective was to determine timing and environmental covariates associated with the migration of individuals to pre-spawn locations. During non-spawning periods (i.e., summer, fall and winter) our objective was to determine environmental covariates associated with large scale movements.

## Methods

### *Study Area*

Cheat Lake was created in 1926 by damming the Cheat River near the West Virginia-Pennsylvania border to serve the needs of a hydroelectric generating facility. The reservoir is approximately 700 ha in size, extends 21 km from the dam to the first riffle, and has a maximum depth of 24 m near the dam. The Cheat River watershed has experienced depressed water quality for over a century as a result of acid precipitation and acid mine drainage from abandoned mine lands (Core 1959; Welsh and Perry 1997; Freund and Petty 2007; Merovich et al. 2007). Consequently, since its establishment Cheat Lake has been subjected to acidification from these sources (Core 1959; WVDNR unpublished data). In recent years, the Cheat River watershed and Cheat Lake have seen substantial water quality improvements likely owing to mitigation efforts throughout the watershed (McClurg et al. 2007; WVDNR unpublished data).

For this study, we separated Cheat Lake into different zones to determine when initiation of migrations occurred. We used methodology similar to that used for Chapters 2 and 4 to designate lake zones, and used results from the Walleye distribution study in Chapter 4 to inform designation of lake zones. For this large-scale movement study, the reservoir was separated into two zones: the main lake zone (including embayments) and the riverine zone (Figure 5.1). Additionally, we regarded the Cheat River upstream of the reservoir as an additional zone (Figure 5.1). Separation of these zones was based on various factors including reservoir morphology, bathymetry, water chemistry differences and overwintering distribution of Walleyes obtained in a separate study (see Chapter 4). Specifically, based on morphology, there is a distinct morphological difference between the riverine zone and main lake zone. The riverine zone is relatively narrow in cross section, whereas the main lake zone is typically 2.5–3 times the width of the riverine zone (Figure 5.1). There is also a distinct difference in hydrological characteristics between the zones. The riverine zone is heavily influenced by the incoming Cheat River in terms of river current. In contrast, the main lake zone is much more lacustrine in character. This is apparent by the typical pattern of overwinter ice formation in the main lake zone but absence of ice in the riverine zone. Additionally, throughout most of the main lake zone, average depths are greater than that occurring within the riverine zone. Also, Walleye distribution data examined in a separate study suggest that during winter all but two of our tagged fish spent most their time downstream of the riverine zone (see Chapter 4).

*Fish Collection and Tagging*

Fifty Walleyes (31 males, 17 females, 2 undetermined, 432–708 mm TL) were collected using boat electrofishing or gill nets in late October/early February 2011–2013. Fish were anesthetized using MS-222 (tricaine methanesulfonate; 100 mg/L). An acoustic transmitter was surgically-implanted into the abdominal cavity of each Walleye (Hart and Summerfelt 1975). Sonotronics coded temperature transmitters (CTT-83-3-I, 62 mm length, 16 mm diameter, 10 g in water) with a battery life of 3 years were used in this study. Fish were placed ventral side up in a V-shaped trough and the gills were continuously irrigated with oxygenated water during surgery. Surgical instruments were sterilized and betadine was applied to the incision site as an antiseptic. An incision of approximately 30–40 mm was made and 3–4 sutures of non-absorbable monofilament were used to close the incision. Surgical procedures lasted less than 7 minutes. Additionally, each fish was marked with a numerically coded external t-bar anchor tag. Each anchor tag displayed contact information in the case of angler caught fish with information recommending the release of the fish (due to the 21 day hold time for MS-222). After surgery and tag placement, fish were placed in a livewell and were monitored until swimming upright and behaving normally (usually a period of 5-10 minutes). To reduce tag-induced behavior, we followed the general rule of transmitter weight (< 2% of the fish weight), and included a recovery period of 4 weeks prior to data collection to monitor for abnormal behavior associated with gear-induced and post-surgery stress or injury (Winter 1996). Other data collected on tagged fish were length, weight, and sex (if determinable). Walleyes were sexed when possible by examination of the gonads through the surgical incision or by expulsion of milt for males. Some Walleyes that were initially difficult to sex were later recaptured via fish surveys or anglers and sex was verified.

*Telemetry*

Walleye locations and movements were monitored year-round, primarily with fixed location telemetry via stationary receivers. Sonotronics submersible underwater receivers (SUR) were deployed at fixed locations throughout Cheat Lake (Figure 5.1). We attempted to deploy receivers in relatively equidistant locations along the length of the reservoir to maximize coverage. As many as 10 receivers were placed throughout the reservoir with an additional receiver located approximately 1 km upstream of the reservoir (above first riffle/run complex and suspected spawning area) in Cheat River. The purpose of the upstream receiver was to determine if at any point tagged Walleyes left the reservoir. The two receivers placed in the primary large embayments at the northern end of the reservoir were lost at the end of 2013, and the receiver located 12 km upstream of the dam was added at the end of 2012. Mean distance between receivers in the main reservoir (not including two embayment receivers) was 2.4 rkm.

Tag detection range of receivers was influenced by thermal stratification, background noise in certain areas (i.e., bridges), and sinuosity of the reservoir. Tag detection range of each receiver varied seasonally due to thermal stratification which reduces the effective range (Shroyer and Logsdon 2009). Range detection tests showed that average detection range during periods of thermal stratification (summer) was approximately 200–500 m, while average detection range during periods of water temperature uniformity was approximately 400–900m. The detection range of receivers was always at least the width of the reservoir at each receiver location. Some supplementary tracking was conducted manually using an acoustic hydrophone, primarily to determine specific location of fish at spawning areas.

*Environmental Data*

We collected data for several environmental covariates including lake elevation, water temperature, lunar illumination, and river discharge. Mean daily river discharge ($m^3s^{-1}$), lake elevation (meters above sea level), and water temperature (˚C) were acquired from the U.S. Geological Survey Water Watch website (http://water.usgs.gov/waterwatch). River discharge and water temperature data from the Albright gauging station on the Cheat River were used for data analysis. The Albright gauging station is approximately 24 rkm upstream from the head of Cheat Lake. Lake elevation data were from the Lake Lynn hydropower station on Cheat Lake. Lunar illumination data were acquired from the U.S. Naval Observatory (http://www.usno.navy.mil/USNO/astronomical-applications). Lunar illumination data consisted of a daily lunar index of the illuminated percentage of the moon face ranging from 0 (new moon) to 1 (full moon).

***Data Analysis***

Data collected from stationary receivers were processed using the Sonotronics software SURsoftDPC. All data were exported to Microsoft Excel. False detections are possible with acoustic telemetry as a result of background noise or in instances when multiple fish are close to the hydrophone (Clements et al. 2005). These erroneous data were eliminated from the dataset by omitting detections that occurred only once within a 24 hr period or by eliminating records when fish were detected as being in separate locations simultaneously (Ramsden et al. 2017).

We used generalized linear mixed models (GLMM) using the PROC GLIMMIX procedure in SAS (SAS 1990) to model covariance associated with repeated measures on movements of individuals. Specifically, binomial logistic regression models with repeated measures and a logit link function were used to examine the relationship between Walleye migration events and environmental covariates, along with non-environmental variables. Models incorporating repeated measures use specialized variance-covariance structures to account for serial correlations present (Henderson et al. 2014; Littell et al. 2006; Rogers and White 2007). Use of a mixed model was necessary due to the combination of fixed (i.e., year, season, sex, lake elevation, water temperature, river discharge, and lunar illumination) and random effects (individual fish) present in the models (Henderson et al. 2014; Littell et al. 2006; Bolker et al. 2008). Due to the use of a linear passive acoustic monitoring array movements could only be defined coarsely on the scale of hundreds of meters (Henderson et al. 2014). For our analyses, we were simply concerned with a binary response of migratory movement during certain periods (i.e., migration vs no migration) in response to environmental covariates. Several recent studies have employed a similar technique of using GLMM's with a binary response variable to model probability of fish movement or migration (Eyler 2014; Henderson et al. 2014; Amtstaetter et al. 2015). Potential covariates for our models included year, season, sex, and several environmental variables (water temperature, river discharge, lake elevation, lunar illumination) as fixed effects. Year was defined as the calendar year from January 1st–December 31st. We defined seasons as the following: winter (December–February), spring (March–May), summer (June–August), and fall (September–November). Individual fish were included as random effects to account for repeated measures on each fish (Rogers and White 2007).

We were interested in modeling migratory movements of Walleyes as related to different stages of the spawning period, including the pre-spawn migration, spawning locations, and post-spawn return migrations. We were also interested in modeling large non-spawning movements occurring in summer, fall, and winter. Covariates were included as daily mean values of incoming river discharge, lake elevation, and water temperature. Lunar illumination data consisted of a daily lunar index of the illuminated percentage of the moon face ranging from 0 (new moon) to 1 (full moon).

The set of candidate models selected for each analysis were ranked by Bayesian Information Criterion (BIC) which has been shown to be more appropriate for models with large sample sizes (Aho et al. 2014; Eyler 2014). We chose to use BIC rather than Akaike Information Criterion (AIC) as BIC has been shown to reduce the likelihood of model overfitting when using large datasets in contrast to AIC (Aho et al. 2014; Eyler 2014). Like AIC, the model with the lowest BIC score was selected as the best fitting model. Information-theoretic approaches select the best model (or suite of competing models) through a parsimonious trade-off among bias, variance, and the number of estimable model parameters (Burnham and Anderson 2002). Given all potential combinations and interactions among covariates, many models could be fit to the data and we selected models to be fit based on published literature of fish movement (Paragamian 1989; Williams 2001; DePhillip et al. 2005; Hanson 2006; Bozek et al. 2011; Phillips 2014). Prior to analysis we assessed multicollinearity using Pearson's Correlation Coefficient and variance inflation factor (VIF). The VIF was calculated for the full model in SAS, and significant collinearity would be suggested by a VIF factor larger than 10 (O'Brien 2007; Eyler 2014). We also computed Pearson's Correlation Coefficient for variables in the full model to further explore potential collinearity between variables.

*Pre-Spawn Migration Analyses*

For the first set of analyses we were interested in determining important environmental covariates associated with migration to spawning grounds. We had a prior assumption that most Cheat Lake Walleyes utilized the riverine zone for spawning based on spring fisheries surveys and angler reports. This was confirmed by yearly direct movements of our study fish from the main lake zone to the riverine zone in the weeks prior to suitable spawning conditions (see Chapter 4). Therefore, our pre-spawn migration analysis is based on modeling the direct movements of our study fish from the main lake zone into the riverine zone under the assumption that these movements are correlated with spawning behavior. For this analysis, we modeled Walleye migratory movements and associated environmental covariates during the period of January 1st to the final upstream migratory movement for each individual prior to spawning. For instance, if an individual fish made its final upstream migratory movement to the spawning area on April 1st, then data for that individual included the period of January 1st to April 1st. For the pre-spawning migration analysis, we included year and sex as fixed effects and individual fish as random effects. Environmental covariates included daily means of water temperature, river discharge (log transformed), and lake elevation, and a lunar illumination index. A global model including year, sex, lake elevation, water temperature, river discharge, and lunar illumination was included for comparison to candidate models. Candidate models included single variable and two variable additive effects models of sex and/or environmental covariates both with and without a year effect. Our final model fitted an intercept to the time-series data.

For analysis of upstream migration we assigned a binomial response (1=migration upstream, 0=no migration upstream) for each Walleye each day prior to final initiation of upstream migration. Initiation of upstream migration was considered when an individual fish first entered the riverine zone of Cheat Lake, signaling departure from their overwintering locations in the main lake zone (lower/middle zones). Therefore, when a fish initiated upstream migration, a “1” was assigned for the day it entered the riverine zone and continued upstream. A “0” was assigned for all other days. Although most individuals in the study occupied the main lake zone downstream of the riverine zone during winter, two individuals displayed a tendency to remain in the riverine zone near the spawning grounds year-round and were thus excluded from this analysis. Additionally, individuals that did not make a pre-spawn migration due to immaturity, emigration from the study area (dam passage), transmitter failure, or mortality were excluded from the analysis.

Additionally, on several occasions upstream migration of individual Walleyes was interrupted and fish made temporary downstream movements back to the main lake. In all instances, these Walleyes eventually made an additional upstream migration back to the spawning area. We assumed these fish reacted to environmental cues to make their initial migration upstream, but subsequent environmental conditions may have interrupted migration resulting in their temporary return to overwintering areas. Due to the relatively small number of fish that exhibited this behavior we did not perform formal statistical testing on these movements. However, to investigate trends in this behavior relative to environmental conditions we did examine descriptive statistics of environmental covariates during these movements compared to periods without temporary downstream movements.

*Spawning Period*

To estimate timing of spawning during each year we used a combination of methods. We examined the final passage of the uppermost acoustic receiver by specific fish, manually tracked locations of telemetered fish during the suspected spawning period, determined periods when water temperatures were suitable for spawning based on previous studies, and used data from biological surveys (gill netting and boat electrofishing) on fish location and spawning status (pre- or post-spawn condition determined by presence-absence of milt or eggs).

We were able to narrow the likely period of spawning by examining passage of the uppermost receiver (below the suspected spawning shoal) by specific telemetered fish. Many fish reached the uppermost receiver and began moving onto the spawning grounds early in the pre-spawn period. These fish subsequently spent many days in the vicinity of the spawning shoal. Consequently, these early arrivals were not as useful in estimating the potential spawning period. Those fish that appeared to move up to the spawning area later (primarily females) were those most useful in estimation of the spawning period. We also periodically located tagged fish close to the spawning period using a portable hydrophone. This allowed us to determine and confirm if fish had in fact moved onto the spawning grounds and pinpoint specific locations of tagged fish in these areas. We also examined water temperature data during periods when tagged fish were located near the spawning shoal. Using published literature on spawning temperature ranges for this region (~ 7–10 ˚C; Bozek et al. 2011) helped determine if spawning was possibly occurring during periods of fish presence at spawning areas. Finally, we also conducted gill net and night-boat electrofishing surveys periodically during the study. By examining the spawning condition (pre- or post-spawn) of captured fish we were able to estimate if spawning commenced. By utilizing all of these methods we were able to come to a general estimation for when spawning likely occurred each year.

*Post-Spawn Migration Analysis*

For the second set of analyses we were interested in determining timing of return migration of individuals from spawning areas to the main lake zone and associated environmental covariates. For this analysis, we modeled Walleye post-spawn downstream migration and associated environmental covariates from the spawning period to the first day an individual fish re-entered the main lake zone. The start date for this analysis was the day after the last pre-spawn upstream migration for each fish. As an example, if an individual fish made its final pre-spawn upstream migration on March $1^{st}$ and then returned to the main lake zone on May $1^{st}$, the period of March $1^{st}$ – May $1^{st}$ would be used for that fish. For the post-spawn migration analysis we included year, season, sex, and environmental covariates (water temperature, river discharge, lake elevation, lunar illumination) as fixed effects and individual fish as random effects. We included season as a fixed effect due to the period from spawning to post-spawn return migration encompassing long time periods (several months for some individuals) for some individuals and due to the seasonal differences in post-spawn movements reported in other studies (DePhillip et al. 2005; Palmer et al. 2005; Hanson 2006). A global model including year, season, sex, lake elevation, water temperature, river discharge, and lunar illumination was included for comparison to candidate models. Candidate models included single variable and two variable additive effects models of sex and/or environmental covariates both with and without a year and/or season effect. A final model fitted an intercept to the time-series data.

For analysis of post-spawn migration we assigned a binomial response (1= migration downstream, 0=no migration downstream) for each Walleye each day prior to return to the main lake. Post-spawn return migration was considered when an individual fish first entered the main lake zone of Cheat Lake, signaling departure from the spawning grounds and riverine zone. Any individuals that did not return to the main lake post-spawn but instead remained in the riverine zone were excluded from this analysis.

*Non-Spawning Movement Analysis*

For the third set of analyses we were interested in determining environmental covariates associated with large non-spawning movements. For this analysis we modeled Walleye non-spawning movements and associated environmental covariates from May 1$^{st}$ to December 31$^{st}$. This time period was chosen as it generally reflected the period when movements were not associated with spawning events. For the non-spawning movements analysis we included year, season, sex, and environmental covariates (water temperature, river discharge, lake elevation, lunar illumination) as fixed effects and individual fish as random effects. We included season as a fixed effect due to the period from May 1st to December 31st encompassing all seasons of the year and due to the seasonal differences in non-spawning movements reported in other studies (DePhillip et al. 2005; Palmer et al. 2005; Hanson 2006). A global model including year, season, sex, lake elevation, water temperature, river discharge, and lunar illumination was included for comparison to candidate models. Candidate models included single variable and two variable additive effects models of sex and/or environmental covariates both with and without a year and/or season effect. A final model fitted an intercept to the time-series data.

For analysis of large non-spawning movements we assigned a binomial response (1 = "movement", 0 = "no movement") for each Walleye during the analysis period. Non-spawning movements were considered as events when individual fish moved past at least 2 receivers (mean of 4.8 rkm) in an upstream or downstream direction in a single day. Individual fish moved frequently between neighboring receivers, but movements past 2 receivers were less common and usually signaled departure from core use areas. For instance, if an individual Walleye moved from receiver number 1 to 2 in a single day that movement was not counted as large scale movement event. However, if a Walleye moved from receiver number 1 to 3 in a single day that movement was considered a large-scale movement event. Limiting movements included in analyses to those of at least 2 receivers or more helped ensure that movements tested were those in which fish were wandering outside of their local ranges. Although most individuals in the study occasionally made large movements during the non-spawning period, a few fish failed to make large movements and were thus excluded from this analysis.

## Results

### *Pre-Spawn Migration*

A total of 31 Walleyes (18 males; 13 females) made upstream migrations during the pre-spawn periods of 2012–2015, with yearly numbers of migrating fish ranging from 9 to 22 (Table 5.1). The earliest upstream migrations occurred in February in all years except 2013, when the earliest migration event occurred on January 13$^{th}$. The latest upstream migrations occurred in early April just before spawning commenced. Number of days with upstream migration events ranged from seven days in 2012 to seventeen days in 2013 (Table 5.1). Two Walleyes were excluded from analysis of upstream migration due to their tendency to remain near the spawning grounds throughout the pre-spawn period and thus not make a significant migration. An additional six Walleyes were excluded from analysis due to their lack of a migration (i.e., non-spawning immature females) from the main lake zone towards the riverine spawning grounds. During surgery, we assumed these fish were immature females due to their large size (>450 mm) yet no evidence of mature gonads.  Sexual immaturity would explain the lack of a spawning migration. We confirmed the immaturity of two of these fish as they were captured in gill netting surveys resulting in mortality and their immaturity was confirmed through dissection. Fish labeled as immature females exhibited no spawning migration and instead remained relatively sedentary in their respective locations in the main lake zone.

Walleyes made upstream pre-spawn migrations during a wide range of environmental conditions, but results did suggest some environmental correlates are better predictors than others. Upstream migration often occurred at times of higher river discharge and/or lake elevation, but conversely migration also often occurred during low river discharge and lake elevation. Upstream migration events occurred during river discharge ranging from 47.85 to 577.66 $m^3 \cdot s^{-1}$ (Table 5.2). Upstream migration occurred during lake elevations ranging from

261.64 to 265.15 meters above sea level (Table 5.2). Upstream migration events were more likely to occur during periods when water temperatures were warmer than average (Table 5.2; Figure 5.2). Upstream migration occurred at a range of water temperatures from 2.2° C to 10.1° C, but most upstream migration events (75%) occurred at water temperatures greater than 4.1° C.

The GLMM analysis supported two different additive-effects models including a model of "year + water temperature" (Δ BIC=0) and a model of "year + sex + water temperature" (Δ BIC=0.53). The BIC selected models had positive coefficients for water temperature for both the "year + water temperature" model (β=0.83, s.e.=0.08) and the "year + sex + water temperature" model (β=0.85, s.e.=0.08). Therefore, pre-spawn upstream migration events were associated with elevated water temperatures. The BIC selected model that included the variables year and water temperature was also supported through graphical comparison of the yearly data and by descriptive statistics (Figure 5.2; Table 5.2). Graphs of yearly data illustrated that upstream migrations were almost always clumped around spikes in water temperature (Figure 5.2). Descriptive statistics demonstrated that mean water temperature during upstream migration events each year was always greater than mean water temperature during non-migration (Table 5.2). Additionally, model selection statistics (Table 5.6) demonstrate that the top 10 models all include the predictor variable water temperature. Regarding the potential effect of sex on upstream migration, female Walleyes did initiate migration later on average compared to male Walleyes. Male Walleyes typically migrated upstream prior to March (68.9 %), with fewer migrating in March (28.9 %) or April (2.2 %). In contrast, fewer females migrated upstream prior to March (39.5 %) as most migrated upstream in March or April (52.6 % in March, 7.9 % in April). Models that included lake elevation, river discharge, and lunar illumination were not supported by the data.

Our evaluation of variable collinearity using VIF and Pearson's Correlation Coefficient indicated that multicollinearity did not significantly affect model performance. O'Brien (2007) suggests that a VIF greater than 10 would indicate an issue with multicollinearity, but VIF in our study was less than 2. We did not have any variable correlations greater than 0.49 and standard errors for all parameter estimates were relatively small (less than 1)

In addition to upstream migrations prior to spawning, at times the migration of Walleyes was interrupted resulting in their temporary return to the main lake. In all cases, fish eventually made a return upstream migration and reached the spawning grounds prior to spawning. In total, 13 fish (7 males; 6 females) made temporary downstream migrations and subsequently returned to the main lake prior to spawning. Additionally, three of these fish (1 male; 2 females) had two instances each of moving back into the main lake prior to spawning. Number of fish with temporary downstream displacement included zero in 2012, seven fish in 2013, four fish in 2014, and one fish in 2015. Descriptive statistics revealed that temporary downstream movements usually occurred during periods of low water temperatures (Figure 5.3). Specifically, these temporary downstream movements usually occurred when water temperatures cooled substantially after a period of warm water temperatures. Descriptive statistics demonstrated that mean water temperatures were lower during downstream movements (mean=1.8 ˚C) compared to the mean during no downstream migration (3.6 ˚C). Most of these downstream movements occurred when water temperature was near freezing (i.e., < 1 ˚C; Figure 5.3). Water temperature was the only environmental variable without overlapping 95% confidence intervals (1.96 * standard error) between downstream movement and no movement periods.

*Spawning Period*

Spawning locations and the timing of spawning were determined each year using a combination of telemetry data from upstream receivers, manual tracking of telemetered fish, water temperature data, and fish surveys (gill netting and electrofishing). Telemetry data indicated that spawning occurred from late March to early April in all years except 2012, when spawning occurred in mid-March (Figure 5.5). Spawning appeared to primarily occur in shallow (< 2 m) rocky shoals just downstream of the first riffle/run at the head of the lake (Figure 5.1). In examining fluctuations of lake levels during periods of estimated spawning activity, the maximum decrease in lake elevation occurred during 2014, when lake elevation decreased by 2 meters (Figure 5.5). In comparison, the maximum decreases in lake elevation during spawning periods in 2012, 2013, and 2015 were 0.6 m, 1.7 m, and 1.7 m respectively (Figure 5.5). Additionally, detection of some individuals at our receiver upstream of the reservoir may suggest that some Walleyes migrate upstream of the reservoir to spawn in the river. However, given the lack of a receiver further upstream, we were unable to determine if these fish continued to move upstream and spawn. It is possible that these fish were simply utilizing the pool area where our receiver was located and moved downstream onto the spawning shoal to spawn.

*Post-Spawn Migration*

From 2012–2014 a total of 24 Walleyes (14 males; 10 females) eventually made post-spawn return migrations from the riverine zone to the main lake zone of the reservoir. Number of return migrants included 5 individuals in 2012, 22 individuals in 2013, and 12 individuals in 2014. Some fish made upstream spawning migrations but did not provide data on a return migration due to either mortality or transmitter failure. Post-spawn data on fish that spawned in

2015 were not used as acoustic receivers were removed from the reservoir immediately after spawning.

The GLMM analysis of post-spawning downstream migration supported a single additive-effects model of “season + sex” (Δ BIC=0; Table 5.7). After graphically examining post-spawning movements related to season and sex, it was apparent that females were more likely to return to the main lake during the spring season and males were more likely to return during autumn. Specifically, most female fish had returned to the main lake by the end of April and most males did not return until October (Figure 5.4). Most post-spawn return migrations for female fish (83 %) occurred within 1-2 weeks after the estimated spawning period (i.e., late March in 2012; mid- to late April in 2013–2015). Only 18 % of post-spawn return migration events for female fish occurred after April, with one post-spawn return trip each in late May, early June, and late October, respectively. In contrast, post-spawn return of male fish to the main lake was more evenly divided between two seasonal periods. For male Walleyes, 39 % made post-spawn return movements to the main lake during the spring (12 April–8 May), while 61 % did not return to the main lake until late summer/autumn (28 Aug–26 Oct). Models that included lake elevation, water temperature, river discharge, and lunar illumination were not supported by the data (Table 5.7).

Our evaluation of variable collinearity using VIF and Pearson’s Correlation Coefficient indicated that multicollinearity did not significantly affect model performance. VIF suggested that multicollinearity was not a problem as our highest value was only 2.43. Water temperature and lake elevation did have a relatively strong correlation (0.62), but standard errors for all parameter estimates were relatively small (less than 1).

*Non-Spawning Movements*

From 2012–2014 a total of 34 Walleyes (16 males; 17 females; 1 unknown) provided data on movement during non-spawning periods. Four of 17 females were immature during part of the study period and five of the 17 females were believed to be immature during the entire study period. The number of fish monitored per year included 6 individuals in 2012, 31 individuals in 2013, and 20 individuals in 2014. Some fish did not provide data on non-spawning movement due to either mortality or transmitter failure. Fish that were tagged in winter of 2014 did not provide non-spawning movement data as acoustic receivers were removed from the reservoir the following spring.

The GLMM analysis of large non-spawning movements supported a single additive-effects model of "river discharge + water temperature" ($\Delta$ BIC=0; Table 5.8). The BIC selected model had positive coefficients for river discharge ($\beta$=0.45, SE=0.06) and water temperature ($\beta$=0.03, SE=0.008). Therefore, large non-spawning movements were associated with elevated river discharge and to a lesser extent elevated water temperatures. Descriptive statistics demonstrated that mean river discharge during movement events each year were higher on average (81.7 $m^3s^{-1}$) than mean river discharge during non-movement (51.6 $m^3s^{-1}$). Additionally, model selection statistics (Table 5.8) demonstrate that the top 10 models all include the predictor variable river discharge, further supporting the importance of river discharge in modelling large non-spawning movements. The results of the GLMM analysis suggests that Walleyes make large non-spawning movements at higher water temperatures on average compared to when movements did not occur. Walleyes made non-spawning movements at water temperatures averaging 17.5 ˚C, whereas water temperature averaged 17.2 ˚C during periods of no long-distance movement, which is a small difference. The effect size of water temperature was also moderately low ($\beta$ = 0.03), so it is likely that water temperature is not as important a predictor as river discharge. Models that included season, sex, lake elevation, and lunar illumination were not supported by the data (Table 5.8).

Our evaluation of variable collinearity using VIF and Pearson's Correlation Coefficient indicated that multicollinearity did not significantly affect model performance. VIF suggested that multicollinearity was not a problem as our highest value was only 1.99. Water temperature and lake elevation did have a relatively strong correlation (0.58), but standard errors for all parameter estimates were relatively small (less than 1).

**Discussion**

Results from this study provide valuable information on the influence of environmental conditions on the seasonal movement and spawning locations of Walleyes in Cheat Lake. Specifically, our results relate to how Walleyes respond to environmental conditions in the context of a hydropower reservoir with varying levels of water level fluctuations. Our results suggest that the best predictors of Walleye movements in Cheat Lake include season, sex, water temperature and river discharge dependent on time period of interest. Specifically, our results suggest that the primary driver of Walleye upstream migration in Cheat Lake during the pre-spawn period is water temperature. Other environmental factors including lake level, river discharge, and lunar illumination were not supported as being significant predictors of Walleye pre-spawn migration. However, given the results of fish movements and locations during the spawning period, lake level fluctuations could potentially impact success of Walleye spawning through stranding of eggs and larvae. During the post-spawn period, results suggest that return migrations back to the main lake are primarily seasonally driven with importance of sex as well. Finally, large movements during non-spawning months are primarily influenced by river discharge and to a lesser extent water temperature.

During the pre-spawn migration period, water temperature was the primary driver of migration both upstream into the riverine zone and for temporary downstream movements prior to spawning. The BIC-selected model and supporting descriptive statistics suggest a positive correlation of water temperature and upstream migration. Additionally, descriptive statistics suggest a negative correlation of water temperature and temporary downstream migrations prior to spawning. Specifically, Walleyes were more likely to begin upstream migration towards spawning areas during periods of higher water temperatures, while some Walleyes would temporarily move back downstream if water temperatures decreased sharply prior to spawning. There was some evidence for sex specific differences in upstream migration. On average, males moved upstream earlier than females, but there were also some female fish that consistently moved upstream as early as males. However, the difference in timing of upstream migration between sexes does suggest sex has some impact on when upstream migration occurs.

Studies on Walleye movements have suggested that pre-spawn migration is correlated with warming water temperatures (Eschmeyer 1950; Preigel 1970; Paragamian 1989; Pitlo 1989; Bellgraph et al. 2008; Bozek et al. 2011). However, there is a wide range of water temperatures for which initiation of migration occurs in other studies (Bozek et al. 2011). Our data suggest that Walleyes typically begin upstream migration when water temperatures are on average greater than 4 degrees Celsius. However, there does appear to be variation among individuals in terms of at what temperatures migration occurs. For instance, if water temperatures remained at or near freezing for long periods, a subtle increase in water temperature may be enough to trigger upstream migration for some individuals. The only upstream migrations to occur at water temperatures less than 3 degrees Celsius during our study occurred during 2015 when water temperatures remained near freezing for most of the pre-spawn period. These movements occurred during slight elevations in water temperature during February and at the start of increasing water temperatures in March. Although Walleyes at times moved during periods of higher river discharge or higher lake elevation, there was large variability of these conditions when migrations occurred. Upstream migration occurred during both low and high periods of river discharge and lake elevation, but almost always occurred during periods of warmer water temperatures. It is apparent from statistical analysis and from graphical representation, that water temperature is the key environmental cue to initiation of upstream migration events.

Regarding temporary downstream migration, Walleyes nearly always made temporary trips back to the main lake during periods of decreasing water temperatures that followed an increase in water temperatures. Presumably, some fish responded to cues related to warming water temperatures and made upstream movements towards spawning areas. However, if these periods of increased water temperatures were subsequently followed by a decrease in water temperature, some fish made movements back into the main lake prior to spawning. In all cases, these fish that made early downstream movements eventually responded again to warmer water temperatures and made a final migration to the spawning grounds. To our knowledge, this specific behavior has not been mentioned in the literature, although some studies have recorded a delay in spawning after arriving at spawning shoals if water temperatures are unsuitably low (Bozek et al. 2011). Additionally, many authors suggest that in general Walleyes will travel to deep water areas when water temperatures decrease (Paragamian 1989; DePhillip et al. 2005; Hanson 2006). However, this is generally referring to Walleyes moving to overwintering areas in late autumn. It is possible that given the relatively short distance from the spawning area to the main lake zone in Cheat Lake (~8 km) that some fish simply prefer to move into the deeper waters downstream during cold periods as opposed to remaining in shallower pools offered near the spawning grounds.

Although lake level was not supported as being good a predictor of upstream migration, it could nevertheless have important consequences during the spawning period. Telemetry results and fishery surveys suggest that Cheat Lake Walleyes likely spawn in shallow shoal areas downstream of the first riffle/run complex at the head of the reservoir. This area is impacted by lake level fluctuations and could lead to stranding of eggs and larvae if lake levels decreased after deposition of eggs. Several studies have suggested the potential for decreasing water levels to lead to egg and larval mortality (Johnson 1961; Priegel 1970; Chevalier 1977; Bozek et al. 2011). Additionally, spawning appears to occur as early as mid-March during warmer years and as late as early April in colder years. Currently a lake drawdown restriction of 2.1 meters exists in April in an attempt to enhance success of Walleye reproduction by minimizing stranding potential. Therefore, any Walleye spawning that occurs prior to this date could be impacted by maximum lake level fluctuations (3.96 m). Walleyes have been documented in other studies as relatively shallow water spawners (< 2 m) (Bozek et al. 2011). Likewise, our manual tracking data and night-time boat electrofishing surveys typically found Walleyes near spawning shoals to be in water less than 2 m deep. Therefore, although the lake elevation restriction of 2.1 meters imposed in April provides less extreme fluctuations, dewatering could still occur if spawning occurred at or near full pool.

Regarding post-spawn movements of Walleyes, other studies suggest that females will typically make return migrations to pre-spawn areas shortly after spawning occurs, while males may spend several weeks in the vicinity of spawning grounds before returning (Rawson 1957; Colby et al. 1979; Paragamian 1989; DePhillip et al. 2005; Hanson 2006; Hayden et al. 2014). However, some studies have identified genetic specific tendencies for post-spawn movements (Palmer et al. 2005). Specifically, Palmer et al. (2005) found that during post-spawn, fish of the Eastern Highland genetic stock remained in riverine habitat near spawning areas, while fish of the Great Lakes stock would quickly return downstream to main lake areas. Results from our study demonstrate an interesting pattern in terms of return movements back into the main lake zone between males and females. Most post-spawn return migrations for female fish occurred within 1–2 weeks after the estimated spawning period (i.e., late March in 2012; mid- to late April in 2013-2015). Only a small proportion of post-spawn return migration events for female fish occurred after April, with one post-spawn return trip each in late May, early June, and late October, respectively. In contrast, post-spawn return of male fish to the main lake was more evenly divided between two seasonal periods. Although several male Walleyes did make return trips to the main lake shortly after spawning, most male fish stayed in the riverine zone near the spawning grounds until autumn. During autumn, male fish would typically leave the riverine zone and switch to primarily occupying the main lake zone. Reasons for this dichotomy in male and female post-spawn behavior are unknown, but other studies have suggested several possibilities. Some studies suggest that males linger near spawning areas in order to have the opportunity to reproduce with several females (Hayden et al. 2014; Phillips 2014). However, this behavior would not explain male Walleyes remaining in these areas for much longer than 1–2 weeks after peak spawning. Other studies suggest that some fish simply choose to remain in these areas to exploit seasonally abundant prey resources (DePhillip et al. 2005). It is possible that our study fish that exhibited post-spawn preference for riverine areas were utilizing abundant prey sources. Electrofishing surveys indicate an abundance of Mimic Shiner, juvenile Smallmouth Bass, Logperch, and Yellow Perch in the riverine zone during spring. Yet another possibility is that riverine post-spawn residents are choosing to remain in the riverine zone to avoid potential thermal-oxygen stress that can occur in the main lake (DePhillip et al. 2005). Cheat Lake thermally stratifies during summer months, creating epilimnetic water temperatures that can be much warmer than the preferred range for Walleyes (Hokansen 1977; Williams 2001; Bozek et al. 2011; Hayden et al. 2014). Additionally, cooler water temperatures in the hypolimnion may not be available due to low dissolved oxygen (<2 mg/L) (Williams 2001; Bozek et al. 2011). Finally, it is possible that this is simply a learned or heritable preference for some fish to utilize the riverine zone for an extended period post-spawn (Palmer et al. 2005; Hanson 2006).

Statistical analysis of large non-spawning movements suggest that Walleyes move out of local ranges in response to elevated river discharge and to a lesser extent elevated water temperatures during non-spawning periods. These movements may be associated with locating more suitable feeding conditions (cooler, more oxygenated water) or exploiting forage availability (i.e. turbid water, prey concentrations, etc.). Other studies suggest that Walleyes will make movements to locate forage or suitable foraging conditions (Peat et al. 2015). Additionally, other studies have pointed out the potential influences of a temperature-oxygen squeeze in reservoirs with significant stratification (Ficke et al. 2007; Bozek et al. 2011). Cheat Lake stratifies from June–September and preferred water temperatures may be at a depth in which oxygen levels are insufficient. Movements to the riverine zone, especially during elevated discharge events, could provide cooler more oxygenated water. Large scale movements in response to elevated river discharge and water temperature during periods without stratification could still possibly be due to Walleyes taking advantages of changes in conditions to forage for prey.

**Management Implications**

Understanding of how environmental conditions influence movements of Walleyes can improve the management of Walleye populations (Williams 2001; Rasmussen et al. 2002; Palmer et al. 2005; Hanson 2006). Specifically, with the knowledge of timing and cues to pre-spawn migration, managers can better predict when upstream migration events are likely to occur. This information would be useful from a management perspective as knowing when and where congregations of Walleyes will occur could help direct spawning stock surveys and potentially improve angler success rates (Williams 2001; Palmer et al. 2005). Additionally, with knowledge of timing and location of Walleye spawning, managers can better predict potential impacts of fluctuating lake levels and angler efforts on the spawning population. In other studies, anglers have heavily exploited Walleyes congregated for spawning (Palmer et al. 2005). Therefore, with knowledge of these spawning congregations in Cheat Lake, managers should be cognizant of the potential for overexploitation of Walleyes by anglers.

Walleyes in Cheat Lake appear to respond to similar cues for upstream migration compared to Walleyes in other studies (Eschmeyer 1950; Preigel 1970; Paragamian 1989; Pitlo 1989; DePhillip et al. 2005; Hanson 2006; Bellgraph et al. 2008; Bozek et al. 2011; Hayden et al. 2014). Cheat Lake Walleyes normally initiated upstream migration prior to spawning during periods of elevated water temperatures. Specifically, most upstream migration events occurred when water temperatures were greater than 4 degrees Celsius. With knowledge of approximate timing of upstream migration of Walleyes during warmer water temperatures from January through April, managers will be able to more accurately determine when Walleyes first begin to congregate in the upper reaches of Cheat Lake. Given the still recovering status of the Walleye population, knowledge of timing of congregating fish and location could be beneficial in assessing the spawning population by targeting these areas during periods of suspected congregation. Additionally, angler success and interest in the fishery could be improved with knowledge of timing of Walleye movements to specific locations. Also, knowledge of timing of spawning and location may be critical for the success of the population given potential impacts from lake elevation changes. Currently, lake elevation restrictions change from maximum drawdown (3.9 m) to a restricted drawdown (2.1 m) on April 1$^{st}$ of each year. This restriction is designed to facilitate successful spawning conditions for Walleyes within Cheat Lake. However, as was witnessed in our study, Walleye spawning likely occurs as early as mid-March, especially in years with warmer temperatures. Therefore, the fluctuation restriction on April 1$^{st}$

would provide little benefit during these years. Not only do decreasing lake levels potentially lead to egg and larval mortality from stranding, but it also could reduce available suitable spawning habitat for Walleyes (Priegel 1970; Chevalier 1977; Ickes et al. 1999; Bozek et al. 2011; Martin et al. 2012). Also, given the likely spawning of individuals in water less than 2 meters deep, the 2.1 meter restriction may not provide complete protection from stranding should spawning occur at or near full pool. This information will be valuable for managers to consider as the recovery of the Cheat Lake Walleye population continues to be monitored.

Results showing stark contrasts in post-spawn movement activity of male and female Walleyes provides managers with valuable information on where and when to expect female and male Walleyes to occur post-spawn. There is an obvious dichotomy in where male and female Walleyes are located post-spawn, and when fish make return trips to pre-spawn locations. Based on our data, we can expect most female Walleyes to make a return migration to the main lake zone shortly (1–2 weeks) after spawning has occurred. In contrast, a significant proportion of male fish remained at or near the spawning area in the riverine zone for several months post-spawning. Thus, managers and anglers should expect most large females to quickly return to their main lake locations after spawning, while many smaller male fish may remain in the riverine zone for several months. Additionally, many of these fish that do not make return migrations until autumn spend weeks or months completely removed from the reservoir and are located in the river upstream.

During non-spawning periods, Walleyes displayed a tendency to make large movements in relation to some environmental covariates. Specifically, during summer, winter, and fall, Walleyes made large scale movements in response to elevated river discharge and to a lesser extent, water temperature. Walleyes may make large movements during periods of elevated river discharge to exploit prey or find areas of recently cooled and oxygenated water. Specifically, the riverine zone and Cheat River typically provide cooler, more oxygenated water during warmer months than the main lake area. Again, knowledge of seasonal distribution of Walleyes in Cheat Lake can provide managers and anglers with improved ability to target specific areas during surveys or fishing trips.

In conclusion, results from our study suggest that seasonal movements of Walleyes in Cheat Lake are similar compared to other systems. Water temperature is a commonly reported driver of pre-spawn migration, however, given the wide range in reported temperatures at which migration occurs, typical temperatures during migration for Cheat Lake Walleyes will provide site specific conditions for this system. Also, just as Walleyes of Cheat Lake appear to respond to elevated water temperatures via upstream migration, stability of these warm temperatures may be important in assuring continued presence of some individuals in the riverine zone. Cold water temperatures on several occasions led to fish temporarily making return trips to the main lake zone. Knowledge of how adult Walleyes respond to changing water temperatures during the pre-spawn period will be useful for both managers and anglers in locating Walleyes during these periods. Presently, the distance from the only boat access ramp to the spawning grounds prior to 1 May is nearly the length of the reservoir (~20 km). This presents challenges for anglers with small boats and/or limited outboard horsepower in reaching this area to exploit congregating adult Walleyes. Although the ability of anglers to adequately reach this area would likely lead to increased angler satisfaction with the resource, managers should be cautious given the relatively small population gathering in such a small area. Angler exploitation could add to any existing environmental challenges for recruitment success. Additionally, managers should further consider the potential impacts of lake level fluctuations on the success of Walleye recruitment. Given the timing and location of Cheat Lake Walleyes and their susceptibility to decreasing lake elevation, it is possible that recruitment is impacted by egg/larval stranding and/or reduced spawning habitat during years of greater variability in lake elevation. Ideally, future studies will examine angler attitudes and exploitation of Walleyes in Cheat Lake to better assess this aspect of the fishery. Additionally, future studies should aim to specifically pinpoint exact egg depositional areas to better understand what impacts lake elevations may or may not be having. By considering the findings of this study and implementing further research mangers should be better able to manage this improving Walleye population.

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**Table 5.1.** Annual count of tagged Walleyes migrating to riverine zone of Cheat Lake prior to spawning, including pre-spawn period duration, earliest movement dates, and number of days with migration.

| Year | Time period | Earliest movement | Days | Days with migration | No. migrating Walleyes |
|---|---|---|---|---|---|
| 2012 | 23 January–10 March | 3 February | 48 | 7 | 9 |
| 2013 | 1 January–4 April | 13 January | 94 | 17 | 22 |
| 2014 | 1 January–4 April | 21 February | 94 | 13 | 19 |
| 2015 | 1 January–20 March | 11 February | 79 | 7 | 10 |

**Table 5.2.** Summary statistics of three environmental variables (mean daily lake elevation, mean daily river discharge, and mean daily water temperature) during days of upstream pre-spawn migration and days without upstream pre-spawn migration.

| Year | Lake elevation (m above sea level) | | River discharge (cms) | | Water temperature (˚C) | |
|---|---|---|---|---|---|---|
| | Mean (95% CI) | Range | Mean (95% CI) | Range | Mean (95% CI) | Range |
| Days with upstream pre-spawn migration | | | | | | |
| 2012 | 263.2 (262.3, 264.2) | 261.6─264.8 | 126.7 (40.3, 213.1) | 53.2─317.1 | 6.3 (5.7, 6.9) | 5.5─7.2 |
| 2013 | 264.1 (263.7, 264.6) | 262.5─265.1 | 132.9 (93.5, 172.2) | 47.9─302.9 | 4.7 (4.0, 5.4) | 3.2─6.6 |
| 2014 | 263.9(263.3, 264.5) | 262.3─265.2 | 145.0 (86.3, 203.7) | 60.6─379.5 | 5.9 (4.7, 7.2) | 3.6─10.1 |
| 2015 | 264.4 (263.7, 265.1) | 263.2─265.1 | 232.3 (66.0, 398.5) | 107.0─577.7 | 4.7 (3.0, 6.4) | 2.2─6.6 |
| All | 263.9 (263.7, 264.3) | 261.6─265.2 | 151.3 (118.2, 184.4) | 47.9─577.7 | 5.3 (4.8, 5.9) | 2.2─10.1 |
| Days without upstream pre-spawn migration | | | | | | |
| 2012 | 264.0 (263.8, 264.3) | 261.6─265.1 | 113.7 (80.1, 147.2) | 30.6─656.9 | 4.2 (3.7, 4.8) | 0.1─7.3 |
| 2013 | 263.9 (263.7, 264.0) | 262.5─265.1 | 108.7 (83.1, 134.6) | 29.2─699.4 | 2.6 (2.2, 3.0) | 0─7.1 |
| 2014 | 263.1 (262.9, 263.3) | 261.9─265.2 | 86.7 (71.3, 102.0) | 18.8─413.4 | 1.9 (1.4, 2.4) | 0.1─10.1 |
| 2015 | 263.8 (263.5, 263.9) | 262.0─265.1 | 116.9 (78.3, 155.5) | 33.1─880.7 | 1.5 (1.1, 1.9) | 0─7.7 |
| All | 263.6 (263.5, 263.7) | 261.6─265.2 | 105.1 (90.9, 119.2) | 18.8─880.7 | 2.3 (2.0, 2.6) | 0─10.1 |

**Table 5.3.** Parameter estimates for best-fitting logistic regression model using environmental variables to describe upstream pre-spawn migration of Walleyes in Cheat Lake, WV from 2012–2015. The intercept includes Year 2015.

| Parameter | Estimate | SE | DF | t-Value | p-value |
|---|---|---|---|---|---|
| Intercept | -5.8386 | 0.4375 | 30 | -13.34 | < 0.0001 |
| Year 2012 | -2.339 | 0.6163 | 3546 | -3.8 | 0.0001 |
| Year 2013 | -1.1799 | 0.4423 | 3546 | -2.67 | 0.0077 |
| Year 2014 | -0.3609 | 0.4243 | 3546 | -0.85 | 0.3951 |
| Year 2015 | 0 | . | . | . | . |

| | | | | | |
|---|---|---|---|---|---|
| Water temperature | 0.8339 | 0.0769 | 3546 | 10.84 | < 0.0001 |

**Table 5.4.** Parameter estimates for best-fitting logistic regression model using environmental variables to describe downstream post-spawn migration of Walleyes in Cheat Lake, WV from 2012-2014.

| Parameter | Estimate | SE | DF | t-Value | p-value |
|---|---|---|---|---|---|
| Intercept | -3.0168 | 0.4991 | 24 | -6.04 | < 0.0001 |
| Spring | -1.9592 | 0.6006 | 3616 | -3.26 | 0.0011 |
| Summer | -3.2676 | 0.7815 | 3616 | -4.18 | < 0.0001 |
| Autumn | 0 | . | . | . | . |
| Female | 1.6466 | 0.5676 | 3616 | 3616 | 0.0037 |
| Male | 0 | . | . | . | . |

**Table 5.5.** Parameter estimates for best-fitting logistic regression model using environmental variables to describe large non-spawning movements of Walleyes in Cheat Lake, WV from 2012-2014.

| Parameter | Estimate | SE | DF | t-Value | p-value |
|---|---|---|---|---|---|
| Intercept | -6.3036 | 0.4024 | 31 | -15.67 | < 0.0001 |
| River discharge | 0.4490 | 0.0586 | 11491 | 7.66 | < 0.0001 |
| Water temperature | 0.0309 | 0.0086 | 11491 | 3.56 | 0.0004 |

**Table 5.6.** BIC model selection statistics for 30 candidate models fit to a 2012–2015 time series of daily upstream pre-spawn migration of Walleyes in Cheat Lake, WV. Single variable and additive-effects models included year (YR), sex (SX), percent lunar illumination (LI), water temperature (WT), log transformed river discharge (RD), and lake elevation (LE). ΔBIC is the difference between a model and a model with the lowest BIC value.

| Model | BIC | ΔBIC |
|---|---|---|
| YR + WT | 616.53 | 0 |
| YR + WT + SX | 617.06 | 0.53 |
| YR + WT + LE | 619.20 | 2.67 |
| YR + WT + LI | 619.50 | 2.97 |
| YR + WT + RD | 619.60 | 3.07 |
| YR + WT + LE + RD + LI + SX (Full) | 624.70 | 8.17 |
| WT | 626.83 | 10.30 |
| WT + LE | 628.11 | 11.58 |
| WT + RD | 629.97 | 13.44 |
| WT + SX | 630.27 | 13.74 |
| RD | 734.21 | 117.68 |
| RD + LE | 735.49 | 118.96 |
| RD + SX | 737.52 | 120.99 |
| YR + RD | 743.42 | 126.89 |
| YR + RD + LI | 744.02 | 127.49 |
| YR + RD + LE | 744.41 | 127.88 |
| YR + RD + SX | 746.85 | 130.32 |
| LE | 764.07 | 147.54 |
| LE + SX | 767.41 | 150.88 |
| YR + LE + LI | 769.90 | 153.37 |
| YR + LE | 771.58 | 155.05 |
| YR + LE + SX | 775.00 | 158.47 |
| LI | 792.30 | 175.77 |
| Intercept | 792.41 | 175.88 |
| LI + SX | 795.57 | 179.04 |
| SX | 795.63 | 179.10 |
| YR | 800.17 | 183.64 |
| YR + LI | 800.60 | 184.07 |
| YR + SX | 803.61 | 187.08 |
| YR + SX + LI | 804.03 | 187.50 |

**Table 5.7**. BIC model selection statistics for 45 candidate models fit to a 2012–2014 time series of daily downstream post-spawn migration of Walleyes in Cheat Lake, WV. Single variable and additive-effects models included year (YR), season (SEAS), sex (SX), percent lunar illumination (LI), water temperature (WT), log transformed river discharge (RD), and lake elevation (LE). ΔBIC is the difference between a model and a model with the lowest BIC value.

| Model | BIC | ΔBIC |
|---|---|---|
| SEAS + SX | 409.68 | 0 |
| SEAS + SX + WT | 411.92 | 2.24 |
| SEAS + SX + LE | 412.39 | 2.71 |
| SEAS + SX + RD | 412.45 | 2.77 |
| SEAS + SX + LI | 412.82 | 3.14 |
| YR + SEAS + WT | 413.11 | 3.43 |
| YR + SEAS + SX | 414.58 | 4.90 |
| SEAS | 414.59 | 4.91 |
| YR + SEAS + RD | 415.73 | 6.05 |
| SEAS + WT | 416.05 | 6.37 |
| SEAS + RD | 417.42 | 7.74 |
| SEAS + LE | 417.43 | 7.75 |
| SEAS + LI | 417.66 | 7.98 |
| YR + SEAS + SX + WT + RD + LE + LI | 420.60 | 10.92 |
| YR + SEAS + LE | 421.14 | 11.46 |
| YR + SEAS + LI | 421.26 | 11.58 |
| SX + WT | 425.70 | 16.02 |
| YR + WT + RD | 427.92 | 18.24 |
| YR + SX + WT | 429.72 | 20.04 |
| WT | 430.48 | 20.80 |
| YR + WT | 430.76 | 21.08 |
| WT + RD | 430.93 | 21.25 |
| YR + LE + WT | 431.55 | 21.87 |
| LE + WT | 432.18 | 22.50 |
| SX | 432.52 | 22.84 |
| SX + RD | 433.57 | 23.89 |
| YR + WT + LI | 433.89 | 24.21 |
| SX + LI | 435.44 | 25.76 |
| SX + LE | 435.72 | 26.04 |
| YR + SX + LE | 436.42 | 26.74 |
| YR + SX | 436.52 | 26.84 |

| | | |
|---|---|---|
| YR + SX + RD | 438.22 | 28.54 |
| Intercept | 438.90 | 29.22 |
| YR + SX + LI | 439.56 | 29.88 |
| RD | 439.66 | 29.98 |
| YR | 441.46 | 31.78 |
| LI | 441.69 | 32.01 |
| LE | 442.09 | 32.41 |
| LE + RD | 442.61 | 32.93 |
| YR + RD | 443.19 | 33.51 |
| YR + LI | 444.45 | 34.77 |
| YR + LE | 444.67 | 34.99 |
| YR + RD + LI | 446.27 | 36.59 |
| YR + LE + RD | 446.38 | 36.70 |
| YR + LE + LI | 447.63 | 37.95 |

**Table 5.8**. BIC model selection statistics for 45 candidate models fit to a 2012–2014 time series of daily long distance non-spawning movements of Walleyes in Cheat Lake, WV. Single variable and additive-effects models included year (YR), season (SEAS), sex (SX), percent lunar illumination (LI), water temperature (WT), log transformed river discharge (RD), and lake elevation (LE). ΔBIC is the difference between a model and a model with the lowest BIC value.

| Model | BIC | ΔBIC |
|---|---|---|
| RD + WT | 2838.83 | 0 |
| RD + LE | 2841.08 | 2.25 |
| YR + RD + WT | 2844.21 | 5.38 |
| YR + RD + LE | 2845.55 | 6.72 |
| RD | 2848.73 | 9.9 |
| SEAS + RD | 2851 | 12.17 |
| YR + RD | 2853.24 | 14.41 |
| SX + RD | 2854.28 | 15.45 |
| YR + SEAS + SX + RD + WT + LE + LI (Full) | 2854.89 | 16.06 |
| YR + SEAS + RD | 2855.05 | 16.22 |
| YR + RD + LI | 2856.47 | 17.64 |
| SEAS + SX + RD | 2856.6 | 17.77 |
| YR + SX + RD | 2859.77 | 20.94 |
| SEAS + LE | 2873.06 | 34.23 |

| | | |
|---|---|---|
| SEAS + SX + LE | 2879.43 | 40.6 |
| YR + SEAS + LE | 2879.55 | 40.72 |
| LE + WT | 2881.84 | 43.01 |
| LE | 2881.88 | 43.05 |
| SX + LE | 2888.29 | 49.46 |
| YR + LE + WT | 2888.33 | 49.5 |
| YR + LE | 2888.53 | 49.7 |
| Intercept | 2890.64 | 51.81 |
| YR + LE + LI | 2891.44 | 52.61 |
| WT | 2893.92 | 55.09 |
| LI | 2894 | 55.17 |
| SEAS | 2894.24 | 55.41 |
| YR + SX + LE | 2895.08 | 56.25 |
| SX | 2896.86 | 58.03 |
| SEAS + LI | 2897.58 | 58.75 |
| SEAS + WT | 2897.7 | 58.87 |
| YR + WT | 2899.77 | 60.94 |
| YR + LI | 2899.78 | 60.95 |
| SX + WT | 2900.17 | 61.34 |
| SX + LI | 2900.22 | 61.39 |
| SEAS + SX | 2900.48 | 61.65 |
| YR + SX | 2903.05 | 64.22 |
| YR + WT + LI | 2903.11 | 64.28 |
| YR + SEAS + LI | 2903.54 | 64.71 |
| YR + SEAS + WT | 2903.67 | 64.84 |
| SEAS + SX + LI | 2903.82 | 64.99 |
| SEAS + SX + WT | 2903.94 | 65.11 |
| YR + SX + WT | 2906.38 | 67.55 |
| YR + SX + LI | 2906.4 | 67.57 |
| YR + SEAS + SX | 2906.77 | 67.94 |

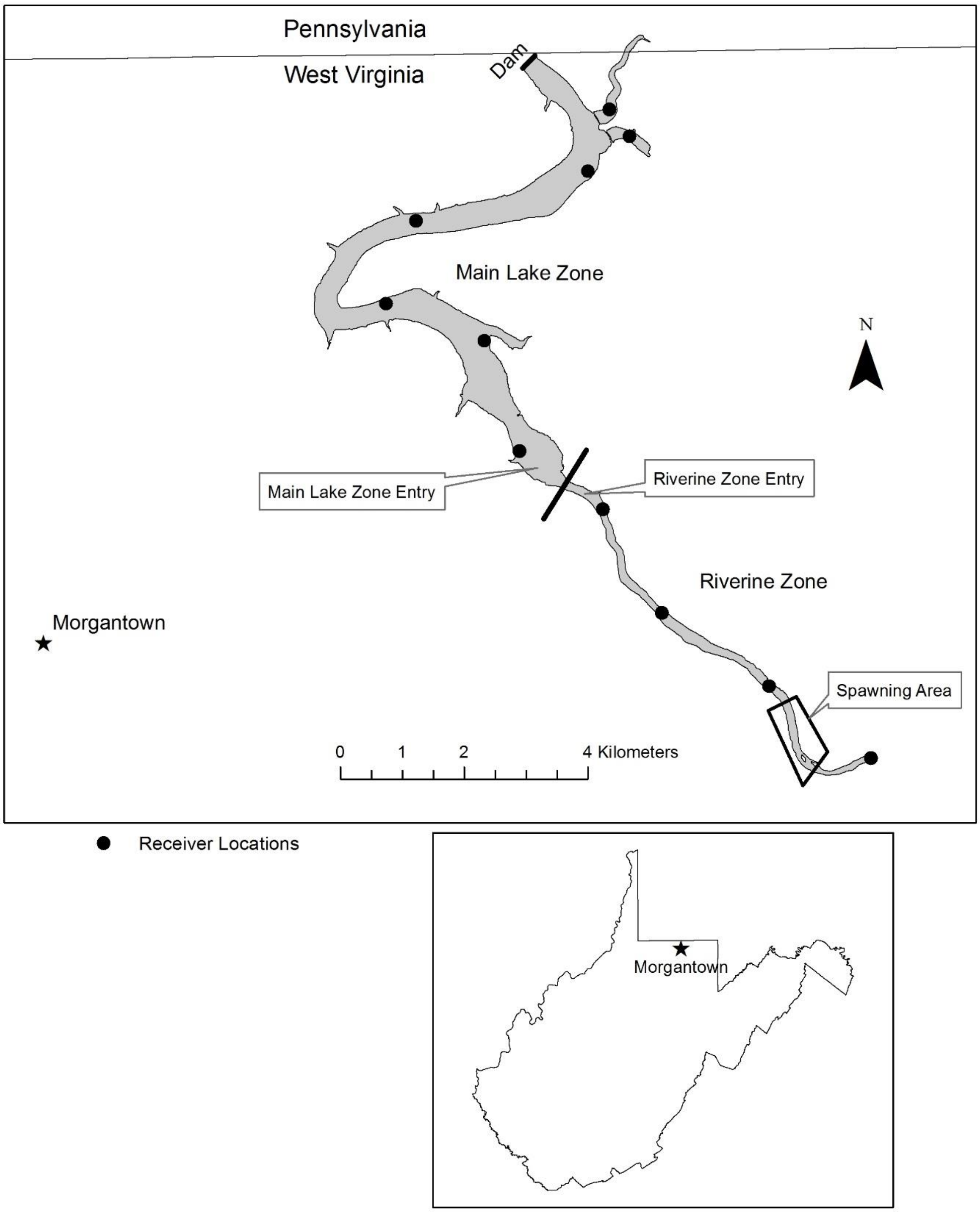
**Figure 5.1.** Study site location and map showing location of acoustic receivers, separation of main lake zone and riverine zone (represented by black bar in between two entry points), and location of spawning area in Cheat Lake, WV. Lower Main Lake is located from the dashed line to the dam

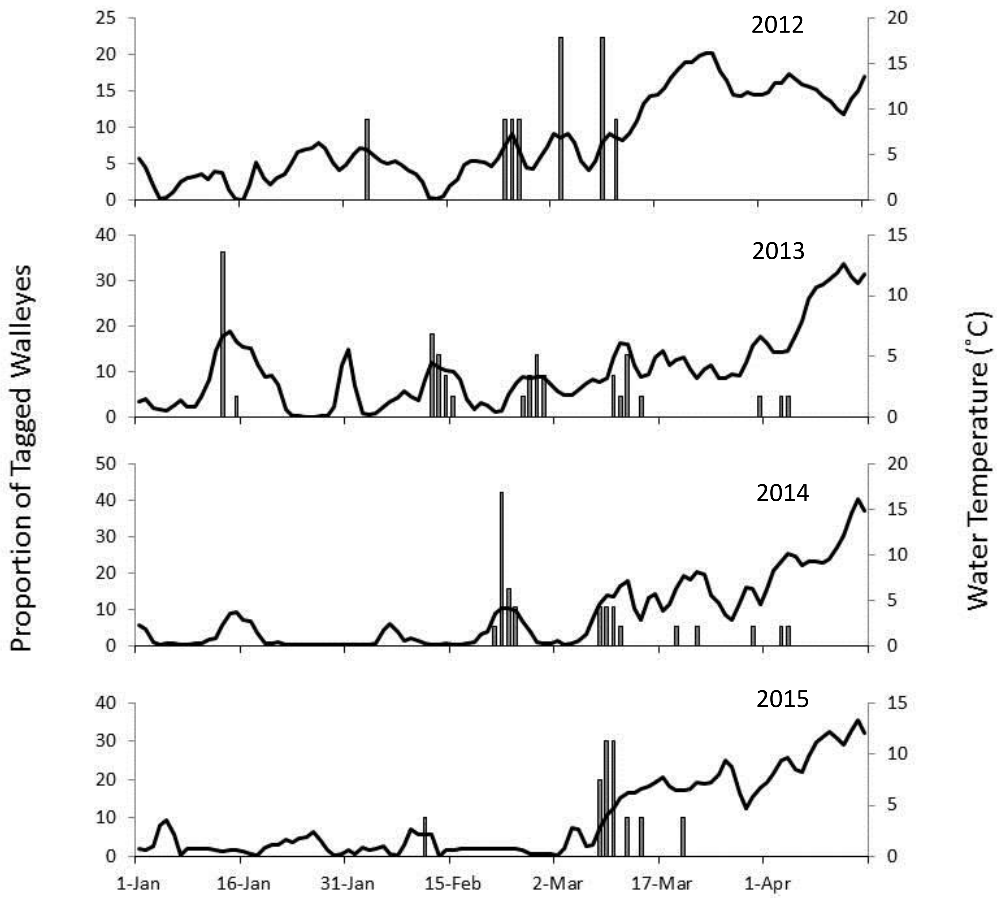
**Figure 5.2.** Daily proportion of tagged Walleyes migrating into the riverine zone (gray bars) and associated water temperature (black line) data for 2012–2015

**Figure 5.3.** Proportion of temporary downstream pre-spawn movement events from riverine zone into main lake zone.

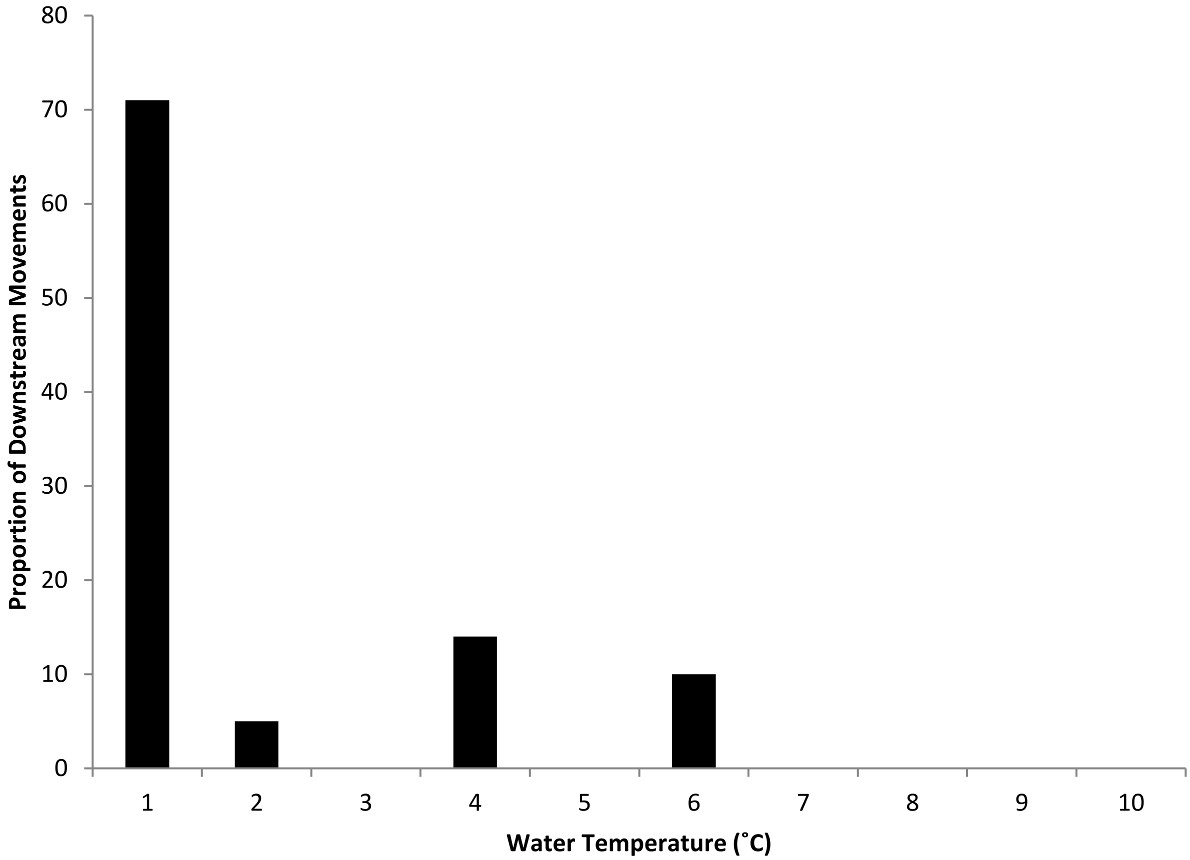
**Figure 5.4.** Monthly post-spawn migration of tagged Walleyes into the main lake represented by proportion of tagged fish migrating per month and separated by sex

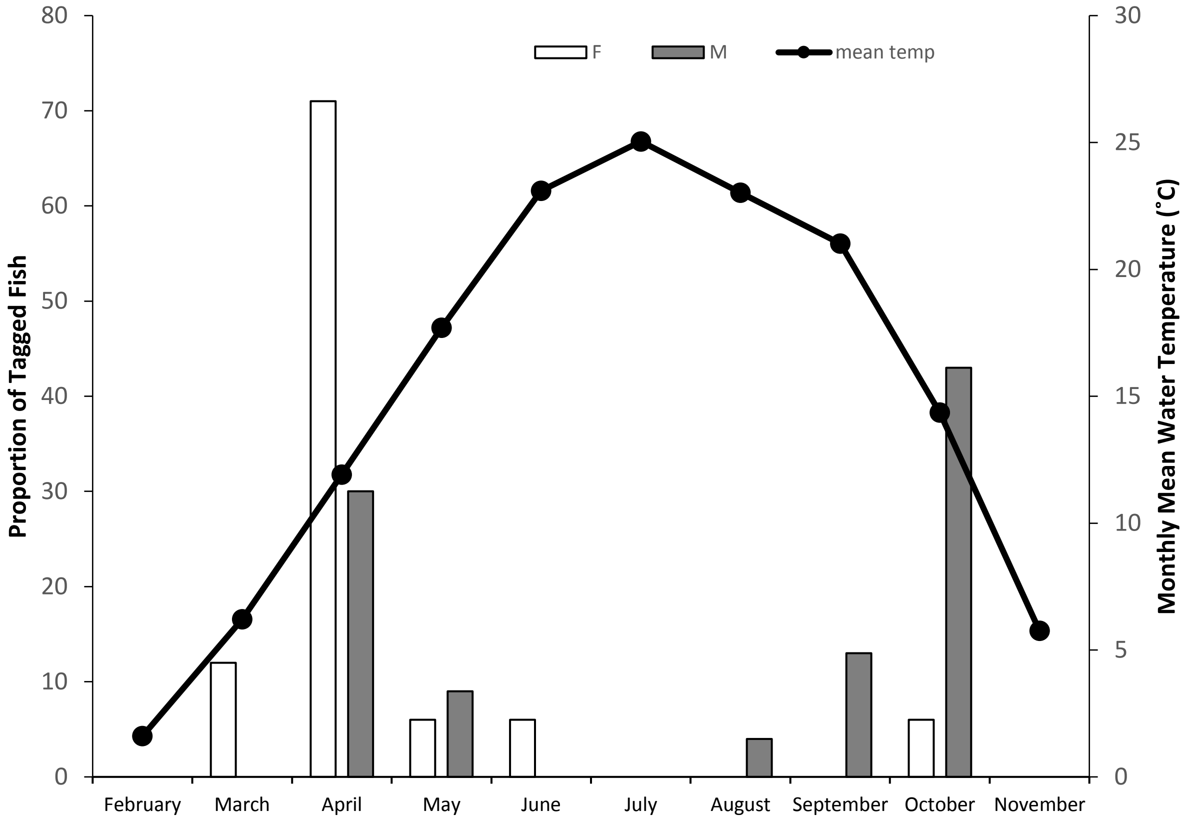
**Figure 5.5.** Lake elevation and water temperature during Walleye spawning 2012–2015. April 1$^{st}$ lake level restriction designated by dashed black line.


Pennsylvania
West Virginia
Dam
Main Lake Zone
N
Main Lake Zone Entry
Riverine Zone Entry
Riverine Zone
Morgantown
Spawning Area
0 1 2 4 Kilometers
Receiver Locations
Morgantown

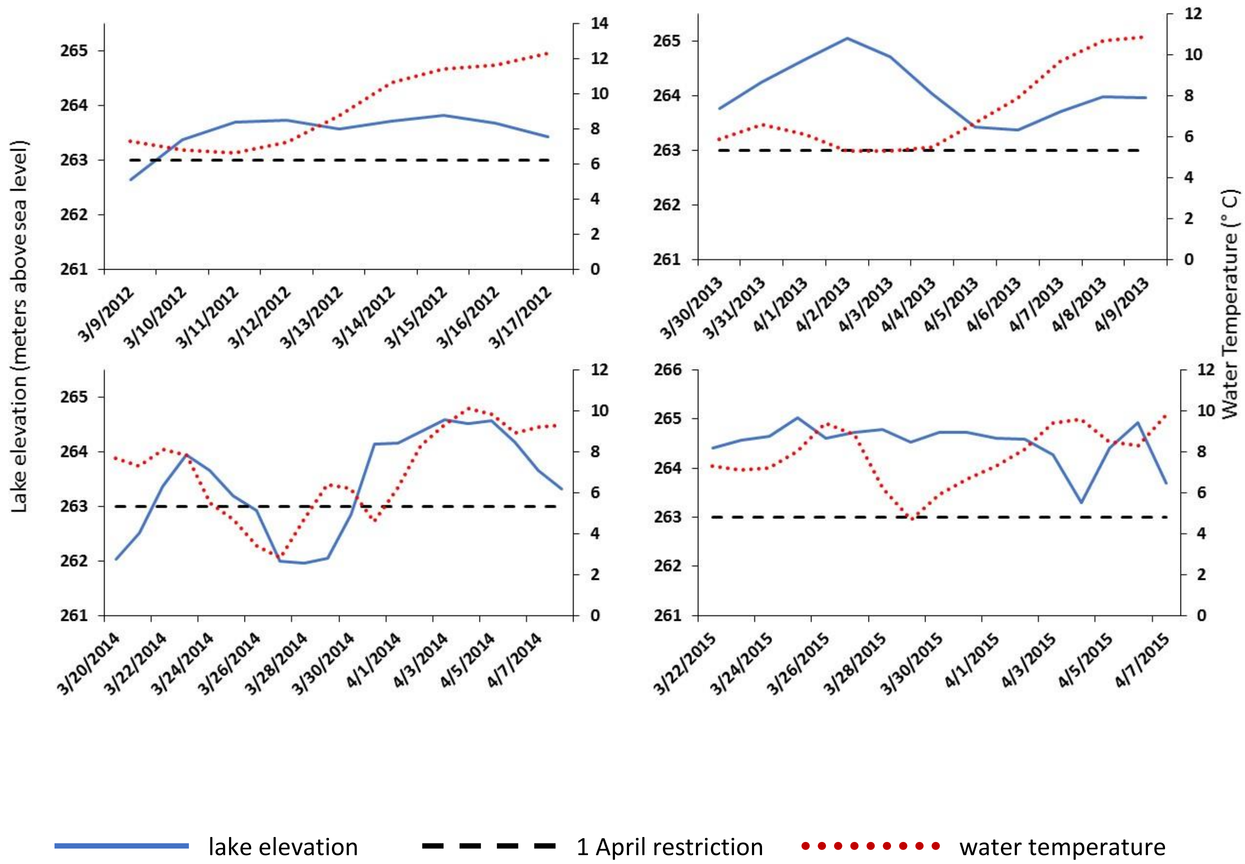


2012
2013
2014
2015
Proportion of Tagged Walleyes
Water Temperature (°C)
1-Jan
16-Jan
31-Jan
15-Feb
2-Mar
17-Mar
1-Apr


Proportion of Downstream Movements
80
70
60
50
40
30
20
10
0
1
2
3
4
5
6
7
8
9
10
Water Temperature (˚C)



F
M
mean temp
Proportion of Tagged Fish
Monthly Mean Water Temperature (˚C)
80
70
60
50
40
30
20
10
0
30
25
20
15
10
5
0
February
March
April
May
June
July
August
September
October
November



Lake elevation (meters above sea level)
Water Temperature (° C)
3/9/2012
3/10/2012
3/11/2012
3/12/2012
3/13/2012
3/14/2012
3/15/2012
3/16/2012
3/17/2012
3/30/2013
3/31/2013
4/1/2013
4/2/2013
4/3/2013
4/4/2013
4/5/2013
4/6/2013
4/7/2013
4/8/2013
4/9/2013
3/20/2014
3/22/2014
3/24/2014
3/26/2014
3/28/2014
3/30/2014
4/1/2014
4/3/2014
4/5/2014
4/7/2014
3/22/2015
3/24/2015
3/26/2015
3/28/2015
3/30/2015
4/1/2015
4/3/2015
4/5/2015
4/7/2015
lake elevation
1 April restriction
water temperature

## Chapter 6 – Future Management Strategies for the Fish Communities of Cheat Lake, WV

The aquatic community of Cheat Lake was impacted for decades as a result of acidification, largely resulting from acid mine drainage (Core 1959). As a result of water quality impairment, species richness and fish abundance was limited (Core 1959; WVDNR unpublished data). Brown Bullhead and White Sucker (both acid tolerant species) were the dominant species (82% of mean annual fish abundance) within the reservoir. Additionally, several species, including Walleye, were extirpated from Cheat Lake during this period (Core 1959). As a result of limited fishery resources available in Cheat Lake, angler opportunities were limited. After the passage of the Clean Water Act (1972), Surface Mining Control and Reclamation Act (1977), and the emergence of additional funding sources to treat acid mine drainage, water quality within the Cheat River watershed began to gradually improve, along with the fish community of Cheat Lake. Additionally, with improvements in water quality, a Walleye population was reestablished within Cheat Lake. Our study aimed to quantify temporal changes in the fish community of Cheat Lake, as they might be related to improvements in water quality. We also focused on evaluating the reestablished Walleye population to further understand population characteristics and spatial ecology within Cheat Lake. We found that the fish community of Cheat Lake has significantly changed over time, likely owing to improvements in water quality. We also found that the Walleye population within Cheat Lake is characterized by fast growing individuals, that reach large maximum sizes. Additionally, Cheat Lake Walleyes exhibit seasonal and sex-based differences in distribution and movement, that could have implications for management of this new fishery.

Given the extensive treatment of acid mine drainage and acid precipitation within the Cheat River watershed over the last few decades, we summarized changes in the pH of Cheat Lake since 1952. We found mean annual pH within the reservoir to remain above 6.0 since

1997, a vast improvement to the pre-1990 era when mean annual pH was regularly less than 5.0. Current acid mine drainage and precipitation treatment within the watershed appears to have improved water quality to suitable levels for most aquatic life. Gradual improvements to water quality within the watershed have led to improvements to the reservoir fish community. Specifically, we found fish species richness and overall fish abundance has significantly increased over time since water quality treatment began. A total of 44 species were collected cumulatively since 1990, compared to the 15 species captured from 1952–1977. Additionally, fish community composition has significantly changed over time due in part to the increases in several acid intolerant species (e.g., Smallmouth Bass, Walleye, Emerald Shiner, Silver Shiner, etc.). Smallmouth Bass, one of the first species to disappear when acidification occurs (Beamish 1976), was nearly absent from the reservoir in 1990, but now represents one of the most abundant sportfish in Cheat Lake. Additionally, while Brown Bullheads and White Suckers used to dominate the reservoir, these tolerant species have decreased in abundance. Instead, Channel Catfish and Golden Redhorse, comparatively intolerant species, have replaced Brown Bullhead and White Sucker as the dominant catfish and sucker species within the lake, respectively. Finally, forage species such as Emerald Shiner, Silver Shiner, Mimic Shiner, Gizzard Shad, Logperch, and Brook Silverside, once essentially extirpated from the lake, have seen substantial increases in abundance.

Another result of improved water quality has been the reestablishment of a Walleye population within Cheat Lake. Reestablishment of a Walleye population was spearheaded by stocking efforts that were deemed feasible due to improved water quality. The reestablished Walleye population exhibits particularly fast growth, with the potential for trophy sizes, especially in female fish. Data also suggest that natural reproduction/recruitment has increased in recent years, likely owing to water quality improvements. The increases in natural reproduction, along with the fast growth and large sizes attained by Cheat Lake Walleyes, creates a potentially valuable fishery for anglers of Cheat Lake.

We used telemetry to assess distribution and movements of Walleyes in Cheat Lake. Walleyes displayed significant seasonal and sex-based differences in habitat use and movement patterns. Additionally, certain environmental factors were important predictors of large scale Walleye movements. Specifically, Walleyes made upstream migrations in the late winter/early spring in preparation for spawning. Models that best predicted occurrence of spawning migrations included variables of sex and water temperature. Specifically, male Walleyes migrated to spawning grounds earlier than female Walleyes and remained there until spawning commenced. Most male Walleyes migrated to spawning grounds prior to March (68.9%) while most females migrated during March (52.6%). An increase in water temperature was a significant predictor of upstream migration as most Walleyes (75%) made upstream migrations at water temperatures > 4.1° C. Spawning occurred in the upper 1 km of Cheat Lake on rocky shoreline areas in water less than 2 meters deep. Spawning also potentially occurred in the Cheat River upstream of the lake as some tagged fish used this area during the spawning period. Female Walleyes returned quickly to the main lake area, while a substantial proportion of male Walleyes remained near the spawning area or in the upstream Cheat River until fall. During non-spawning periods, elevated river discharge and water temperature were associated with large scale movements of Walleyes. Male Walleyes were more likely to use riverine habitats compared to female Walleyes, except during fall and winter when nearly all Walleyes congregated in main lake habitats.

My research has shown that water quality improvements throughout the Cheat River watershed have also led to improved water quality within Cheat Lake. In conjunction with these water quality improvements, there have been significant changes to the fish community of Cheat Lake, with increased species richness, total fish abundance, and increases in pollution intolerant species. However, acid mine drainage issues are persistent through time and effectively require permanent treatment (Skousen et al. 1998). Treatment of mine drainage within the watershed is made possible by regulatory mandates such as SMCRA and CWA, in addition to other state and federal funding sources. Lapses or reductions in funding of water quality treatment would likely result in the worsening of acidification within Cheat Lake and the return of pre-1990 conditions. Likewise, the fish community of Cheat Lake would be negatively impacted by the return of acidic conditions. Certainly, species such as Walleye and Smallmouth Bass, along with many acid intolerant forage species would eventually face extirpation.

In addition to treatment of mine drainage, the current water regime of Cheat Lake provides for relatively stable water levels from May–October. These stable water levels likely facilitate successful reproduction by late spring/early summer spawners such as Centarchids and Ictalurids. These stable water levels also guarantee inundation of important littoral habitat such as aquatic vegetation and coarse woody debris, providing refuge and nursery areas for age-0 fishes such as Yellow Perch. However, despite relatively stable water levels during late spring/early summer, some Cheat Lake fishes are still vulnerable to potential effects from hydropower operations during periods of larger water level fluctuations (November–April). Specifically, water level fluctuations during March and April could significantly impact early spawning fishes such as Walleye and Yellow Perch. These species spawn in shallow water and water level fluctuations can limit available habitat or cause stranding of already deposited eggs (Priegel 1970; Krieger et al. 1983). In our study, we witnessed dewatered Yellow Perch eggs and determined that Walleye spawning occurred in relatively shallow water (< 2 m) susceptible to water level decreases. Currently, water level fluctuations are limited in April to help reduce impacts to spawning Walleye and Yellow Perch. These reductions in water level fluctuations may benefit these species, although at current levels littoral spawning areas are still impacted. Additionally, telemetered Walleyes were found to spawn as early as mid-March during some years. Specifically, in some years, water temperatures reached 5°C or greater by mid-March and maintained this temperature resulting in spawning activity. In this scenario, spawning Walleyes would not benefit from the April reductions in water level fluctuations. Additionally, spent Yellow Perch were captured in surveys in the month of March, likewise indicating that in years when water temperatures suitable for spawning are reached prior to April, spawning may occur.

My research indicates that a Walleye population has been successfully reestablished within Cheat Lake, and population characteristics create both a unique and potentially vulnerable fishery. Cheat Lake Walleyes show faster growth and larger maximum sizes than in many other West Virginia reservoirs, and provide anglers a unique opportunity. Additionally, there is evidence of increasing natural reproduction. However, resource managers should be aware of the potential for impacts to the population via exploitation. Given the improvements to the fish community and the inevitable increase in angler use with better fishing opportunities, managers should be wary of the impacts to the fisheries. Given uncertainties with hatchery production of Walleyes in WV, natural reproduction may be important for sustaining the Cheat Lake population. However, large congregations of Walleyes near the lake headwaters during spawning and concentration of females during non-spawning periods in main lake areas closer to public access points, potentially create vulnerability of this population to overexploitation. Currently, there is an 8 fish per day, 381 mm minimum length limit on Walleyes in Cheat Lake. This current regulation allows for liberal harvest of Walleyes, at a minimum length that does little to protect mature females. If harvest were to increase or female fish show increased vulnerability, managers may need to consider altering regulations.

Given the findings of this study and to ensure the future persistence of the fish community of Cheat Lake, it would be beneficial for resource managers to incorporate these results and management implications into future monitoring and management plans. Future plans could identify management goals for the fish community, along with monitoring plans and management actions that could be implemented in response to future findings. Given the research findings presented within this dissertation, the following are some potential management goals for the Cheat Lake fish community: 1). Maintain the fish community of Cheat Lake (considering current fish community composition, species richness, relative abundance, etc.). 2). Improve natural reproduction/recruitment success of Walleyes in Cheat Lake, and 3). Improve recreational fishing opportunities for trophy Walleye and other sportfish in Cheat Lake. Resource managers should develop future monitoring and management plans while considering these management goals. Resource managers should continue monitoring of water quality (i.e., pH) of Cheat Lake. Continued water quality monitoring will detect any unexpected decreases in pH which could impact the fish community. Unexpected decreases in pH could indicate issues with water quality treatment within the watershed which could be investigated further with pertinent agencies. Additionally, there should be continued periodic monitoring of the fish community of Cheat Lake to monitor for changes to the fish community structure. Changes to the fish community of Cheat Lake could indicate stressors from water quality or water level fluctuations. Additionally, further research should be conducted on the impacts of angler harvest on the sportfish of Cheat Lake. To accomplish this, a creel survey should be implemented. Without harvest information that could be quantified from a creel survey, it will be difficult to model the impact of future regulations. Likewise, further age and growth studies of additional sportfish in Cheat Lake would provide baseline data for future comparisons and to aid in management regulations. Also, given the potential impacts of spring water level fluctuations to Yellow Perch and Walleye, consideration should be given to altering the current water regime. Ideally water level restrictions would be extended to approximately mid-March, however, economic considerations for the hydropower company will be important in future actions. Should changes to the water level regime not be feasible, then enhancements to deep-water spawning habitat should be considered to facilitate reproduction of Walleye and Yellow Perch during periods of low water levels. Additional, monitoring steps and adaptive management actions could be outlined to most effectively manage the Cheat Lake fish community.

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(d) TRC. 2020. Freshwater Mussel Reconnaissance Scoping Survey Report;

# Freshwater Mussel Reconnaissance Scoping Survey Report

Cheat River

November 2020

## Lake Lynn Hydroelectric Project (FERC No. P-2459)

**Prepared For:**

Lake Lynn Generation, LLC
2 Bethesda Metro Center, Suite 1330
Bethesda, Maryland 20814

**Prepared By:**

TRC Companies, Inc.
1382 West Ninth Street, Suite 400
Cleveland, OH 44113

# TABLE OF CONTENTS



## FIGURES



## APPENDICES

## ACRONYM LIST

| | |
|---|---|
| AMD | Acid Mine Drainage |
| °C | Celsius |
| EnviroScience | EnviroScience, Inc. |
| FERC | Federal Energy Regulatory Commission |
| Lake Lynn | Lake Lynn Generation, LLC |
| MW | Megawatt |
| NOI | Notice of Intent |
| PAD | Pre-Application Document |
| PFBC | Pennsylvania Fish and Boat Commission |
| Project | Lake Lynn Hydroelectric Project (FERC No. P-2459) |
| Protocol | 2020 West Virginia Mussel Survey Protocols |
| Study Plan | *Lake Lynn Hydroelectric Project (FERC No. P-2459) Final Study Plan* dated September 2020 |
| TRC | TRC Companies, Inc. |
| USFWS | United States Fish and Wildlife Service |
| WVDNR | West Virginia Division of Natural Resources |

# Acknowledgements

Lake Lynn Generation, LLC (Lake Lynn) has contracted TRC Companies, Inc. (TRC), to conduct a reconnaissance scoping survey for the Lake Lynn Hydroelectric Project (FERC No. P-2459) (Project) near Morgantown, Monongalia County, West Virginia and Fayette County, Pennsylvania near the borough of Point Marion. TRC contracted EnviroScience, Inc. (EnviroScience) for an approved malacologist for the survey. Ms. Joyce Foster (TRC) was the Project Manager, Ms. Sarah Veselka (EnviroScience) was the Pennsylvania and West Virginia Approved Malacologist and Ms. Lindsey Jakovljevic (TRC) was the field team lead for the duration of the survey. Mr. Thomas Radford (TRC) and Mr. Tony Tredway (TRC) assisted with the field effort. Ms. Jakovljevic, Ms. Veselka, and Mr. Radford co-authored this report.

## 1.0 Introduction

Lake Lynn Generation LLC (Lake Lynn), owner and operator of the Lake Lynn Hydroelectric Project (FERC No. P-2459) (Project), is relicensing the Project with the Federal Energy Regulatory Commission (FERC). The current FERC license was issued in December 1994 and will expire on November 30, 2024. The Project is located on the Cheat River near Morgantown, Monongalia County, West Virginia and Fayette County, Pennsylvania near the borough of Point Marion (**Figure 1**). Lake Lynn filed a Notice of Intent (NOI) and Pre-Application Document (PAD) with FERC on August 29, 2019 and held a Joint Meeting and Site Visit in December 2019. Following the Joint Meeting and Site Visit, resource agencies and other stakeholders were afforded the opportunity to comment on the PAD and to request natural resource studies that they deemed were needed to evaluate Project impacts on natural, cultural and recreational resources. The United States Fish and Wildlife Service (USFWS) reviewed the NOI and PAD and requested that a mussel reconnaissance scoping survey be conducted downstream of the dam.

## 2.0 Objectives

The purpose of the reconnaissance scoping survey as outlined in the *Lake Lynn Hydroelectric Project (FERC No. P-2459) Final Study Plan* dated September 2020 (Study Plan) is to identify what freshwater mussel species, if any, may occur within the Cheat River from the Project dam to the confluence with the Monongahela River, approximately 3.5-miles downstream.

## 3.0 Background and Existing Information

By email dated May 18, 2020, Lake Lynn provided a draft Mussel Survey Plan to the USFWS, Pennsylvania Fish and Boat Commission (PFBC), and West Virginia Division of Natural Resources (WVDNR). Lake Lynn convened a meeting via Microsoft Teams and conference call on May 20, 2020 to discuss the draft Mussel Survey Plan. The draft Mussel Survey Plan proposed following 2020 West Virginia Mussel Survey Protocols (Protocol) guidance for effort required for Group 3 streams (WVDNR, 2020) and defining the survey area as the area inside the Project boundary and a downstream buffer (DSB) limit of 25 meters beyond the Project boundary. The Resource Agencies expressed concerns about limiting the survey area and requested that the survey area extend 1 mile downstream of the Project since they considered this project as a scoping project without a full hydraulic study. As an action item, Lake Lynn agreed to share the 1993 Project Instream Flow Study to provide additional information about the Project's operational influence downstream of the dam and the geographic scope of the survey.

Lake Lynn distributed the 1993 Project Instream Flow Study to the resource agencies on June 2, 2020. The 1993 Project Instream Flow Study reported that water level fluctuations due to Project operation are greatest in the segment of river extending 1.02-miles below the Project dam. The 1993 Project Instream Flow Study also reported that the water depth in the Cheat

River segment from the 1.02-mile point below the Project dam to the confluence with the Monongahela is dependent upon and maintained by Pool 7 water elevations during Project shutdown.

By email dated July 9, 2020, Lake Lynn provided a revised draft Mussel Survey Plan to the USFWS, PFBC, and WVDNR. Comments were received from WVDNR and PFBC. WVDNR requested that the first page of the Mussel Survey Plan clarify the intent of the survey and noted that if the intent is to conduct a reconnaissance scoping survey, then the methodology provided is sufficient. WVDNR also requested that the Mussel Survey Plan address the handling of mussels and include a completed summary protocol form. PFBC agreed with the proposed survey methodology outlined in the Mussel Survey Plan dated July 9, 2020 but disagreed with the limits of the survey area being restricted to 1.02-miles downstream of the Project dam (copies of relevant correspondence are included in Attachment 2 of the Mussel Survey Plan in **Appendix A**).

A revised survey plan was submitted to WVDNR and PFBC by EnviroScience, Inc. (EnviroScience) on Monday September 7, 2020. Comments were received on September 8, 2020 from PFBC stating that the one mile was not sufficient and that a survey would need to be performed to the confluence of the Monongahela River, approximately 3.5 miles downstream, of the Project boundary.

The draft Mussel Survey Plan was revised based on comments received on September 8, 2020 from PFBC. The final Mussel Survey Plan was approved by WVDNR on September 9, 2020 and by PFBC on September 11, 2020 and is provided in **Appendix A**.

The Project is a 51.2 megawatt (MW) single development hydroelectric project operated since 1926. It consists of:

- a 125-foot high by 1,000-foot long concrete gravity-type dam with a 624-foot long spillway controlled by 26 Tainter gates, each 17 feet high by 21 feet long;
- a reservoir with a surface area of 1,729 acres and containing about 72,00 acre-feet of water at full pool elevation of 870 feet National Geodetic Vertical Datum;
- a log boom and track racks at the intake facility;
- eight 12-foot by 18-foot gated penstocks of reinforced concrete;
- a 72-foot by 165-foot by 68-foot high brick powerhouse containing four identical Francis generating units with a total rated capacity of 51.2 MW;
- dual 800-foot long 13 8-kilovolt transmission lines; and
  appurtenant facilities.

# 4.0 Study Area

The study area within the Cheat River includes the Project boundary, which extends approximately 200 meters downstream of the Project dam, and approximately 3.5 miles downstream of the Project boundary to the confluence of the Monongahela River. The entirety of the Study Area is within the channel of the Cheat River and excludes its tributaries that exist within the reach. TRC Companies, Inc. (TRC) has preliminarily defined the study area as depicted on the attached **Figure 2**.

# 5.0 Methods

Ms. Lindsey (Moss) Jakovljevic (TRC) was the field team leader for this survey. TRC collaborated with EnviroScience for the duration of the field work and Sarah Veselka (EnviroScience) was the Pennsylvania and West Virginia permitted malacologist (Permit #19-ES0034 and 2020.111) for the survey. The survey was conducted within the study area on September 16 and 17, 2020. Conditions (visibility and flow) at each site were adequate for detecting mussel presence. Visibility was exceptional and clear to the bottom in most cases. The flow conditions were observed to be low and normal. Maximum depth observed was approximately four meters. Weather was clear and air temperatures averaged 21 degrees Celsius (°C) for the duration of the field work. Water temperatures averaged 21.7 °C for the duration of the fieldwork.

## 5.1 Qualitative Survey Design

Reconnaissance scoping survey efforts were coordinated and led by a West Virginia and Pennsylvania approved malacologist. The qualified malacologist provided survey oversight and guidance on execution of the survey and was the lead taxonomist in the field for the duration of the work. The survey followed modified West Virginia Protocol guidance (WVDNR, 2020) with additional guidance from the *American Fisheries Society Monograph 8* (Strayer and Smith, 2003). The survey area included the Project boundary, that extends approximately 200 meters downstream of the Project dam, and approximately 3.5 miles downstream of the Project boundary to the confluence with the Monongahela River.

TRC and EnviroScience biologists performed a reconnaissance scoping survey to determine areas of suitable mussel habitat and evaluate mussel presence/absence within the survey area downstream of the Project dam. The habitat assessment started at the Project dam and continued approximately 3.5 miles downstream to the confluence of the Monongahela River (**Figure 2**). The habitat assessment started at the dam instead of the mouth of the Cheat River, as stated in the Survey Plan, as it was easier to navigate the river with the flow instead of against it. The banks were searched for shell material and the substrate was evaluated to identify suitable mussel habitat (stable burrowable substrates including sand, gravel, cobble, etc.). Once suitable mussel habitat was located, a qualitative timed search was employed for a minimum of 10 minutes to search for live mussels and shell material. In the state of West Virginia, there was one qualitative search every 100 meters in the best possible substrate. Qualitative surveys in the Commonwealth of Pennsylvania were only performed where suitable habitat was identified. If live mussels were observed, the area was searched until the limits of the mussel bed were delineated.

This reconnaissance scoping survey consisted of visually and tactilely searching the area for the presence of mussels and to determine the limits of any mussel concentrations. Snorkeling was used to visually and tactilely search for mussels at the substrate surface; moving cobble and woody debris; hand sweeping away silt, sand and/or small detritus; and disturbing/probing the upper 5 centimeters (2 inches) of substrate to ensure recovery of buried mussels. Data was collected separately for each qualitative search.

Photographs were taken of the survey area. Data recorded included:

- substrate composition of each sample (visual percentage based on Wentworth scale;
- water depth (meters);
- mussel shells (classified as fresh dead, weathered dead, or relic shell);
- where applicable; Global Positioning System (GPS) coordinates of the survey area,
- mussel aggregation limits; and
- other notable features such as land use and general observations about the stream.

## 6.0 Results

In accordance with the approved survey plan, biologists from TRC and EnviroScience completed a reconnaissance scoping survey at 12 discrete sites within the Cheat River, from the Project dam downstream to the confluence with the Monongahela River (approximately 3.5 miles). The survey was conducted on September 16 and 17, 2020. The survey area included the Project boundary, that extends approximately 200 meters downstream of the Project dam, and approximately 3.5 miles downstream of the Project boundary to the confluence with the Monongahela River.

During the survey, no live native mussels were observed. However, eight live native mussels comprised of one species (*Potamilus alatus* [Pink heelsplitter]), were observed from the confluence of the Cheat River and the Monongahela River outside of the downstream limits of the survey area. The live mussels observed were not within one of the recorded sites searched and were assumed to be part of a mussel bed located in the Monongahela River. The mussels were observed while surveyors were heading to the kayak take out location. Live *Corbicula fluminea* (Asian Clam), an invasive freshwater clam, was observed in abundance at Site #11. Additionally, several sub-fossil relic shells of multiple species were collected along the left descending bank of the Cheat River at Site #12. These relic shells appeared to be extremely old and assumed to have been washed up the Cheat River from the Monongahela River during a flood event. Representative photographs of the survey area and mussels ovserved are provided in **Appendix B**.

## 6.1 Mussel Community

The reconnaissance scoping survey effort was concentrated in areas were suitable mussel habitat was present. Zero live mussels were observed within the survey area of the Cheat River. However, a total of eight live mussels, representing one species (*P. alatus* [Pink heelsplitter]) were observed approximately 3.5-miles downstream of the Project dam at the confluence with the Monongahela River. The live mussels observed were not within one of the recorded sites searched and were assumed to be part of a mussel bed located in the Monongahela River. The mussels were found while surveyors were heading to the kayak take out location. All live mussels observed were located along the left descending bank at the confluence of the Cheat River and Monongahela River in an area of sand, silt, and mud, outside of the survey area. No federal or state listed species were observed during the survey.

## 6.2 Mussel Habitat

Beginning in the 1970s, whitewater paddlers on the Cheat River observed water quality becoming increasingly degraded by acid mine drainage (AMD) discharging from abandoned mine lands and active coal mine operations. In the spring of 1994, polluted water from an illegally-sealed major underground coal mine blew out the hillside and poured into Muddy Creek. This massive release of mine water entered the main stem of the Cheat River just upstream of the Cheat Canyon, and turned the river orange for miles. A second blowout in 1995 further accentuated the problem and caused American Rivers, Inc., a national river conservation organization, to name the Cheat as one of the nation's ten most endangered rivers (Friends of the Cheat, 2020). AMD inputs heavy metals into bodies of water adjacent to coal mining activities, such as the Cheat River. Freshwater mussels are confined to the river bottom, generally immobile, and are therefore very sensitive to poor water quality. The input of AMD may continue to affect the water quality in this reach of the Cheat River and create an environment that is not conducive to mussel colonization.

Starting at approximately 0.4 miles downstream of the Project dam and continuing to the confluence of the Monongahela River, there was evidence of AMD, a yellow-orange coating on the rocks, sediment, and aquatic plants, from Grassy Run, a tributary of the Cheat River (**Attachment 2**; photos 18-20). There was also evidence of AMD coming from unnamed tributaries of the Cheat River, along the left descending bank at 1.8 miles downstream and along the right descending bank at approximately 1.9 miles downstram (**Attachment 2**; photos 44-46).

Substrate within the Cheat River from the Project dam to approximately 1.2-miles downstream was deemed suitable for freshwater mussel presence. Substrate throughout the survey area was mostly a heterogenous mixture of cobble, gravel, and sand. Cobble and gravel were the predominant substrates throughout the reach. Water depths within this reach ranged between 0.2 meters and 1.5 meters. The Cheat River from the Project dam to approximately 1.2-miles downstream was primarily a riffles/run complex. Despite the presence of suitable substrate throughout this section of the Cheat River, no mussel communities or shell material, were observed.

From 1.2-miles downstream of the Project dam to the confluence with the Monongahela River, the Cheat River was majority pool, with depths ranging between 1.5 meters and 4 meters. The substrate in this reach transitioned from cobble, gravel, and sand to mostly sand and silt. Three sites were surveyed in this reach where suitable habitat was found along the banks. Site #11 was the best possible site that was searched within the survey area that could support live mussels. Live *Corbicula fluminea* (Asian Clam), an invasive freshwater clam, was observed in abundance at Site #11 (**Figure 3**). Despite the presence of suitable mussel habitat throughout this section of the Cheat River, no native freshwater mussel communities, were observed within the study area. However, eight live native mussels were found outside the study area, within the Monongahela river while kayaking to the takeout location. Relic shell material was also observed at Site #12. A summary of substrate characteristics of each site is provided in **Table 1**. Table 1. Summary of Substrate characteristics in the Cheat River, 2020.

**Table 1. Summary of Substrate characteristics in the Cheat River, 2020.**

| Site | State | % Substrate Composition | | | | | | | | **Total** |
|---|---|---|---|---|---|---|---|---|---|---|
| | | Br | Bo | Co | Gr | Sd | St | LWD | Vegetation | |
| 1 | WV | *10* | *30* | *45* | *10* | *5* | – | – | – | **100** |
| 2 | WV | *5* | *25* | *40* | *20* | *10* | – | – | – | **100** |
| 3 | PA | – | – | *70* | – | – | – | – | *30* | **100** |
| 4 | PA | – | – | *45* | *30* | *25* | – | – | – | **100** |
| 5 | PA | – | – | *60* | *30* | – | – | – | *10* | **100** |
| 6 | PA | – | *5* | *55* | *25* | – | – | – | *15* | **100** |
| 7 | PA | – | – | *60* | *40* | – | – | – | – | **100** |
| 8 | PA | – | – | *40* | *35* | – | – | *5* | *20* | **100** |
| 9 | PA | – | – | *65* | *15* | – | – | – | *20* | **100** |
| 10 | PA | – | – | *75* | *15* | – | – | – | *10* | **100** |
| 11 | PA | – | – | *60* | *15* | *25* | – | – | – | **100** |
| 12 | PA | – | – | – | – | *55* | *35* | *10* | – | **100** |
| Br= Bedrock, Bo= Boulder, Cb= Cobble, Gr= Gravel, Sd= Sand, St= Silt, LWD= Large Woody Debris | | | | | | | | | | |

## 7.0 Variances from the Study Plan

The habitat assessment was conducted from the dam to the confluence instead of from the confluence to the dam. This was done as it was more efficient to conduct the survey with the flow of the river.

# 8.0 Summary

In accordance with the approved survey plan, biologists from TRC and EnviroScience completed a reconnaissance scoping survey at 12 discrete sites within the Cheat River, from the Project dam downstream to the confluence with the Monongahela River (approximately 3.5 miles). The survey was conducted on September 16 and 17, 2020. The survey area included the Project boundary, that extends approximately 200 meters downstream of the Project dam, and approximately 3.5 miles downstream of the Project boundary to the confluence with the Monongahela River.

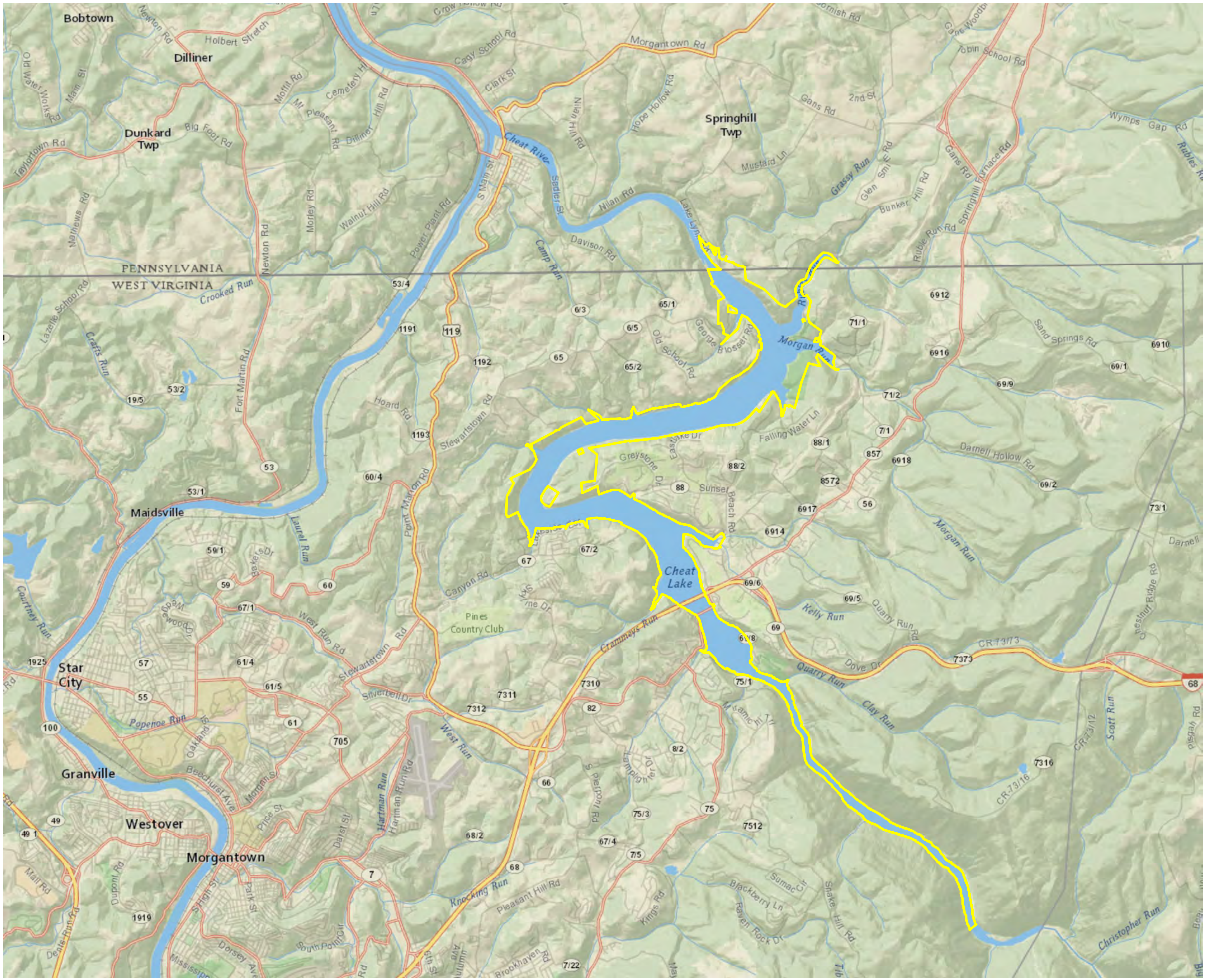
Suitable mussel habitat exists within the surveyed reach of the Cheat River. From the dam to approximately 1.2 miles downstream, the substrate was a heterogenous mixture of cobble, gravel, and sand and was predominately a riffle/run complex. From 1.2 miles downstream to the confluence of the Monongahela River the substrate was mostly sand and silt with intermittent cobble bars along the shore, at the confluence of tributaries, and island margins. This section of the Cheat River was predominately a pool. No native freshwater mussels were observed within the study area during the survey. Live *Corbicula fluminea* (Asian Clam), an invasive freshwater clam, was observed at Site #11 and several sub-fossil relic shells of multiple species were observed along the left descending bank of the Cheat River at Site #12 (approximately 3.4 miles downstream at the confluence to the Monongahela River). Additionally, there were eight live mussels of one species (*P. alatus*) found outside of the survey area at the confluence of the Monongahela River. The lack of established mussel communities within this reach of the Cheat River is possibly due to water quality influenced by AMD.

## 9.0 References


Friends of the Cheat. “History.” Friends of the Cheat, 2020, www.cheat.org/about/history/.

Strayer, D.L., and D.R. Smith. 2003. A guide to sampling freshwater mussel populations. American Fisheries Society, Monograph 8, Bethesda, Maryland.

West Virginia Division of Natural Resources (WVDNR). 2020. West Virginia Mussel Survey Protocols. West Virginia Division of Natural Resources. unpublished. 25pp + app.





## LEGEND

FERC Project Boundary

N

0 0.5 1 2 Miles

PROJECT:

**LAKE LYNN GENERATION, LLC**

TITLE:

Project Location Map

| | | | |
|---|---|---|---|
| DRAWN BY: | K. BABCOCK | PROJ. NO.: | 232345.0000.0000 |
| CHECKED BY: | | | |
| APPROVED BY: | | **FIGURE 1** | |
| DATE: | JULY 2019 | | |

TRC

14 Gabriel Drive
Augusta, ME 04330

FILE NO.: Lake_Lynn_Project_Location.mxd

TRC - GIS

Coordinate System: NAD 1983 UTM Zone 17N (Foot US)
Map Rotation: 0

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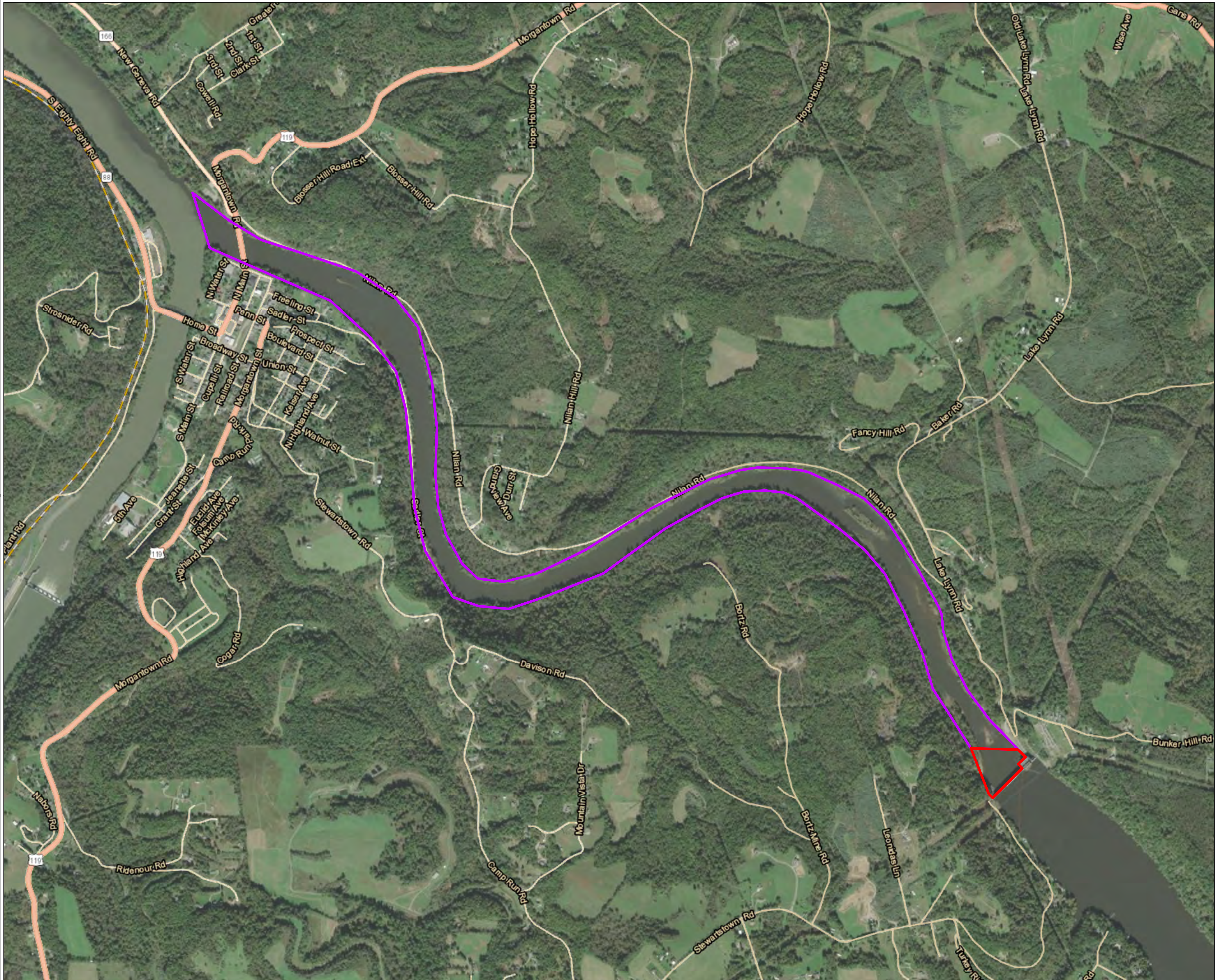
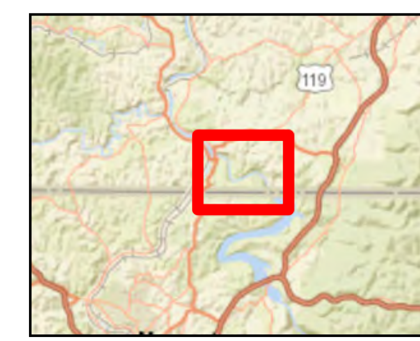
TRC - GIS



Project Boundary

Downstream Survey Buffer

0 1,500 3,000 Feet

1 " = 1,500 ' 1:18,000

**LAKE LYNN HYDROELECTRIC PROJECT**
**MONONGALIA COUNTY, WEST VIRGINIA**

**FIGURE 2**
**SURVEY AREA LIMITS**

TRC

1382 West Ninth Street
Suite 400
Cleveland, OH 44113
Phone: 216-344-3072

SEPTEMBER 2020

Fig02_SurveyArea.mxd

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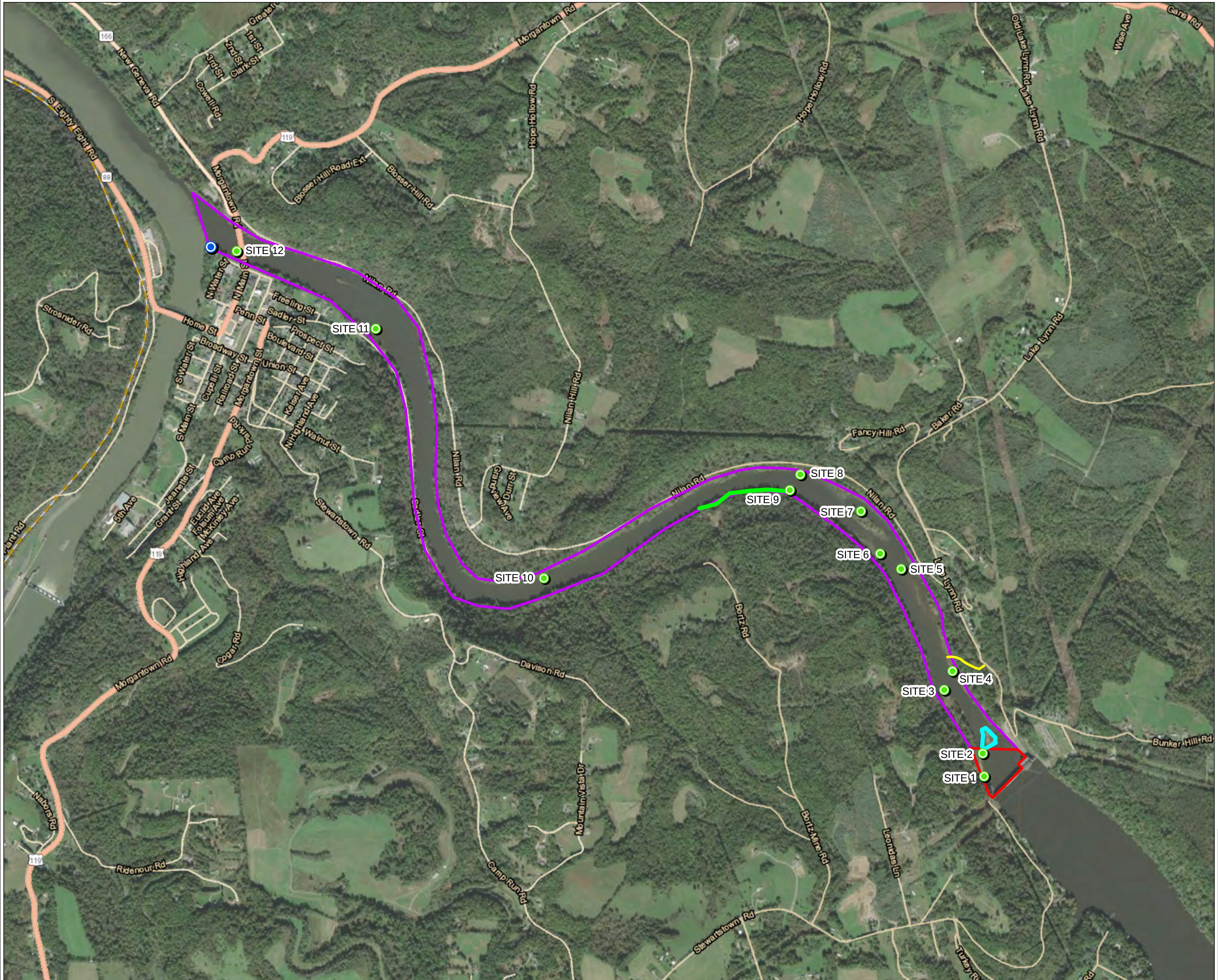
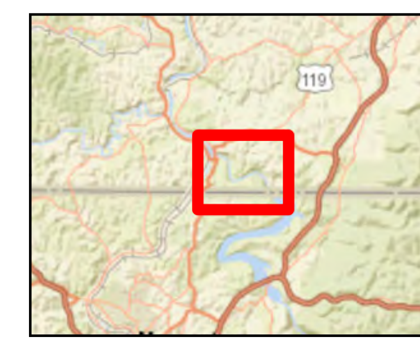
TRC - GIS




| | |
|---|---|
| Project Boundary | |
| Downstream Survey Buffer | |
| Live Mussel Observation | |
| Suitable Mussel Habitat (Survey Site Location) | |
| Island/Out of Water | |
| Acid Mine Drainage Stream | |
| Suitable Mussel Habitat | |




0 1,500 3,000 Feet

1 " = 1,500 ' 1:18,000

**LAKE LYNN HYDROELECTRIC PROJECT**
**Monongalia County, West Virginia and Fayette County, Pennsylvania**

## FIGURE 3
## RECONNAISSANCE MUSSEL SURVEY AREA SITE LOCATIONS

TRC

1382 West Ninth Street
Suite 400
Cleveland, OH 44113
Phone: 216-344-3072

OCTOBER 2020 Fig03_ReconSites.mxd

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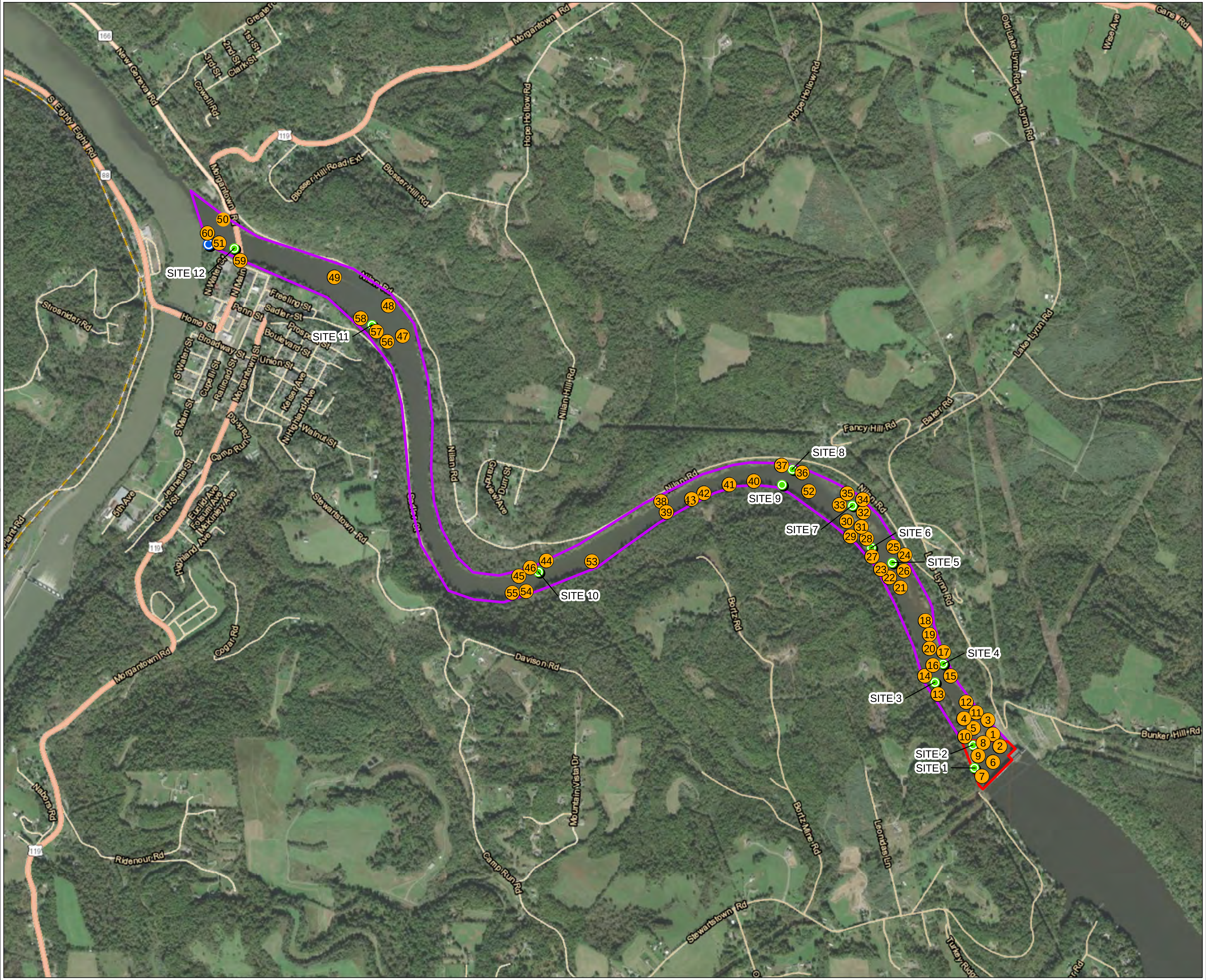
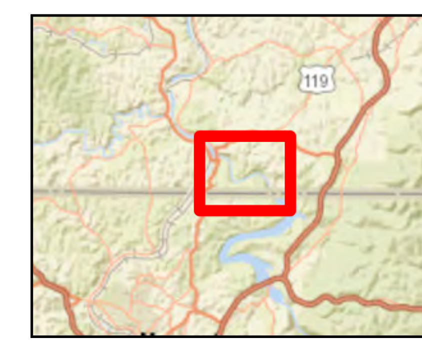



| | |
|---|---|
| | Project Boundary |
| | Downstream Survey Buffer |
| | Live Mussel Observation |
| | Suitable Mussel Habitat (Survey Site Location) |
| | Photo Location |



0 1,500 3,000 Feet

1 " = 1,500 ' 1:18,000

**LAKE LYNN HYDROELECTRIC PROJECT**
**Monongalia County, West Virginia and Fayette County, Pennsylvania**

**FIGURE 4**
**PHOTO LOCATION MAP**

TRC

1382 West Ninth Street
Suite 400
Cleveland, OH 44113
Phone: 216-344-3072

OCTOBER 2020

Fig04_Photos.mxd

TRC - GIS

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TRC

# Appendix A
# Approved Mussel Survey Plan, Agency Correspondence, Permits

REVISED 2020 MUSSEL SURVEY PLAN (SEPTEMBER 2020)
CHEAT RIVER – LAKE LYNN HYDROELECTRIC PROJECT
MONONGALIA COUNTY, WEST VIRGINIA AND FAYETTE COUNTY, PENNSYLVANIA

Survey Background and Justification

Lake Lynn Generation LLC (Lake Lynn) is relicensing the Lake Lynn Hydroelectric Project (FERC No. P-2459) (Project) with the Federal Energy Regulatory Commission (FERC). The current FERC license was issued in December 1994 and will expire on November 30, 2024. The Project is located on the Cheat River near Morgantown, West Virginia in Monongalia County, West Virginia and Fayette County, Pennsylvania (**Figure 1**). Lake Lynn filed a Notice of Intent (NOI) and Pre-Application Document (PAD) with FERC on August 29, 2019 and held a Joint Meeting and Site Visit in December 2019. Following the Joint Meeting and Site Visit, resource agencies and other stakeholders were afforded the opportunity to comment on the PAD and to request resource studies that they deemed were needed to evaluate Project impacts on natural, cultural and recreational resources. The U.S. Fish and Wildlife Service (USFWS) reviewed the NOI and PAD and requested that a mussel survey be conducted downstream of the dam.

By email dated May 18, 2020, Lake Lynn provided a draft Mussel Survey Plan to the USFWS, Pennsylvania Fish and Boat Commission (PBFC), and West Virginia Division of Natural Resources (WVDNR). Lake Lynn convened a meeting via MS Teams and conference call on May 20, 2020 to discuss the draft Mussel Survey Plan. The draft Mussel Survey Plan proposed following West Virginia Protocol guidance for effort required for Group 3 streams (WVDNR, 2020) and defining the survey area as the area inside the Project boundary and a downstream buffer (DSB) limit of 25 meters beyond the Project boundary. The Resource Agencies expressed concerns about limiting the survey area and requested that the survey area extend 1 mile downstream of the Project since they considered this project as a scoping project without a full hydraulic study. As an action item, Lake Lynn agreed to share the 1993 Project Instream Flow Study to provide additional information about the Project's operational influence downstream of the dam and the geographic scope of the survey.

Lake Lynn distributed the 1993 Project Instream Flow Study to the Resource Agencies on June 2, 2020. The 1993 Project Instream Flow Study reported that water level fluctuations due to Project operation are greatest in the segment of river extending 1.02 mile below the Project dam. The 1993 Project Instream Flow Study also reported that the water depth in the Cheat River segment from the 1.02-mile point below the Project dam to the confluence with the Monongahela is dependent upon and maintained by Pool 7 water elevations during Project shutdown.

By email dated July 9, 2020, Lake Lynn provided a revised draft Mussel Survey Plan to the USFWS, PBFC, and WVDNR. Comments were received from WVDNR and PFBC. WVDNR requested that the first page of the Mussel Survey Plan clarify the intent of the survey and noted that if the intent is to conduct a reconnaissance scoping survey, then the methodology provided is sufficient. WVDNR also requested that the Mussel Survey Plan address the handing of mussels and include a completed summary protocol form. PFBC agreed with the proposed survey methodology outlined in the Mussel Survey Plan dated July 9, 2020 but disagreed with the limits of the survey area being restricted to 1.02 miles downstream of the Project dam (copies of relevant correspondence is included in **Attachment 2**).

A revised Survey Plan was submitted to WVDNR and PFBC by EnviroScience on Monday, September 7, 2020. Comments were received on September 8, 2020 from PFBC stating that the one mile was not sufficient and that a survey would need to be performed to the confluence of the Monongahela River, approximately 3.5 miles downstream, of the Project boundary.

REVISED 2020 MUSSEL SURVEY PLAN (SEPTEMBER 2020)
CHEAT RIVER – LAKE LYNN HYDROELECTRIC PROJECT
MONONGALIA COUNTY, WEST VIRGINIA AND FAYETTE COUNTY, PENNSYLVANIA

The draft Mussel Survey Plan has been revised based on comments received on September 8, 2020 from PFBC and follow-up discussion with PFBC. The objective of this mussel survey is to conduct a reconnaissance scoping survey to identify what mussels, if any, may be within the Cheat River from the Project dam to approximately 3.5 miles downstream to the confluence of the Monongahela River. Mussel habitat (location, depth, and substrate) and the occurrence density, distribution, and relative abundance of any mussel species present will be recorded.

The Project is a 51.2 megawatt (MW) single development project operated since 1926. It consists of:

- a 125-foot high by 1,000-foot long concrete gravity-type dam with a 624-foot long spillway controlled by 26 Tainter gates, each 17 feet high by 21 feet long;
- a reservoir with a surface area of 1,729 acres and containing about 72,00 acre-feet of water at full pool elevation of 870 feet National Geodetic Vertical Datum;
- a log boom and track racks at the intake facility;
- eight 12-foot by 18-foot gated penstocks of reinforced concrete;
- a 72-foot by 165-foot by 68-foot high brick powerhouse containing four identical Francis generating units with a total rated capacity of 51.2 MW;
- dual 800-foot long 13 8-kilovolt transmission lines; and
- appurtenant facilities.

Survey Plan

Reconnaissance scoping survey efforts will be coordinated and led by a West Virginia and Pennsylvania approved malacologist. The qualified malacologist will provide survey oversight and guidance on execution of the survey and will be the lead taxonomist in the field for the duration of the work. The survey will follow modified West Virginia Protocol guidance (WVDNR, 2020) with additional guidance from the American Fisheries Society Monograph 8 (Strayer and Smith, 2003). The survey area includes the Project boundary that extends approximately 200 meters downstream of the Project dam and will continue approximately 3.5 miles downstream to the confluence with the Monongahela River. TRC has preliminarily defined the survey area as depicted on the attached **Figure 2**. A summary protocol form (Mussel Survey Scope of Work Summary Sheet) is attached (**Attachment 1**).

TRC will perform a reconnaissance scoping survey to determine areas of suitable mussel habitat and evaluate for mussel presence/absence within the survey area downstream of the dam. The habitat assessment will start at the mouth of the Cheat River, approximately 3.5 miles downstream of the Project boundary and move upstream to the Project dam (**Figure 2**). The banks will be searched for shell material and the substrate will be evaluated to identify suitable mussel habitat (stable burrowable substrates including sand, gravel, cobble, etc.). Once suitable mussel habitat is located, a qualitative timed search will be employed for a minimum of 10-minutes to search for live mussels and shell material. In the state of West Virginia, there will be at least one qualitative dive every 100 meters in the best possible substrate, if no suitable habitat is located. Qualitative surveys in the Commonwealth of Pennsylvania will only be performed where suitable habitat is identified. If live mussels are collected, the area will be searched until the limits of the mussel bed are delineated.

This survey will consist of visually and tactilely searching the survey area for presence of mussels and to determine limits of any mussel concentrations. Snorkeling and surface supplied air diving will be used to visually and tactilely search for mussels at the substrate surface; moving cobble and woody debris; hand sweeping away silt, sand and/or small detritus; and disturbing/probing the upper 5cm (2in) of substrate in order to ensure recovery of buried mussels. Data will be collected separately for each qualitative search.

**If any federally listed species are observed during survey or efforts, efforts will stop and PBFC, WVDNR, and USFWS will be immediately contacted.**

Data Collection

Photographs will be taken of the survey area and a minimum of one representative photo of each mussel species will be taken for verification purposes. Live mussels will be kept in stream water in mesh collection bags and out of water time will be kept to one (1) minute or less during processing. Mussels that are bagged and held for identification will be hand placed back into their respective habitats where they were collected. At a minimum, data to be recorded includes: substrate composition of each sample (visual percentage based on Wentworth scale; water depth (meters); mussel species, individual size (length, height, and width to the nearest millimeter), sex (where applicable), and age (external annuli count); mussel shells (classified as fresh dead, weathered dead, or relic shell); where applicable; Global Positioning System (GPS) coordinates of the survey area, mussel aggregation limits; and other notable features such as land use and general observations about the stream.

Reporting

A report documenting the results of the habitat assessment survey will be prepared upon completion of field work. Reports will follow technical reporting guidelines and will include an introduction, methods, results, and discussion with associated tables, figures, and appendices. Maps showing the survey area, mussel distribution, and habitat conditions will also be included, along with photo documentation of the survey area and mussel species encountered. Reporting will follow Protocol recommendations.

References

Strayer, D.L., and D.R. Smith. 2003. A guide to sampling freshwater mussel populations. American Fisheries Society, Monograph 8, Bethesda, Maryland.

West Virginia Division of Natural Resources (WVDNR). 2020. West Virginia Mussel Survey Protocols. West Virginia Division of Natural Resources. unpublished. 25pp + app.


BASE MAP FROM USGS TOPOGRAPHIC MAP WEB SERVICE, QUAD: LAKE LYNN

NORTH

1 " = 2,000 '

1:24,000

0 1,000 2,000 FEET


TRC

1382 West Ninth Street
Suite 400
Cleveland, OH 44113
Phone: 216-344-3072

TRC - GIS

PROJECT:

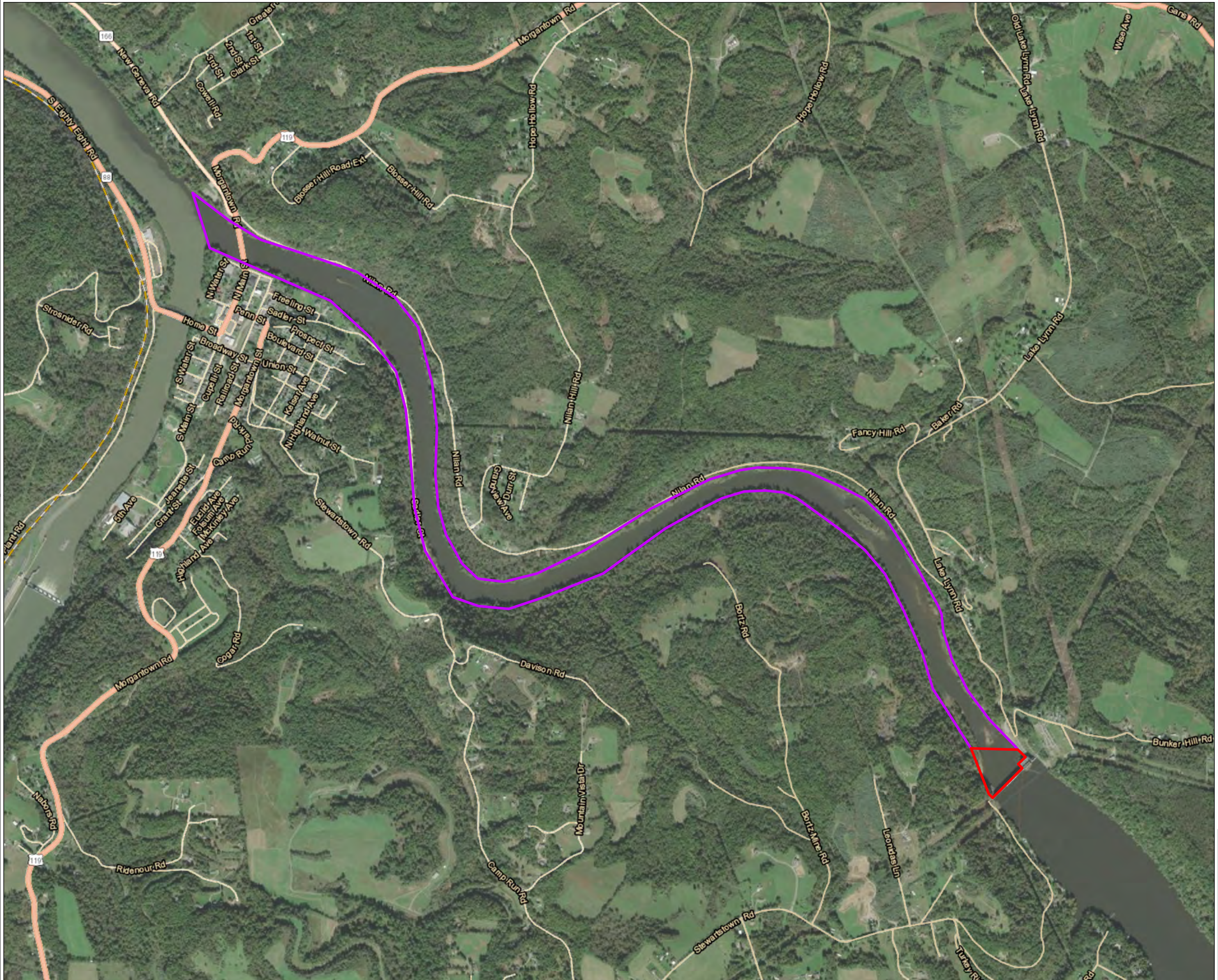
**LAKE LYNN HYDROELECTRIC PROJECT**
**MONONGALIA COUNTY, WEST VIRGINIA**

TITLE:

**SITE LOCATION MAP**

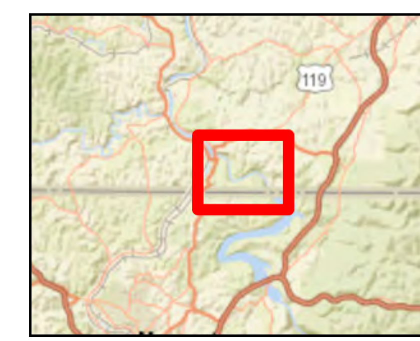
**FIGURE 1**

TRC - GIS




Project Boundary

Downstream Survey Buffer




0 1,500 3,000 Feet

1 " = 1,500 ' 1:18,000

N

**LAKE LYNN HYDROELECTRIC PROJECT**
**MONONGALIA COUNTY, WEST VIRGINIA**

**FIGURE 2**
**SURVEY AREA LIMITS**


TRC

1382 West Ninth Street
Suite 400
Cleveland, OH 44113
Phone: 216-344-3072


SEPTEMBER 2020 Fig02_SurveyArea.mxd

Plot Date: 9/9/2020, 11:03:27 AM by MOPEL -- LAYOUT: ANSI B(11"x17")
Path: S:\1-PROJECTS\Cube_PE_Hydro\282346_LakeLynnHydro\Fig02_SurveyArea.mxd

# Mussel Survey Scope of Work Summary Sheet

Form Date **3/16/2020**

## Project Title: Reconnaissance Scoping Survey for the Lake Lynn Hydroelectric Relicensing Project (FERC No. P-2459) on the Cheat River, Monongalia County, West Virginia and Fayette County, Pennsylvania

Project Company: Lake Lynn Generation LLC
Date Submitted: 9/7/2020
Mussel Contractor: EnviroScience, Inc.
Date Revised: 9/9/2020
Lead Malacologist: Sarah Veselka
Project Contractor: TRC Environmental Corporation
Collectors: if applicable Lindsey Jakovljevic, Tom Radford, Tony Tredway
County: Monongalia, WV and Fayette, PA
Group (Circle One): 1 2 (3) 4
Stream: Cheat River
Location Description: The Project is located on the Cheat River near Morgantown, West Virginia in Monongalia County, West Virginia and Fayette County, Pennsylvania
Navigational Pool if Applicable: ______
If Group 1 or 2, Receiving Stream: ______

Project Type: Hydropower (corresponds to Table 3, WV Mussel Survey Protocol)

| | | | | | |
|---|---|---|---|---|---|
| ADI Length: | 100 m | ADI Width: | 195 m | Salvage area ($m^2$): | |
| US Buffer Length: | NA | US Buffer Width: | NA | USS Buffer Length: | |
| DS Buffer Length: | 3.5 Miles | DS Buffer Width: | 60 m | DSS Buffer Length: | |
| Lateral Buffer Length: | NA | Lateral Buffer Width: | BB | Lateral S Buffer Width: | |

Phase 1 Survey Method: Transect ☐ Cells ☐ Other ☒ qualitative spot dives

# Transects/Length (m): | Cell Size (mxm): | Cell Search Effort (Min/$m^2$)

| # Transects/Length (m) | | Cell Size (mxm) | Cell Search Effort (Min/$m^2$) |
|---|---|---|---|
| | ADI: | | 10-minute spot dive in suitable habitat or every 100 m (WV ONLY) |
| | USB: | | NA |
| | DSB: | | 10-minute spot dive in suitable habitat or every 100 m (WV ONLY) |

______ Spacing Between Transects (M)

Coordinates (Decimal Degrees, NAD83)

| | Long. | Lat. |
|---|---|---|
| Upstream End US Buffer: | NA | NA |
| Upstream End ADI: | -79.857352 | 39.719387 |
| ADI Center: | -79.857683 | 39.720052 |
| Downstream End ADI: | -79.858185 | 39.720662 |
| Downstream End DS Buffer: | -79.901564 | 39.742802 |
| RELOCATION AREA: | NA | NA |

Map: Show ADI, USB, DSB and survey layout with outline of proposed impact.

Did you provide? Justification must be provided in scope of work
Addressed Alternative Methods ☐ Yes FERC relicense no alternate methods
Addressed Alternative Sites ☐ Yes FERC relicense no alternate sites

Phase 2 requested?: ☐ Yes ☒ No

Request for Relocation: ☐ Yes ☒ No
Method:
(check one)
☐ Cell Size (mxm): ______
☐ Moving Transect:
☐ Other:______

Multiple passes are to be made through the area until less than 5 % of the number collected on the first two passes combined are recovered on the

## Foster, Joyce

**Subject:** FW: [EXTERNAL] Lake Lynn Relicensing - Draft Mussel Survey Plan
**Location:** Microsoft Teams Meeting

**Start:** Wed 5/20/2020 11:00 AM
**End:** Wed 5/20/2020 12:00 PM
**Show Time As:** Tentative

**Recurrence:** (none)

**Meeting Status:** Not yet responded

**Organizer:** Jody Smet

-----Original Appointment-----
**From:** Jody Smet <Jody.Smet@eaglecreekre.com>
**Sent:** Monday, May 18, 2020 11:04 PM
**To:** Jody Smet; Janet_Norman@fws.gov; Jacob Harrell; Heather Smiles; Foster, Joyce
**Cc:** Robert Flickner; Dale Short
**Subject:** [EXTERNAL] Lake Lynn Relicensing - Draft Mussel Survey Plan
**When:** Wednesday, May 20, 2020 11:00 AM-12:00 PM (UTC-05:00) Eastern Time (US & Canada).
**Where:** Microsoft Teams Meeting



All,

Based on the responses received to the Doodle poll, I would also like to schedule a conference call at 11 a.m. on Wednesday, May 20, to discuss the attached draft survey plan for the proposed Lake Lynn Project mussel survey. We anticipate that this call will last no more than an hour. Please join by phone, or MS Teams link, below. Please forward this invitation to others, as appropriate.

Thank you.

________________________________________________________________________________

## Join Microsoft Teams Meeting

+1 920-393-6252 United States, Green Bay (Toll)

Conference ID: 578 406 16#

Local numbers | Reset PIN | Learn more about Teams | Meeting options

________________________________________________________________________________

| | |
|---|---|
| **From:** | Jody Smet |
| **To:** | Smiles, Heather A |
| **Subject:** | [EXTERNAL] RE: Lake Lynn Relicensing - Draft Mussel Survey Plan |
| **Date:** | Tuesday, May 19, 2020 8:16:18 AM |



Great, thanks Heather.

Jody J. Smet, AICP
Vice President Regulatory Affairs
Eagle Creek Renewable Energy

Please note my new email address – jody.smet@eaglecreekre.com

-----Original Appointment-----
**From:** Smiles, Heather A <hsmiles@pa.gov>
**Sent:** Tuesday, May 19, 2020 8:15 AM
**To:** Jody Smet
**Subject:** Accepted: Lake Lynn Relicensing - Draft Mussel Survey Plan
**When:** Wednesday, May 20, 2020 11:00 AM-12:00 PM (UTC-05:00) Eastern Time (US & Canada).
**Where:** Microsoft Teams Meeting

Jody,

Our Malacologist, Nevin Welte, will join the meeting. For your records, below is his information.

Thanks,

**Heather A. Smiles** | Chief, Division of Environmental Services
PA Fish and Boat Commission
595 East Rolling Ridge Drive | Bellefonte, PA  16823
Phone:  814.359.5194
Email: hsmiles@pa.gov
www.fishandboat.com

Nevin Welte
Malacologist/Nongame Biologist, Natural Diversity Section
Pennsylvania Fish & Boat Commission
Centre Region Office
595 E. Rolling Ridge Dr.
Bellefonte, PA 16823
c-nwelte@pa.gov

412-586-2334

| | |
|---|---|
| **From:** | Jody Smet |
| **To:** | Norman, Janet; Harrell, Jacob D; Heather Smiles; c-nwelte@pa.gov |
| **Cc:** | Dale Short; Robert Flickner; Michael Scarzello; Matthew Nini; Foster, Joyce |
| **Subject:** | [EXTERNAL] Lake Lynn Relicensing – Revised Draft Mussel Survey Plan |
| **Date:** | Thursday, July 9, 2020 11:11:10 AM |
| **Attachments:** | image001.png<br>Lake Lynn Mussel Survey Plan_REV 1.pdf |



All,

As follow-up to our call on May 20 discussing the draft Lake Lynn Mussel Survey Plan and review of the 1993 Lake Lynn Instream Flow Study Report, we have attached a revised draft Lake Lynn Mussel Survey Plan for your review. Please provide your comments on the revised Survey Plan by July 17.

Thank you,

**Jody J. Smet, AICP | Vice President Regulatory Affairs**
**Eagle Creek Renewable Energy**
Desk: 804 739 0654
Mobile: 804 382 1764
Email: jody.smet@eaglecreekre.com

| | |
|---|---|
| **From:** | Jody Smet |
| **To:** | Foster, Joyce |
| **Subject:** | FW: [EXTERNAL] Lake Lynn Relicensing – Revised Draft Mussel Survey Plan |
| **Date:** | Tuesday, July 14, 2020 10:42:38 AM |
| **Attachments:** | image001.png |



Jody J. Smet, AICP
Vice President Regulatory Affairs
Eagle Creek Renewable Energy

Please note my new email address – jody.smet@eaglecreekre.com

**From:** Norman, Janet <janet_norman@fws.gov>
**Sent:** Tuesday, July 14, 2020 10:37 AM
**To:** Jody Smet <Jody.Smet@eaglecreekre.com>
**Subject:** Re: [EXTERNAL] Lake Lynn Relicensing – Revised Draft Mussel Survey Plan

Received, thank you.
Will look over this week.

Janet

Janet Norman
Fish and Wildlife Biologist
USFWS Chesapeake Bay Field Office
177 Admiral Cochrane Dr.
Annapolis, MD 21401
(O) 410-573-4533
(Fax) 410-269-0832
(cell) 410-320-5519

---

**From:** Jody Smet <Jody.Smet@eaglecreekre.com>
**Sent:** Thursday, July 9, 2020 11:10 AM
**To:** Norman, Janet <janet_norman@fws.gov>; Harrell, Jacob D <Jacob.D.Harrell@wv.gov>; Heather Smiles <hsmiles@pa.gov>; c-nwelte@pa.gov <c-nwelte@pa.gov>
**Cc:** Dale Short <Dale.Short@eaglecreekre.com>; Robert Flickner <Robert.Flickner@eaglecreekre.com>; Michael Scarzello <Michael.Scarzello@eaglecreekre.com>; Matthew Nini <Matthew.Nini@eaglecreekre.com>; Foster, Joyce <JFoster@trccompanies.com>
**Subject:** [EXTERNAL] Lake Lynn Relicensing – Revised Draft Mussel Survey Plan

**This email has been received from outside of DOI - Use caution before clicking on links, opening attachments, or responding.**

All,

As follow-up to our call on May 20 discussing the draft Lake Lynn Mussel Survey Plan and review of the 1993 Lake Lynn Instream Flow Study Report, we have attached a revised draft Lake Lynn Mussel Survey Plan for your review. Please provide your comments on the revised Survey Plan by July 17.

Thank you,

---

**Jody J. Smet, AICP | Vice President Regulatory Affairs**
**Eagle Creek Renewable Energy**
Desk: 804 739 0654
Mobile: 804 382 1764
Email: jody.smet@eaglecreekre.com

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— EXCELLENCE IN HYDRO —

| | |
|---|---|
| **From:** | Jody Smet |
| **To:** | Foster, Joyce |
| **Subject:** | [EXTERNAL] FW: Lake Lynn Mussel Survey Plan Comments |
| **Date:** | Thursday, July 30, 2020 9:39:25 AM |
| **Attachments:** | Lake Lynn Mussel Survey Plan Revision Comments.pdf |



FYI, I haven't seen any others.

Jody J. Smet, AICP
Vice President Regulatory Affairs
Eagle Creek Renewable Energy

Please note my new email address – jody.smet@eaglecreekre.com

**From:** Harrell, Jacob D <Jacob.D.Harrell@wv.gov>
**Sent:** Tuesday, July 21, 2020 2:37 PM
**To:** Jody Smet <Jody.Smet@eaglecreekre.com>
**Subject:** Lake Lynn Mussel Survey Plan Comments

Jody,

Please see the attached comments concerning the Lake Lynn Mussel Survey Plan. Comments by our Diversity section are included within.

Thanks,

Jacob Harrell

Coordination Unit
WVDNR – Wildlife Resources Section
1110 Railroad Street
Farmington, WV 26571
(304)704-9328
Jacob.D.Harrell@wv.gov

**Sarah Veselka**

---

**From:** Welte, Nevin <c-nwelte@pa.gov>
**Sent:** Friday, September 11, 2020 9:30 AM
**To:** Sarah Veselka
**Cc:** Jacob.D.Harrell@wv.gov; Smiles, Heather A; Jody.Smet@eaglecreekre.com; Foster, Joyce; Jakovljevic, Lindsey; Urban, Chris; Anderson, Robert M
**Subject:** RE: [External] FW: Lake Lynn Survey Plan

Hi Sarah,

Thanks for sharing with us a revised study plan. PFBC concurs with the proposed survey methodology and extent of the study area. Please keep us posted on anticipated survey dates and we may join you in the field.

Thanks again and good luck with the survey,

Nevin

Nevin Welte
Malacologist/Nongame Biologist, Natural Diversity Section
Pennsylvania Fish & Boat Commission
Centre Region Office
595 E. Rolling Ridge Dr.
Bellefonte, PA 16823
c-nwelte@pa.gov

---

**From:** Sarah Veselka <sveselka@enviroscienceinc.com>
**Sent:** Thursday, September 10, 2020 5:10 PM
**To:** Welte, Nevin <c-nwelte@pa.gov>
**Cc:** Jacob.D.Harrell@wv.gov; Smiles, Heather A <hsmiles@pa.gov>; Jody.Smet@eaglecreekre.com; Foster, Joyce <JFoster@trccompanies.com>; Jakovljevic, Lindsey <LJakovljevic@trccompanies.com>; Urban, Chris <curban@pa.gov>; Anderson, Robert M <Robert_M_Anderson@fws.gov>
**Subject:** RE: [External] FW: Lake Lynn Survey Plan

Hi Nevin,

Thank you for your comments. Please find the requested revised survey plan attached here for your review.

Thank you,

Sarah

**Sarah Veselka**
**EnviroScienceInc.com**
**"Excellence in Any Environment"**

---

**From:** Welte, Nevin <c-nwelte@pa.gov>
**Sent:** Tuesday, September 8, 2020 8:51 AM

**To:** Sarah Veselka <sveselka@envirosciencein c.com>; Sargent, Barbara D <Barbara.D.Sargent@wv.gov>
**Cc:** Jacob.D.Harrell@wv.gov; Smiles, Heather A <hsmiles@pa.gov>; Jody.Smet@eaglecreekre.com; Foster, Joyce <JFoster@trccompanies.com>; Jakovljevic, Lindsey <LJakovljevic@trccompanies.com>; Urban, Chris <curban@pa.gov>; Anderson, Robert M <Robert_M_Anderson@fws.gov>
**Subject:** RE: [External] FW: Lake Lynn Survey Plan

Hi Sarah,

Thanks for the email and the attached survey plan. While PFBC agrees with the proposed survey methods (i.e., "how to look for mussels") we continue to disagree with the extent of the study area (1.0 mile downstream of the project). The extent of the study area was not revised based upon recent PFBC comments submitted by Heather Smiles (email dated August 3, 2020) and no biological rationale was given for maintaining a limited study area. Any data collected from this limited study area will be continue to be insufficient data to answer the question of whether or not this dam or its operations have an effect on Pennsylvania's freshwater mussels. We continue to advise that the study scope be revised and extended to include the length of the Cheat River in Pennsylvania using the approach described in Heather's email (in quotes below).

"Although the Cheat River has not been examined recently to detect freshwater mussels it is possible that species have recolonized the Cheat in areas that contain suitable mussel habitat. A survey of the Pennsylvania stretch of the Cheat would entail a scouting trip to determine areas of potentially suitable habitat followed by a qualitative survey of these areas (similar to the Large Scoping Projects in the WV mussel protocol). Such an effort would be necessary to determine whether mussels are present and to determine, to some extent, what the effects of the existing management of Lake Lynn are having on the Cheat River downstream of the dam."

We look forward to reviewing a revised study plan.

Thanks,

Nevin

Nevin Welte
Malacologist/Nongame Biologist, Natural Diversity Section
Pennsylvania Fish & Boat Commission
Centre Region Office
595 E. Rolling Ridge Dr.
Bellefonte, PA 16823
c-nwelte@pa.gov

---

**From:** Sarah Veselka <sveselka@envirosciencein c.com>
**Sent:** Monday, September 7, 2020 4:19 PM
**To:** Welte, Nevin <c-nwelte@pa.gov>; Sargent, Barbara D <Barbara.D.Sargent@wv.gov>
**Cc:** Jacob.D.Harrell@wv.gov; Smiles, Heather A <hsmiles@pa.gov>; Jody.Smet@eaglecreekre.com; Foster, Joyce <JFoster@trccompanies.com>; Jakovljevic, Lindsey <LJakovljevic@trccompanies.com>
**Subject:** [External] FW: Lake Lynn Survey Plan

Hello Nevin and Barb,

On behalf of Lake Lynn Generation and TRC, please find the attached mussel survey plan for the Lake Lynn Hydroelectric Project for your review and approval. I will be acting as the WV/PA qualified malacologist for the Project.

Thank you,

Sarah

**Sarah Veselka**
**EnviroScienceInc.com**
**"Excellence in Any Environment"**

**Sarah Veselka**

---

| | |
|---|---|
| **From:** | Sargent, Barbara D <Barbara.D.Sargent@wv.gov> |
| **Sent:** | Wednesday, September 9, 2020 10:20 AM |
| **To:** | Sarah Veselka |
| **Cc:** | Harrell, Jacob D |
| **Subject:** | RE: [External] FW: Lake Lynn Survey Plan |
| **Attachments:** | carlson_bAdd10.pdf; veselka_sAdd08.pdf; dunford_dAdd04.pdf; schwegman_rAdd04.pdf; mathias_pAdd04.pdf; winterringer_rAdd04.pdf |

Hi Sarah—

I have attached your addenda for the Lake Lynn project. The Scope is approved only for the WV portion; we defer to PA for their portion.

b.

---

**From:** Sarah Veselka [mailto:sveselka@enviroscienceinc.com]
**Sent:** Monday, September 07, 2020 4:19 PM
**To:** Welte, Nevin; Sargent, Barbara D
**Cc:** Harrell, Jacob D; hsmiles@pa.gov; Jody.Smet@eaglecreekre.com; Foster, Joyce; Jakovljevic, Lindsey
**Subject:** [External] FW: Lake Lynn Survey Plan

CAUTION: External email. Do not click links or open attachments unless you verify sender.

Hello Nevin and Barb,

On behalf of Lake Lynn Generation and TRC, please find the attached mussel survey plan for the Lake Lynn Hydroelectric Project for your review and approval. I will be acting as the WV/PA qualified malacologist for the Project.

Thank you,

Sarah

**Sarah Veselka**
EnviroScienceInc.com
"Excellence in Any Environment"

| | |
|---|---|
| **From:** | Jody Smet |
| **To:** | Norman, Janet; Harrell, Jacob D; Heather Smiles; c-nwelte@pa.gov |
| **Cc:** | Dale Short; Robert Flickner; Michael Scarzello; Matthew Nini; Foster, Joyce |
| **Subject:** | [EXTERNAL] RE: Lake Lynn Relicensing – Revised Draft Mussel Survey Plan |
| **Date:** | Thursday, July 30, 2020 9:41:00 AM |
| **Attachments:** | image001.png |



All,

Comments were due on the revised mussel survey plan on 7/17. We received comments from WVDNR. We are working to finalize this study plan so that we are prepared to be in the field in late August / early September.

Thank you,

Jody J. Smet, AICP
Vice President Regulatory Affairs
Eagle Creek Renewable Energy

Please note my new email address – jody.smet@eaglecreekre.com

---

**From:** Jody Smet
**Sent:** Thursday, July 9, 2020 11:10 AM
**To:** Norman, Janet <janet_norman@fws.gov>; Harrell, Jacob D <Jacob.D.Harrell@wv.gov>; Heather Smiles <hsmiles@pa.gov>; c-nwelte@pa.gov
**Cc:** Dale Short <Dale.Short@eaglecreekre.com>; Robert Flickner <Robert.Flickner@eaglecreekre.com>; Michael Scarzello <Michael.Scarzello@eaglecreekre.com>; Matthew Nini <Matthew.Nini@eaglecreekre.com>; Foster, Joyce <JFoster@trccompanies.com>
**Subject:** Lake Lynn Relicensing – Revised Draft Mussel Survey Plan

All,

As follow-up to our call on May 20 discussing the draft Lake Lynn Mussel Survey Plan and review of the 1993 Lake Lynn Instream Flow Study Report, we have attached a revised draft Lake Lynn Mussel Survey Plan for your review. Please provide your comments on the revised Survey Plan by July 17.

Thank you,

**Jody J. Smet, AICP | Vice President Regulatory Affairs**
**Eagle Creek Renewable Energy**
Desk: 804 739 0654
Mobile: 804 382 1764
Email: jody.smet@eaglecreekre.com

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| | |
|---|---|
| **From:** | Jody Smet |
| **To:** | Foster, Joyce |
| **Subject:** | FW: [External] RE: Lake Lynn Relicensing – Revised Draft Mussel Survey Plan - PFBC Comments |
| **Date:** | Monday, August 3, 2020 12:29:10 PM |
| **Attachments:** | image001.png |



Jody J. Smet, AICP
Vice President Regulatory Affairs
Eagle Creek Renewable Energy

Please note my new email address – jody.smet@eaglecreekre.com

**From:** Smiles, Heather A <hsmiles@pa.gov>
**Sent:** Monday, August 3, 2020 11:35 AM
**To:** Jody Smet <Jody.Smet@eaglecreekre.com>
**Subject:** RE: [External] RE: Lake Lynn Relicensing – Revised Draft Mussel Survey Plan - PFBC Comments

Dear Jody,

Thanks for the opportunity to review the proposed study plan. While PFBC agrees with the proposed survey methodologies, we disagree with the limits of the study area being restricted to 1.02 miles downstream of the dam.

Per the study plan, the study area was restricted based upon the area of fluctuating water elevations, but wetted width of a river is but one component of regulated rivers that may have an adverse effect on freshwater mussel communities. Discharge water temperature is another critical component to the survival and persistence of a viable mussel community. Discharge temperatures are controlled by where water is being released from within the impoundment, and coldwater releases have a well-documented effect on freshwater mussel communities including limiting gametogenesis, growth, as well as altering the host fish community which affects mussel community composition. The Lake Lynn study limit should, at minimum, consider the entire length of the Cheat that has temperature affected by the discharge of the dam.

In lieu of a temperature study delimits the downstream thermal effects of the dam, a mussel study that focuses on potential mussel habitat from the dam downstream to its confluence with the Monongahela River would be appropriate to ascertain what species if any, occur in the Cheat River.

If such a survey effort results in the detection of no mussels or a limited community in the Cheat River then it would be a worthy biological objective of relicensing to try and mimic, to the extent practicable, the natural flow and/or thermal regime as much as possible to maintain the river's restoration potential.

The proximity of the project to recent/known populations of state listed species (e.g., Snuffbox, Salamander Mussel, and Pistolgrip) approximately ~ 2.4 miles from the confluence of the Cheat and Monongahela River confluence suggests that it is a possibility that these species could occur in the Cheat, could disperse there in the future, and thus may be affected by Lake Lynn dam operations.

As you may know, the Cheat contained a diverse mussel fauna including the state and federal listed Clubshell (*Pleurobema clava*), a species undergoing a federal status assessment (SSA) (Longsolid, *Fusconaia subrotunda*), as well as two species that haven't been seen in Pennsylvania in over 100 years (Pimpleback, *Cyclonaias pustulosa* and Purple Wartyback, *C. tuberculata*). This Cheat River population was likely an extension of the Monongahela River population which was also quite diverse (e.g., Fanshell, *Cyprogenia stegaria*) until the effects of the steel and associated industries became too severe, before 1900. The Monongahela River, like the Ohio River (21 mussel species in PA), is a river in recovery since water quality improvements began in the 1970s.

Despite the effects of that industry, Dunkard Creek – a tributary to the Monongahela River just 2.4 miles downstream of the Cheat – was considered the crown jewel of the Monongahela River system until 2009, when a toxic event wiped that fauna out. Dunkard Creek harbored – as of 2009 – the state and federally endangered Snuffbox (*Epioblasma triquetra*), the state endangered Salamander Mussel (*Simpsonaias ambigua*, also undergoing a federal SSA), and the state endangered Pistolgrip (*Tritogonia verrucosa*). Numerous other species also occurred in Dunkard and PFBC and WVDNR are actively working to restore Dunkard with common mussels and via propagation and augmentation efforts. It's not unreasonable to suspect that glochidia-inoculated host fishes from Dunkard Creek were able to traverse the short distance to the Cheat River.
Although the Cheat River has not been examined recently to detect freshwater mussels it is possible that species have recolonized the Cheat in areas that contain suitable mussel habitat. A survey of the Pennsylvania stretch of the Cheat would entail a scouting trip to determine areas of potentially suitable habitat followed by a qualitative survey of these areas (similar to the Large Scoping Projects in the WV mussel protocol). Such an effort would be necessary to determine whether mussels are present and to determine, to some extent, what the effects of the existing management of Lake Lynn are having on the Cheat River downstream of the dam.

We look forward to reviewing a modified mussel survey plan.

**Heather A. Smiles** | Chief, Division of Environmental Services
PA Fish and Boat Commission
595 East Rolling Ridge Drive | Bellefonte, PA 16823
Phone: 814.359.5194
Email: hsmiles@pa.gov
www.fishandboat.com

---

**From:** Jody Smet <Jody.Smet@eaglecreekre.com>
**Sent:** Thursday, July 30, 2020 9:41 AM

**To:** Norman, Janet <janet_norman@fws.gov>; Harrell, Jacob D <Jacob.D.Harrell@wv.gov>; Smiles, Heather A <hsmiles@pa.gov>; Welte, Nevin <c-nwelte@pa.gov>
**Cc:** Dale Short <Dale.Short@eaglecreekre.com>; Robert Flickner <Robert.Flickner@eaglecreekre.com>; Michael Scarzello <Michael.Scarzello@eaglecreekre.com>; Matthew Nini <Matthew.Nini@eaglecreekre.com>; Foster, Joyce <JFoster@trccompanies.com>
**Subject:** [External] RE: Lake Lynn Relicensing – Revised Draft Mussel Survey Plan

***ATTENTION:*** *This email message is from an external sender. Do not open links or attachments from unknown sources. To report suspicious email, forward the message as an attachment to CWOPA_SPAM@pa.gov.*

All,

Comments were due on the revised mussel survey plan on 7/17. We received comments from WVDNR. We are working to finalize this study plan so that we are prepared to be in the field in late August / early September.

Thank you,

Jody J. Smet, AICP
Vice President Regulatory Affairs
Eagle Creek Renewable Energy

Please note my new email address – jody.smet@eaglecreekre.com

---

**From:** Jody Smet
**Sent:** Thursday, July 9, 2020 11:10 AM
**To:** Norman, Janet <janet_norman@fws.gov>; Harrell, Jacob D <Jacob.D.Harrell@wv.gov>; Heather Smiles <hsmiles@pa.gov>; c-nwelte@pa.gov
**Cc:** Dale Short <Dale.Short@eaglecreekre.com>; Robert Flickner <Robert.Flickner@eaglecreekre.com>; Michael Scarzello <Michael.Scarzello@eaglecreekre.com>; Matthew Nini <Matthew.Nini@eaglecreekre.com>; Foster, Joyce <JFoster@trccompanies.com>
**Subject:** Lake Lynn Relicensing – Revised Draft Mussel Survey Plan

All,

As follow-up to our call on May 20 discussing the draft Lake Lynn Mussel Survey Plan and review of the 1993 Lake Lynn Instream Flow Study Report, we have attached a revised draft Lake Lynn Mussel Survey Plan for your review. Please provide your comments on the revised Survey Plan by July 17.

Thank you,

**Jody J. Smet, AICP | Vice President Regulatory Affairs**
**Eagle Creek Renewable Energy**
Desk: 804 739 0654
Mobile: 804 382 1764
Email: jody.smet@eaglecreekre.com

EAGLE CREEK
RENEWABLE ENERGY
— EXCELLENCE IN HYDRO —

**DIVISION OF NATURAL RESOURCES**
**Wildlife Resources Section**
**District I**
**PO Box 99, 1110 Railroad Street**
**Farmington, West Virginia 26571-0099**
**Telephone 304 825-6787**
**Fax 304 825-6270**
**TDD 800-354-6087**

**Stephen S. McDaniel**
**Director**

July 20, 2020

Jody Smet, AICP
Vice President Regulatory Affairs
Eagle Creek Renewable Energy
2 Bethesda Metro Center, Suite 1330
Bethesda, MD 20814

**RE: Lake Lynn Hydroelectric Project, FERC no. 2459; Lake Lynn Mussel Survey Plan Revision**

Dear Ms. Smet:

Thank you for allowing the West Virginia Division of Natural Resources, Wildlife Resources Section (WRS) the opportunity to review the Mussel Survey Plan as part of the relicensing process for the Lake Lynn Hydroelectric Project, FERC no. 2459. The WRS has reviewed the plan and offers the following comments for your consideration.

As provided, it is unclear if the intent of the surveys is for scoping or to identify potential impacts related to the project. Such intent should be made clear on the first page of the mussel survey plan. If the intent is to conduct a reconnaissance scoping survey to identify what mussels, if any, may be within the project impact area, then the methodology as provided would be sufficient. However, if the intent of the survey is to identify potential impacts that may occur due to project operation, then the methodology provided is insufficient and would fail to meet the standards of the 2020 West Virginia Mussel Survey Protocols which would require additional work (i.e. transect surveys).

Within West Virginia, the Cheat River is a Group 3 stream (large river not expected to have federally threatened and endangered mussel species). Transect surveys on Group 3 streams must include a minimum of 500 linear meters of surveyed area and contain a minimum of 5 transects (up to a maximum of 10 transectes).

With further regard to the methodology, the handling of mussels should be addressed within the survey plan. Mussels that are bagged and held for identification need to be hand placed back into their respective habitat where they were collected.

A summary protocol form, see attached, must also be completed and attached to the mussel survey plan. The mussel survey plan must also be approved by the Diversity Section of the West Virginia Division of Natural Resources and a scientific collection permit would need to be obtained to survey the sections of the survey within West Virginia.

Thank you again for the opportunity to provide comments regarding the mussel survey plan. If you have any questions or comments concerning the mussel survey plan please contact me at (304)989-0208 or by email at jacob.d.harrell@wv.gov.

Sincerely Yours,

Jacob Harrell
Hydropower Coordination Biologist

# Mussel Survey Scope of Work Summary Sheet

Form Date: 3/16/2020

## Project Title:

Project Company: ______________ Date Submitted: ______________
Mussel Contractor: ______________ Date Revised: ______________
Lead Malacologist: ______________
Project Contractor: ______________
Collectors: if applicable ______________
County: ______________ Group (Circle One): 1 2 3 4
Stream: ______________ Location Description:
Navigational Pool if Applicable: ______________
If Group 1 or 2, Receiving Stream: ______________

Project Type: ______________ (corresponds to Table 3, WV Mussel Survey Protocol)

| | | | | | |
|---|---|---|---|---|---|
| ADI Length: | | ADI Width: | | Salvage area ($m^2$): | |
| US Buffer Length: | | US Buffer Width: | | USS Buffer Length: | |
| DS Buffer Length: | | DS Buffer Width: | | DSS Buffer Length: | |
| Lateral Buffer Length: | | Lateral Buffer Width: | | Lateral S Buffer Width: | |

Phase 1 Survey Method: Transect ☐ Cells ☐ Other ☐ ______________

| # Transects/Length (m): | | Cell Size (mxm): | Cell Search Effort (Min/$m^2$) |
|---|---|---|---|
| ______ | ADI: | ______ | ______ |
| ______ | USB: | ______ | ______ |
| ______ | DSB: | ______ | ______ |

______ Spacing Between Transects (M)

Coordinates (Decimal Degrees, NAD83)

| | | |
|---|---|---|
| Upstream End US Buffer: | Long. ______ | Lat. ______ |
| Upstream End ADI: | Long. ______ | Lat. ______ |
| ADI Center: | Long. ______ | Lat. ______ |
| Downstream End ADI: | Long. ______ | Lat. ______ |
| Downstream End DS Buffer: | Long. ______ | Lat. ______ |
| RELOCATION AREA: | Long. ______ | Lat. ______ |

Map: Show ADI, USB, DSB and survey layout with outine of proposed impact.

Did you provide? Justification must be provided in scope of work

Addressed Alternative Methods ☐ Yes Provide Description in Scope
Addressed Alternative Sites ☐ Yes Provide Description in Scope

Phase 2 requested?: ☐ Yes ☐ No

Request for Relocation: ☐ Yes ☐ No

Method:
(check one)
☐ Cell Size (mxm): ______
☐ Moving Transect:
☐ Other: ______________

Multiple passes are to be made through the area until less than 5 % of the number collected on the first two passes combined are recovered on the

**COMMONWEALTH OF PENNSYLVANIA**
PENNSYLVANIA FISH AND BOAT COMMISSION
Bureau of Fisheries - Environmental Services Division - Natural Diversity Section
595 E. Rolling Ridge Drive
Bellefonte, PA 16823

Permit Issue Date:May 21, 2020 Permit Print Date:May 27, 2020  - PERMIT NO. 2020-03-0241 Type 3

THIS IS TO CERTIFY THAT ACTING UNDER THE PROVISIONS OF THE FISH AND BOAT CODE, ACT 1980-175 AMENDED:

| Name and Town of Permit Owner | Age | Height | Weight | Eyes | Hair | PA Fishing License # |
|---|---|---|---|---|---|---|
| SARAH VESELKA, EnviroScience, Inc.-Malacologist Morgantown, WV | 41 | 5ft. 7In. | 1 | Hazel | Brown | 071-887-806 |

AND ASSISTANTS LISTED, ARE HEREBY AUTHORIZED TO COLLECT FISH OR OTHER AQUATIC LIFE FOR SCIENTIFIC PURPOSES AND IS LIMITED TO THOSE ACTIVITIES AS DESCRIBED IN RESPONSE TO THE APPLICATION PROJECT DETAILS SECTION. THIS PERMIT IS VALID FOR COLLECTION PROJECTS: (SEE ATTACHED SHEET)

UNLESS OTHERWISE PERMITTED, ALL SPECIES MUST BE RELEASED UNHARMED AT SITE OF CAPTURE. A SCIENTIFIC COLLECTOR'S PERMIT DOES NOT GRANT THE PERSONS THE AUTHORITY TO TRESPASS ON PRIVATE PROPERTY.

THIS PERMIT IS GOOD FOR THE CALENDAR YEAR **2020** OR DATE SPECIFIED IN PERMIT CONDITIONS, WHICHEVER COMES FIRST.

THE OWNER OF THIS PERMIT AND LISTED ASSISTANTS MUST BE THE HOLDERS OF A RESIDENT OR NONRESIDENT FISHING LICENSE WHICH MUST BE CARRIED WITH THEM AT ALL TIMES, ALONG WITH THIS PERMIT, OR A COPY THEREOF. PROPER NOTIFICATION MUST BE GIVEN TO THE REGIONAL LAW ENFORCEMENT OFFICE COVERING THE COUNTY IN WHICH COLLECTIONS ARE BEING CONDUCTED. OFFICES ARE OPEN MONDAY THRU FRIDAY BETWEEN 8:00AM AND 4:00PM

IN WITNESS THEREOF, I HAVE HEREUNTO SET MY HAND AND AFFIXED THE OFFICAL SEAL OF THE COMMISSION THE DAY AND DATE FIRST ABOVE WRITTEN

Christopher A. Urban

EXECUTIVE DIRECTOR OR DESIGNEE

Pennsylvania Fish & Boat Commission

**Natural Diversity Section**
595 E. Rolling Ridge Drive
Bellefonte, PA 16823-9620
*(814) 359-5237 Fax: (814) 359-5175*

May 27, 2020

SARAH E VESELKA
EnviroScience, Inc.
129 Greenbag Road,
Morgantown, WV 26501

**RE: Chapter 75.4 Special Permit for Collection of Threatened and Endangered Species**
**Scientific Collectors' Permits No. 2020-03-0241 Type 3**

Dear SARAH E VESELKA:

THIS IS TO CERTIFY THAT, pursuant to PA 58 Code §75.4,

**SARAH E VESELKA**

and approved Scientific Collectors' Permit (SCP) assistants, are hereby granted written permission to search for, trap, measure, and mark threatened and endangered species under Pennsylvania Fish and Boat Commission jurisdiction in exception of the prohibition of possession. Specifically, this permit grants permission for SARAH E VESELKA to survey for the following species:

| **Common Name** | ***Scientific Name*** |
|---|---|
| Northern Riffleshell | *Epioblasma torulosa rangiana* |
| Snuffbox | *Epioblasma triquetra* |
| Sheepnose Mussel | *Plethobasus cyphyus* |
| Clubshell | *Pleurobema clava* |
| Salamander Mussel | *Simpsonaias ambigua* |
| Pistolgrip Mussel | *Quadrula verrucosa* |
| Rayed Bean Mussel | *Villosa fabalis* |

Upon capture, these specimens will be measured, marked, photo-documented, and immediately released to the point of capture and reported to the Commission within 48 hours via the Scientific Collectors' Permit online reporting system. This Special Permit **DOES NOT AUTHORIZE** any individual to kill or take from the wild endangered or threatened species. However, this permit authorizes valid Scientific Collector Permit holders (Types I, II and III) and their approved SCP assistants to engage in scientific collecting for endangered or threatened species at the locations approved on their 2020 Scientific Collectors' Permit. **Any endangered or threatened species captured during these permitted activities shall be released as authorized by the conditions outlined in your Scientific Collector's permit.** Deceased specimens, in whole or parts, shall be reported immediately to the Pennsylvania Fish & Boat Commission to determine disposition. This permit, unless sooner revoked, is effective immediately and expires with the 2020 Scientific Collectors' Permit.

FOR THE PENNSYLVANIA FISH AND BOAT COMMISSION

Christopher A. Urban

Christopher A. Urban, Chief
Natural Diversity Section

**DIVISION OF NATURAL RESOURCES**
Wildlife Resources Section
Elkins Operations Center
738 Ward Rd., PO Box 67
Elkins, WV 26241
Telephone 304-637-0245
Fax 304-637-0250

Stephen S. McDaniel
Director

# ADDENDUM TO SCIENTIFIC COLLECTING PERMIT NO. 2020.111

Permittee: Sarah Veselka
Address: EnviroScience, Inc.
West Virginia – Appalachia Operations
129 Greenbag Road
Morgantown, WV 26501

Expiration Date: October 1, 2020

THE FOLLOWING PROVISIONS ARE ADDED TO THIS PERMIT: The Scope of Work is approved for the West Virginia portion of the project only. The WVDNR defers to the Pennsylvania Fish and Boat Commission for surveys conducted in their waters.

Mussel surveys are permitted in the Cheat River in Monongalia at the West Virginia – Pennsylvania state line (Lake Lynn Hydroelectric Relicensing)

**THIS ADDENDUM MUST BE ATTACHED TO ORIGINAL PERMIT.**

Must be signed before valid.

Sarah Veselka

Signature of permittee

Scientific Collecting Permit Coordinator

9/9/2020

Date of Issue

# Appendix B
# Photolog

# PHOTOGRAPHIC RECORD

**Mussel Reconnaissance Scoping Survey**

Lake Lynn Hydroelectric Project (FERC No. P-2459)

| **Client Name:** Lake Lynn Generation LLC | **Site Location:** Cheat River, Monongalia County, West Virginia and Fayette County, Pennsylvania | **Project No.** 282346.2020.000 |
|---|---|---|

| | |
|---|---|
| **Photo No. 1.** |  |
| **Date:** September 16, 2020 | |
| **Description:** View of the Lake Lynn Generation, LLC development looking upstream, facing east. | |

| | |
|---|---|
| **Photo No. 2.** |  |
| **Date:** September 16, 2020 | |
| **Description:** View of the Lake Lynn Generation, LLC dam development looking upstream, facing southeast. | |

**Photo No. 3.**

**Date:**
September 16, 2020

**Description:**

View of the right descending bank of the island just downstream of the Project dam, facing south west.

**Photo No. 4.**

**Date:**
September 16, 2020

**Description:**

Cross stream view looking towards the left descending bank of the Cheat River, facing west.

| Client Name: | Site Location: | Project No. |
|---|---|---|
| Lake Lynn Generation LLC | Cheat River, Monongalia County, West Virginia and Fayette County, Pennsylvania | 282346.2020.000 |

| | |
|---|---|
| **Photo No. 5.** |  |
| **Date:** September 16, 2020 | |
| **Description:** View of the left descending bank of the Cheat River from the island just downstream of the dam, facing southwest. | |

| | |
|---|---|
| **Photo No. 6.** |  |
| **Date:** September 16, 2020 | |
| **Description:** View of Site 1 from the island directly downstream of the Project dam. | |

| Client Name: | Site Location: | Project No. |
|---|---|---|
| Lake Lynn Generation LLC | Cheat River, Monongalia County, West Virginia and Fayette County, Pennsylvania | 282346.2020.000 |

| Photo No. 7. | |
|---|---|
| **Date:** September 16, 2020 |  |
| **Description:** Substrate within Site 1, directly downstream of the dam. | |

| Photo No. 8. | |
|---|---|
| **Date:** September 16, 2020 |  |
| **Description:** View of the substrate at the point of Site 2. | |

| | |
|---|---|
| **Photo No. 9.** |  |
| **Date:** September 16, 2020 | |
| **Description:** View of the left descending bank from Site 2. | |

| | |
|---|---|
| **Photo No. 10.** |  |
| **Date:** September 16, 2020 | |
| **Description:** View of Site 2 on the island directly downstream of the Project dam, facing northeast. | |

# PHOTOGRAPHIC RECORD

## Mussel Reconnaissance Scoping Survey

Lake Lynn Hydroelectric Project (FERC No. P-2459)

| **Client Name:**<br>Lake Lynn Generation LLC | **Site Location:**<br>Cheat River, Monongalia County, West Virginia and Fayette County, Pennsylvania | **Project No.**<br>282346.2020.000 |
|---|---|---|

| **Photo No. 11.** |  |
|---|---|
| **Date:**<br>September 16, 2020 | |
| **Description:**<br><br>View of the Cheat River looking downstream along the right descending bank downstream of the island, facing northwest. | |

| **Photo No. 12.** |  |
|---|---|
| **Date:**<br>September 16, 2020 | |
| **Description:**<br><br>View of the Cheat River looking across at the left descending bank downstream of the island, facing southwest. | |

| Client Name: | Site Location: | Project No. |
|---|---|---|
| Lake Lynn Generation LLC | Cheat River, Monongalia County, West Virginia and Fayette County, Pennsylvania | 282346.2020.000 |

| | |
|---|---|
| **Photo No. 13.** |  |
| **Date:** September 17, 2020 | |
| **Description:** Representative view of Site 3, facing west. | |

| | |
|---|---|
| **Photo No. 14.** |  |
| **Date:** September 17, 2020 | |
| **Description:** Representative view of Site 3 looking downstream, facing north. | |

| Client Name: | Site Location: | Project No. |
|---|---|---|
| Lake Lynn Generation LLC | Cheat River, Monongalia County, West Virginia and Fayette County, Pennsylvania | 282346.2020.000 |

**Photo No. 15.**

**Date:**
September 16, 2020

**Description:**

Representative view of Site 4, facing northwest.

**Photo No. 16.**

**Date:**
September 16, 2020

**Description:**

Representative view of Site 4, facing northwest.

| **Client Name:** Lake Lynn Generation LLC | **Site Location:** Cheat River, Monongalia County, West Virginia and Fayette County, Pennsylvania | **Project No.** 282346.2020.000 |
|---|---|---|

| | |
|---|---|
| **Photo No. 17.** |  |
| **Date:** September 16, 2020 | |
| **Description:** Substrate within Site 4. | |

| | |
|---|---|
| **Photo No. 18.** |  |
| **Date:** September 16, 2020 | |
| **Description:** Representative photo of acid mine drainage, downstream of Site 4, facing east. | |

| Client Name: | Site Location: | Project No. |
|---|---|---|
| Lake Lynn Generation LLC | Cheat River, Monongalia County, West Virginia and Fayette County, Pennsylvania | 282346.2020.000 |

| | |
|---|---|
| **Photo No. 19.** |  |
| **Date:** September 16, 2020 | |
| **Description:** Evidence of acid mine drainage, downstream of Site 4. | |

| | |
|---|---|
| **Photo No. 20.** |  |
| **Date:** September 16, 2020 | |
| **Description:** View of milky colored water with iron covered rocks, downstream of Site 4. | |

| | |
|---|---|
| **Photo No. 21.** |  |
| **Date:**<br>September 16, 2020 | |
| **Description:**<br><br>Representative view of Site 5 looking downstream, facing north. | |

| | |
|---|---|
| **Photo No. 22.** |  |
| **Date:**<br>September 16, 2020 | |
| **Description:**<br><br>Representative view of Site 5, looking at the left descending bank, facing southwest. | |

**Photo No. 23.**

**Date:**
September 16, 2020

**Description:**

View of substrate within Site 5.

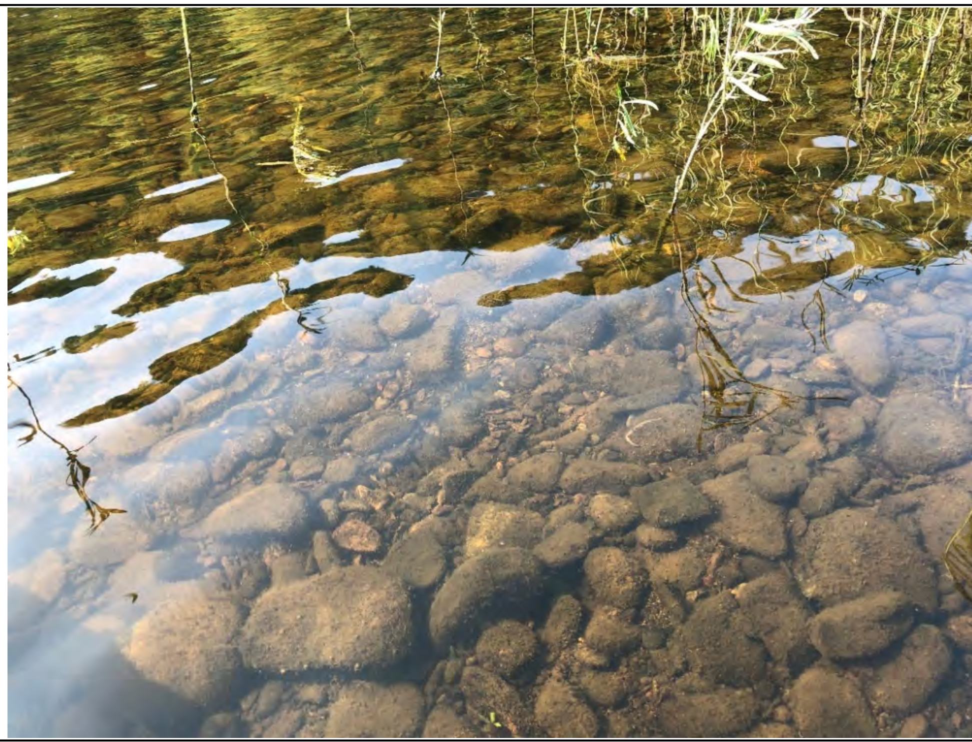

**Photo No. 24.**

**Date:**
September 16, 2020

**Description:**

Representative view of Site 5 looking downstream at right descending bank, facing northeast.

# PHOTOGRAPHIC RECORD

**Mussel Reconnaissance Scoping Survey**

Lake Lynn Hydroelectric Project (FERC No. P-2459)

| Client Name: | Site Location: | Project No. |
|---|---|---|
| Lake Lynn Generation LLC | Cheat River, Monongalia County, West Virginia and Fayette County, Pennsylvania | 380830.0000.0000 |

**Photo No. 25.**

**Date:**
September 16, 2020

**Description:**

Representative view of Site 5 looking downstream at left descending bank, facing northwest.

**Photo No. 26.**

**Date:**
September 16, 2020

**Description:**

Representative view of a riffle within Site 5 looking upstream, facing southeast.

| Client Name: | Site Location: | Project No. |
|---|---|---|
| Lake Lynn Generation LLC | Cheat River, Monongalia County, West Virginia and Fayette County, Pennsylvania | 380830.0000.0000 |

| | |
|---|---|
| **Photo No. 27.** |  |
| **Date:** September 17, 2020 | |
| **Description:** View of the right descending bank at Site 6, facing west. | |

| | |
|---|---|
| **Photo No. 28.** |  |
| **Date:** September 17, 2020 | |
| **Description:** Representative view of Site 6, facing west. | |

| **Client Name:** Lake Lynn Generation LLC | **Site Location:** Cheat River, Monongalia County, West Virginia and Fayette County, Pennsylvania | **Project No.** 380830.0000.0000 |
|---|---|---|

| **Photo No. 29.** | |
|---|---|
| **Date:** September 17, 2020 | |
| **Description:** Representative view of Site 6 looking downstream at the left descending bank, facing northwest. |  |

| **Photo No. 30.** | |
|---|---|
| **Date:** September 17, 2020 | |
| **Description:** Representative view of Site 6 looking upstream, facing east. |  |

# PHOTOGRAPHIC RECORD

**Mussel Reconnaissance Scoping Survey**

Lake Lynn Hydroelectric Project (FERC No. P-2459)

| Client Name: | Site Location: | Project No. |
|---|---|---|
| Lake Lynn Generation LLC | Cheat River, Monongalia County, West Virginia and Fayette County, Pennsylvania | 380830.0000.0000 |

| | |
|---|---|
| **Photo No. 31.** |  |
| **Date:** September 17, 2020 | |
| **Description:** View of substrate within Site 6. | |

| | |
|---|---|
| **Photo No. 32.** |  |
| **Date:** September 16, 2020 | |
| **Description:** Representative view of the island adjacent to Site 7, facing southwest. | |

| **Client Name:** | **Site Location:** | **Project No.** |
|---|---|---|
| Lake Lynn Generation LLC | Cheat River, Monongalia County, West Virginia and Fayette County, Pennsylvania | 380830.0000.0000 |

**Photo No. 33.**

**Date:** September 16, 2020

**Description:**

Representative view of Site 7 looking downstream, facing northwest.

**Photo No. 34.**

**Date:** September 16, 2020

**Description:**

Representative view of Site 7 looking upstream at the right descending bank, facing northeast.

# PHOTOGRAPHIC RECORD

## Mussel Reconnaissance Scoping Survey

Lake Lynn Hydroelectric Project (FERC No. P-2459)

| Client Name: | Site Location: | Project No. |
|---|---|---|
| Lake Lynn Generation LLC | Cheat River, Monongalia County, West Virginia and Fayette County, Pennsylvania | 380830.0000.0000 |

**Photo No. 35.**

**Date:**
September 16, 2020

**Description:**

View of substrate within Site 7.

**Photo No. 36.**

**Date:**
September 16, 2020

**Description:**

View of Site 8 looking upstream at a riffle, facing southeast.

**Photo No. 37.**

**Date:**
September 16, 2020

**Description:**

View of Site 8 looking across at the right descending bank, facing north.

**Photo No. 38.**

**Date:**
September 16, 2020

**Description:**

Representative view of the Cheat River approximately 1.5 miles downstream, looking downstream, facing west.

| Client Name: Lake Lynn Generation LLC | Site Location: Cheat River, Monongalia County, West Virginia and Fayette County, Pennsylvania | Project No. 380830.0000.0000 |
|---|---|---|

| Photo No. 39. | |
|---|---|
| Date: September 16, 2020 |  |
| Description: Representative view of the Cheat River approximately 1.5 miles downstream, looking at the left descending bank, facing southwest. | |

| Photo No. 40. | |
|---|---|
| Date: September 17, 2020 |  |
| Description: View of Site 9 looking downstream at the left descending bank, facing northwest. | |

# PHOTOGRAPHIC RECORD

**Mussel Reconnaissance Scoping Survey**

Lake Lynn Hydroelectric Project (FERC No. P-2459)

| **Client Name:** Lake Lynn Generation LLC | **Site Location:** Cheat River, Monongalia County, West Virginia and Fayette County, Pennsylvania | **Project No.** 380830.0000.0000 |
|---|---|---|

| **Photo No. 41.** |  |
|---|---|
| **Date:** September 17, 2020 | |
| **Description:** Representative view of Site 9 looking upstream, facing east. | |

| **Photo No. 42.** |  |
|---|---|
| **Date:** September 17, 2020 | |
| **Description:** View of Site 9 looking upstream along the left descending bank, facing southeast. | |

# PHOTOGRAPHIC RECORD

**Mussel Reconnaissance Scoping Survey**

Lake Lynn Hydroelectric Project (FERC No. P-2459)

| **Client Name:** | **Site Location:** | **Project No.** |
|---|---|---|
| Lake Lynn Generation LLC | Cheat River, Monongalia County, West Virginia and Fayette County, Pennsylvania | 380830.0000.0000 |

**Photo No. 43.**

**Date:** September 17, 2020

**Description:**

View from the downstream end of Site 9 looking downstream, facing northwest.

**Photo No. 44.**

**Date:** September 16, 2020

**Description:**

Representative view of Site 10, facing northwest.

**Photo No. 45.**

**Date:**
September 16, 2020

**Description:**

Representative view of Site 10 looking downstream, facing west.

**Photo No. 46.**

**Date:**
September 16, 2020

**Description:**

View of Site 10, facing north.

| | |
| --- | --- |
| **Photo No. 47.** |  |
| **Date:** September 16, 2020 | |
| **Description:** Representative view of the Cheat River approximately 2.9 miles downstream of the Project dam, looking downstream, facing west. | |

| | |
| --- | --- |
| **Photo No. 48.** |  |
| **Date:** September 16, 2020 | |
| **Description:** Representative view of the Cheat River approximately 2.9 miles downstream of the Project dam, looking downstream, facing west. | |

| **Photo No. 49.** | |
| --- | --- |
| **Date:** September 16, 2020 |  |
| **Description:** Representative view of the Cheat River approximately 3.1 miles downstream of the Project dam, looking downstream, facing west. | |

| **Photo No. 50.** | |
| --- | --- |
| **Date:** September 16, 2020 |  |
| **Description:** Representative view of the Cheat River approximately 3.1 miles downstream of the Project dam, looking upstream, facing east. | |

| | |
| --- | --- |
| **Photo No. 51.** |  |
| **Date:** September 16, 2020 | |
| **Description:** Representative view of the Cheat River approximately 3.5 miles downstream, at the mouth of the Monongahela River, facing south. | |

| | |
| --- | --- |
| **Photo No. 52.** |  |
| **Date:** September 17, 2020 | |
| **Description:** Representative view of the Cheat River approximately 1 mile downstream, facing northwest. | |

# PHOTOGRAPHIC RECORD

**Mussel Reconnaissance Scoping Survey**

Lake Lynn Hydroelectric Project (FERC No. P-2459)

| **Client Name:** | **Site Location:** | **Project No.** |
|---|---|---|
| Lake Lynn Generation LLC | Cheat River, Monongalia County, West Virginia and Fayette County, Pennsylvania | 380830.0000.0000 |

**Photo No. 53.**

**Date:**
September 17, 2020

**Description:**

Representative view of the Cheat River approximately 1.75 miles downstream, facing west.

**Photo No. 54.**

**Date:**
September 17, 2020

**Description:**

View of the left descending bank of the Cheat River approximately 2 miles downstream, facing south.

| **Client Name:** Lake Lynn Generation LLC | **Site Location:** Cheat River, Monongalia County, West Virginia and Fayette County, Pennsylvania | **Project No.** 380830.0000.0000 |
|---|---|---|

| **Photo No. 55.** |  |
|---|---|
| **Date:** September 17, 2020 | |
| **Description:** Representative view of Cheat River approximately 2 miles downstream, facing west. | |

| **Photo No. 56.** |  |
|---|---|
| **Date:** September 17, 2020 | |
| **Description:** View of the left descending bank at Site 11, facing south. | |

| **Client Name:** Lake Lynn Generation LLC | **Site Location:** Cheat River, Monongalia County, West Virginia and Fayette County, Pennsylvania | **Project No.** 380830.0000.0000 |
|---|---|---|

**Photo No. 57.**

**Date:** September 17, 2020

**Description:**

View of Site 11 looking upstream along the left descending bank, facing west.

**Photo No. 58.**

**Date:** September 17, 2020

**Description:**

View of Site 11 looking downstream along the left descending bank, facing southwest.

| | |
|---|---|
| **Photo No. 59.** |  |
| **Date:** September 17, 2020 | |
| **Description:** Relic shells found under the SR 119 bridge along the left descending bank approximately 1,000 feet from the mouth of the Monongahela River. | |

| | |
|---|---|
| **Photo No. 60.** |  |
| **Date:** September 17, 2020 | |
| **Description:** Representative photo of *Potamilus alatus* (Pink heelsplitter) found downstream of Site 12, near the mouth of the Monongahela River. | |

(e) United States Fish and Wildlife Service (USFWS). 2022. qPCR analysis of eDNA filter samples collected in 2021 at Lake Lynn Dam Target species: American Eel (Anguilla rostrata);

U.S. Fish & Wildlife Service

Northeast Fishery Center
Conservation Genetics Lab

**qPCR analysis of eDNA filter samples collected in 2021 at Lake Lynn Dam**
**Target species: American Eel (*Anguilla rostrata*)**

Christopher B. Rees, Lauren M. Atkins and Meredith L. Bartron
USFWS Northeast Fishery Center, Lamar, Pennsylvania

**Report prepared for:**
Janet Norman[1] and Rick McCorkle[2]
[1]U. S. Fish and Wildlife Service, Chesapeake Bay Field Office, Maryland
[2]U. S. Fish and Wildlife Service, Pennsylvania Field Office, State College, Pennsylvania

January 28, 2022

Photo credit: C. Rees (August 2, 2018)

## Introduction

This project was conducted to assess if the presence of American Eel DNA was detected in the downstream vicinity of the Lake Lynn hydroelectric dam on the Cheat River along the border of Pennsylvania and West Virginia. The sampling effort was to examine the logistics of collecting river water grab samples below Lake Lynn dam and to test the samples using two validated American Eel eDNA qPCR markers (*AME1* and *AME2*). Due to past sampling efforts resulting in no detection of American Eel eDNA, an additional qPCR marker was included to detect the presence of DNA from a common species at the site, Smallmouth Bass (*Micropterus dolomieu*), to confirm that detectable fish DNA could be captured and detected from the environmental samples. This sampling effort reflects sampling conducted in 2021 based on five sample sites and include both daytime and night-time collection in case movement of the species targeted for detection varied diurnally.

## Methods

### *Sample collection*

Five sites were sampled below the dam at Lake Lynn (Table 1) by Lake Lynn Generation staff or contractors on May 27, 2021, June 10, 2021, August 10, 2021, and September 8, 2021.

At each of the selected sampling sites, two-liter grab samples were collected by wading into the river or reaching from the river bank and placing a clean two-liter Nalgene bottle in the surface film while facing upriver. Lake Lynn Generation staff followed the recommended procedures outlined in an August 2018 training and sampling event so that samples were collected in each event in standardized fashion. It was recommended that sample collection progressed from downstream to upstream to limit contamination of downstream sites due to sampling gear or dislodged substrate. Immediately following collection of river water, one field blank (2 liters of distilled water) was filtered. Both environmental samples and field control samples were filtered through a 47mm glass fiber filter (1.5 µm pore size) inside the plant through use of a hand pump. Filtration proceeded until filters became clogged or the entire 2L sampled was filtered. In the event a filter clogged, the volume filtered was recorded and the filter sample was transferred to the filter tube and the rest of the grab sample was discarded. Filters were placed in a cooler with ice, temporarily stored at -20 °C at the power plant, shipped overnight to NEFC on ice packs, and stored at -80 °C until DNA extraction.

An additional sampling event occurred July 14, 2021, but during shipping the cooler was damaged, some samples were missing, and those received had thawed and were warm, so this shipment of filter samples was not processed.

Each sampling event included a field control sample (to test for contamination during filtration for both the day and night sampling events. Of all 2L grab samples collected, two resulted in the filtration of two distinct filters: sample LLG-21-028 and LLG-21-029, and sample LLG-21-047 and LLG-21-048. Each filter was extracted and analyzed separately.

*DNA Extractions*

Filters were extracted using the Qiagen DNeasy Blood and Tissue Kit (Qiagen Corporation, Valencia, CA) using modified filter extraction protocol following that of the U.S. Fish and Wildlife Service eDNA Quality Assurance Project Plan (QAPP) for filter samples (U.S. Fish and Wildlife Service, 2020). Samples were eluted with 200 µl of Buffer AE. Extractions were carried out in a dedicated DNA extraction room with mechanical controls/hoods to maintain a clean, contamination-free work environment.

Extractions were conducted in three batches, and with each batch, two negative extraction controls were extracted. One negative extraction control had no filter but otherwise included all extraction reagents to verify components of the extraction kit used were free of contamination. The second was a dry sterile filter to verify the filters used were free of contamination. Also included with each batch of extractions was one positive extraction control where 200 µl of American Eel DNA extracted from a fin clip was added directly to a sterile filter. All DNA extracts were stored at -20°C until quantitative PCR analysis.

*Quantitative PCR (qPCR) analysis*

Two fluorescent qPCR probe-based markers (Rees et al., in prep) were used for detection of American Eel DNA. One marker (*AME1*) is based in the ND2 region of the American Eel mitochondrial genome while the other marker (*AME2*) is based in the cytochrome B (cytB) region. An additional marker was used to test for the presence of DNA from a common species, Smallmouth Bass (*SMBCOI1*, developed by NEFC, Chris Rees) for a subset of samples from each sample date (n = 3-4 during each sampling event, Table 2) including samples collected during night and daylight. Use of an additional marker to test for the presence of DNA from a common species is useful to confirm that amplifiable DNA is present in the environmental samples and can be detected using the same methods used to detect DNA from the primary target species (in this case, American Eel). Use of multiple validated markers targeting different regions of the mitochondrial DNA of the target organism provides a secondary confirmation test or verification of eDNA detections (Farrington et al., 2015, Guan et al. 2019). Reaction conditions for qPCR analysis were: 500 nanoMolar each primer, 125 nanoMolar each qPCR probe, and 1x concentration of TaqMan® Environmental Master Mix 2.0 (Applied Biosystems™, Waltham, MA). Each probe (Applied Biosystems™, Waltham, MA) was either a TaqMan® MGB (minor groove binder) probe or a dual-quenched ZEN probe (Integrated DNA Technologies, Coralville, IA) each quenched with a non-fluorescent quencher on the 3’ end and labeled on the 5’ end with either 6-FAM or VIC. qPCR reactions were run in 20 µl volumes and included 17 µl of master mix/primer/probe mixture and 3ul of DNA template. All qPCR reactions were analyzed on an ABI ViiA7 PCR thermalcycler (Applied Biosystems™, Waltham, MA). Cycling conditions were based on manufacturer’s recommendations and carried out for 45 cycles.

Two synthetic double-stranded gBlock® DNA standards (Integrated DNA Technologies, Coralville, IA) was used to serve as positive qPCR control material, one for *AME1*/*AME2* and the other for *SMBCOI2*. The gBlock standard material was used at 1250 copies during qPCR amplification of environmental samples to verify efficient performance of both American Eel qPCR assays. Finally, American Eel and Smallmouth Bass fin clip DNA was included as additional qPCR positive control material for each marker analyzed.

*Inhibition Tests*

PCR inhibition was tested by running triplicate PCR reactions for all DNA extracts using the TaqMan® Exogenous IPC (Internal Positive Control) Reagents Kit (Applied Biosystems™, Waltham, MA) following the manufacturer's recommendations. qPCR IPC reactions were run in 20ul volumes and included 17ul of master mix/primer/probe mixture and 3ul of DNA template. All qPCR reactions were analyzed on an ABI ViiA7 PCR thermalcycler (Applied Biosystems™, Waltham, MA). Cycling conditions were based on manufacturer's recommendations and carried out for 40 cycles.

*Environmental Samples*

For each individual sample collected, 8 PCR replicates were performed per sample per marker. The negative and positive DNA extraction controls were also assayed in octet per marker. The qPCR positive controls were run in duplicate. Finally, negative qPCR controls were also included on each plate and run in quadruplicate per marker. Following PCR, *Ct* (cycle threshold or the cycle at which fluorescence signal rises above the background fluorescence level of a given qPCR assay) values were calculated. Each plate was checked for absence of amplification in negative control reactions and positive amplification in positive controls. Any environmental sample that resulted in a *Ct* value of <45 was considered positive for American Eel or Smallmouth Bass DNA.

**Results**

*qPCR Inhibition Tests*

The absence of PCR inhibition was verified for all environmental samples collected below Lake Lynn Dam. Inhibition was conducted on two separate PCR runs. Cycle threshold (*Ct*) values from all replicates for environmental samples during inhibition testing of plate 1 demonstrated a mean *Ct* of 26.57 and a standard deviation of 0.06 On plate 2, *Ct* values for all environmental samples demonstrated a mean of 26.15 and a standard deviation of 0.067. Taken together, no environmental samples fell outside of our scoring criteria for classifying a sample as inhibited (a positive shift of 1 cycle for an individual sample from the mean *Ct* of a plate of samples). None of the eDNA samples analyzed from the 2021 collection events from downstream of the Lake Lynn Dam demonstrated evidence of PCR inhibition.

*Environmental Samples*

For the filters collected below Lake Lynn Dam in 2021, all environmental samples were negative from the May, June, and September sampling events for the presence of American Eel DNA at both *AME1* and *AME2* qPCR markers (Table 2). Two samples from the August sampling event (LLG-21-026 and LLG-21-030, Table 2) were positive for American Eel eDNA. One sample (LLG-21-026, Table 2) was positive with 2 and 1 replicates at *AME1* and *AME2* respectively out of eight replicates per marker (Table 2), and the sample (LLG-21-030, Table 2) was positive with one replicate (of eight) for *AME1* only. The two positive detections were at different locations: the “island farbank” and “near powerhouse”, both samples were collected during daylight hours. The night sampling event at those locations was conducted just under four hours prior to the collection of the day samples, and no detections of American Eel eDNA were observed for those or other sites sampled on August 10, 2021.

A subset of samples was also analyzed for the presence of Smallmouth Bass DNA, and all but one (10 out of 11) tested samples were positive for the detection of Smallmouth Bass eDNA (Table 1). The eight field negative control samples did not amplify DNA for either American Eel or Smallmouth Bass DNA. All negative and positive qPCR and DNA extraction controls performed with expected results reflecting high integrity of the DNA samples and efficient performance of qPCR reactions.

**Summary**

American Eel eDNA was detected in environmental samples from one of the four sampling events during 2021 below the Lake Lynn Dam. These positive samples were collected during the daylight hours on August 10, 2021. Detection reflected a low quantity of American Eel eDNA present due to amplification of limited number of replicates, and lack of detection at the same sites less than four hours earlier in the day during the night sampling event. Use of a qPCR marker to test the same samples for the presence of a common species, Smallmouth Bass, confirmed that amplifiable DNA was present in all but one of the environmental samples analyzed (10 out of 11), with the inference that samples were handled in accordance with recommended sampling protocols and their quality was not compromised in such a way that would limit successful amplification of American Eel eDNA if it was present. In addition, all samples collected did not demonstrate PCR inhibition and other extraction and PCR negative and positive controls demonstrated expected results.

**References**

Farrington, H.L., Edwards, C.E., Guan, X., Carr, M.R., Baerwaldt, K., and Lance, R.F. (2015). Mitochondrial Genome Sequencing and Development of Genetic Markers for the Detection of DNA of Invasive Bighead and Silver Carp (*Hypophthalmichthys nobilis* and *H. molitrix*) in Environmental Water Samples from the United States. PLOS ONE *10*, e0117803.

Guan, X., Monroe, E.M., Bockrath, K.D., Rees, C.B., Baerwaldt, K.L., Nico, L.G., Lance, R.F. (2019). A suite of environmental DNA markers for the Black Carp, *Mylopharyngodon piceus,* in North America. Transactions of the American Fisheries Society, in press.

U.S. Fish and Wildlife Service (2020). Quality Assurance Project Plan.

Table 1. Site and sample metadata from samples collected below Lake Lynn Dam, from September 2019 to October 2020. If provided as part of the collection data, the time of collection and light condition are also included.

| NEFC ID | Field ID | Collection Date | Collection Time | Light Condition | Site Description |
|---|---|---|---|---|---|
| LLG-21-013 | LL1_2 | 5/27/2021 | 12:24 | Day | Control |
| LLG-21-014 | LL3-2_1 | 5/27/2021 | 10:53 | Day | Island, east bank |
| LLG-21-015 | LL2-2_1 | 5/27/2021 | 11:03 | Day | Near powerhouse |
| LLG-21-016 | LL4-2_1 | 5/27/2021 | 10:40 | Day | Island, far bank |
| LLG-21-017 | LL5-2_1 | 5/27/2021 | 10:21 | Day | East bank, downriver |
| LLG-21-018 | GR-2_1 | 5/27/2021 | 10:05 | Day | Furthest downstream, east bank |
| LLG-21-019 | GR-1_1 | 5/27/2021 | 5:08 | Night | Furthest downstream, east bank |
| LLG-21-020 | LL2-1_1 | 5/27/2021 | 5:50 | Night | Near powerhouse |
| LLG-21-021 | LL3-1_1 | 5/27/2021 | 5:40 | Night | Island, east bank |
| LLG-21-022 | LL5-1_1 | 5/27/2021 | 5:15 | Night | East bank, downriver |
| LLG-21-023 | LL4-1_1 | 5/27/2021 | 5:33 | Night | Island, far bank |
| LLG-21-024 | LL1_1 | 5/27/2021 | 8:28 | Night | Control |
| LLG-21-001 | LL1_3 | 6/10/2021 | 7:11 | Night | Control |
| LLG-21-002 | LL3-3_1 | 6/10/2021 | 4:56 | Night | Island, east bank |
| LLG-21-003 | LL4-3_1 | 6/10/2021 | 4:49 | Night | Island, far bank |
| LLG-21-004 | GR-3_1 | 6/10/2021 | 4:22 | Night | Furthest downstream, east bank |
| LLG-21-005 | LL2-3_1 | 6/10/2021 | 5:04 | Night | Near powerhouse |
| LLG-21-006 | LL5-3_1 | 6/10/2021 | 4:30 | Night | East bank, downriver |
| LLG-21-007 | LL3-4_1 | 6/10/2021 | 8:39 | Day | Island, east bank |
| LLG-21-008 | LL2-4_1 | 6/10/2021 | 8:52 | Day | Near powerhouse |
| LLG-21-009 | LL1_4 | 6/10/2021 | 10:16 | Day | Control |
| LLG-21-010 | LL4-4_1 | 6/10/2021 | 8:31 | Day | Island, far bank |
| LLG-21-011 | GR-4_1 | 6/10/2021 | 8:02 | Day | Furthest downstream, east bank |
| LLG-21-012 | LL5-4_1 | 6/10/2021 | 8:16 | Day | East bank, downriver |
| LLG-21-025 | LL5_8_1 | 8/10/2021 | 8:40 | Day | East bank, downriver |
| LLG-21-026 | LL4_8_1 | 8/10/2021 | 8:58 | Day | Island, far bank |
| LLG-21-027 | LL3_8_1 | 8/10/2021 | 9:04 | Day | Island, east bank |
| LLG-21-028 | GR_8_1 | 8/10/2021 | 8:30 | Day | Furthest downstream, east bank |
| LLG-21-029 | GR_8_2 | 8/10/2021 | 8:30 | Day | Furthest downstream, east bank |
| LLG-21-030 | LL2_8_1 | 8/10/2021 | 9:13 | Day | Near powerhouse |
| LLG-21-031 | LL1_8 | 8/10/2021 | 10:29 | Day | Control |
| LLG-21-032 | GR_7_1 | 8/10/2021 | 5:17 | Day | Furthest downstream, east bank |
| LLG-21-033 | GR_7_2 | 8/10/2021 | 5:17 | Night | Furthest downstream, east bank |
| LLG-21-034 | LL3_7_1 | 8/10/2021 | 5:33 | Night | Island, east bank |
| LLG-21-035 | LL2_7_1 | 8/10/2021 | 5:41 | Night | Near powerhouse |
| LLG-21-036 | LL4_7_1 | 8/10/2021 | 5:38 | Night | Island, far bank |
| LLG-21-037 | LL5_7_1 | 8/10/2021 | 5:23 | Night | East bank, downriver |
| LLG-21-038 | LL1_7 | 8/10/2021 | 7:37 | Night | Control |
| LLG-21-039 | GR_10_1 | 9/8/2021 | 8:20 | Day | Furthest downstream, east bank |

| | | | | | |
|---|---|---|---|---|---|
| LLG-21-040 | LL4_10_1 | 9/8/2021 | 8:56 | Day | Island, far bank |
| LLG-21-041 | LL2_10_1 | 9/8/2021 | 9:12 | Day | Near powerhouse |
| LLG-21-042 | LL5_10_1 | 9/8/2021 | 8:37 | Day | East bank, downriver |
| LLG-21-043 | LL3_10_1 | 9/8/2021 | 9:05 | Day | Island, east bank |
| LLG-21-044 | LL1_10 | 9/8/2021 | 10:29 | Day | Control |
| LLG-21-045 | LL2_9_1 | 9/8/2021 | 5:52 | Night | Near powerhouse |
| LLG-21-046 | LL4_9_1 | 9/8/2021 | 5:33 | Night | Island, far bank |
| LLG-21-047 | GR_9_1 | 9/8/2021 | 4:58 | Night | Furthest downstream, east bank |
| LLG-21-048 | GR_9_2 | 9/8/2021 | 4:58 | Night | Furthest downstream, east bank |
| LLG-21-049 | LL3_9_1 | 9/8/2021 | 5:43 | Night | Island, east bank |
| LLG-21-050 | LL5_9_1 | 9/8/2021 | 5:11 | Night | East bank, downriver |
| LLG-21-051 | LL1_9 | 9/8/2021 | 7:45 | Night | Control |

Table 2. qPCR results for American Eel detection using *AME1* and *AME2* markers, and Smallmouth Bass detection using *SMBCOI1* marker. Only a subset of samples was analyzed using the *SMBCOI1* marker as a confirmation of detection of Smallmouth Bass eDNA, but all samples below were analyzed with both *AME1* and *AME2* to test for the presence of American Eel eDNA. The number of replicates positive (out of eight replicates per marker) are indicated, and if any of the replicates were positive then the mean *Ct* (cycle threshold) value is indicated if the *Ct* value for a given sample was <45. If no replicates were positive, then no mean *Ct* is listed (-). Sample types were either environmental samples (ENV), or field control samples (FC).

| | | | | *AME1* | | *AME2* | | *SMBCOI1* | |
|---|---|---|---|---|---|---|---|---|---|
| NEFC ID | Site ID | Sample Type | Field ID | Replicates Positive | Mean Ct | Replicates Positive | Mean Ct | Replicates Positive | Mean Ct |
| LLG-21-013 | Control | FC | LL1_2 | 0 | - | 0 | - | | |
| LLG-21-014 | LL3-1 | ENV | LL3-2_1 | 0 | - | 0 | - | 8 | 37.1 |
| LLG-21-015 | LL2-1 | ENV | LL2-2_1 | 0 | - | 0 | - | | |
| LLG-21-016 | LL4-1 | ENV | LL4-2_1 | 0 | - | 0 | - | | |
| LLG-21-017 | LL5-1 | ENV | LL5-2_1 | 0 | - | 0 | - | | |
| LLG-21-018 | GR-1 | ENV | GR-2_1 | 0 | - | 0 | - | | |
| LLG-21-019 | GR-1 | ENV | GR-1_1 | 0 | - | 0 | - | | |
| LLG-21-020 | LL2-1 | ENV | LL2-1_1 | 0 | - | 0 | - | 8 | 35.1 |
| LLG-21-021 | LL3-1 | ENV | LL3-1_1 | 0 | - | 0 | - | | |
| LLG-21-022 | LL5-1 | ENV | LL5-1_1 | 0 | - | 0 | - | | |
| LLG-21-023 | LL4-1 | ENV | LL4-1_1 | 0 | - | 0 | - | 8 | 35.2 |
| LLG-21-024 | Control | FC | LL1_1 | 0 | - | 0 | - | | |
| LLG-21-001 | Control | FC | LL1_3 | 0 | - | 0 | - | | |
| LLG-21-002 | LL3-1 | ENV | LL3-3_1 | 0 | - | 0 | - | | |
| LLG-21-003 | LL4-1 | ENV | LL4-3_1 | 0 | - | 0 | - | | |
| LLG-21-004 | GR-1 | ENV | GR-3_1 | 0 | - | 0 | - | 8 | 34.9 |
| LLG-21-005 | LL2-1 | ENV | LL2-3_1 | 0 | - | 0 | - | | |
| LLG-21-006 | LL5-1 | ENV | LL5-3_1 | 0 | - | 0 | - | | |
| LLG-21-007 | LL3-1 | ENV | LL3-4_1 | 0 | - | 0 | - | | |
| LLG-21-008 | LL2-1 | ENV | LL2-4_1 | 0 | - | 0 | - | | |
| LLG-21-009 | Control | FC | LL1_4 | 0 | - | 0 | - | | |
| LLG-21-010 | LL4-1 | ENV | LL4-4_1 | 0 | - | 0 | - | 8 | 35 |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| LLG-21-011 | GR-1 | ENV | GR-4_1 | 0 | - | 0 | - | | |
| LLG-21-012 | LL5-1 | ENV | LL5-4_1 | 0 | - | 0 | - | | |
| LLG-21-025 | LL5-1 | ENV | LL5_8_1 | 0 | - | 0 | - | | |
| LLG-21-026 | LL4-1 | ENV | LL4_8_1 | 2 | 38.5 | 1 | 38.4 | 8 | 34.3 |
| LLG-21-027 | LL3-1 | ENV | LL3_8_1 | 0 | - | 0 | - | | |
| LLG-21-028 | GR-1 | ENV | GR_8_1 | 0 | - | 0 | - | | |
| LLG-21-029 | GR-1 | ENV | GR_8_2 | 0 | - | 0 | - | | |
| LLG-21-030 | LL2-1 | ENV | LL2_8_1 | 1 | 37.8 | 0 | - | 8 | 31.4 |
| LLG-21-031 | Control | FC | LL1_8 | 0 | - | 0 | - | | |
| LLG-21-032 | GR-1 | ENV | GR_7_1 | 0 | - | 0 | - | | |
| LLG-21-033 | GR-1 | ENV | GR_7_2 | 0 | - | 0 | - | | |
| LLG-21-034 | LL3-1 | ENV | LL3_7_1 | 0 | - | 0 | - | 8 | 33.7 |
| LLG-21-035 | LL2-1 | ENV | LL2_7_1 | 0 | - | 0 | - | | |
| LLG-21-036 | LL4-1 | ENV | LL4_7_1 | 0 | - | 0 | - | | |
| LLG-21-037 | LL5-1 | ENV | LL5_7_1 | 0 | - | 0 | - | | |
| LLG-21-038 | Control | FC | LL1_7 | 0 | - | 0 | - | | |
| LLG-21-039 | GR-1 | ENV | GR_10_1 | 0 | - | 0 | - | 0 | NA |
| LLG-21-040 | LL4-1 | ENV | LL4_10_1 | 0 | - | 0 | - | 6 | 37.6 |
| LLG-21-041 | LL2-1 | ENV | LL2_10_1 | 0 | - | 0 | - | | |
| LLG-21-042 | LL5-1 | ENV | LL5_10_1 | 0 | - | 0 | - | | |
| LLG-21-043 | LL3-1 | ENV | LL3_10_1 | 0 | - | 0 | - | | |
| LLG-21-044 | Control | FC | LL1_10 | 0 | - | 0 | - | | |
| LLG-21-045 | LL2-1 | ENV | LL2_9_1 | 0 | - | 0 | - | 3 | 39.5 |
| LLG-21-046 | LL4-1 | ENV | LL4_9_1 | 0 | - | 0 | - | | |
| LLG-21-047 | GR-1 | ENV | GR_9_1 | 0 | - | 0 | - | | |
| LLG-21-048 | GR-1 | ENV | GR_9_2 | 0 | - | 0 | - | | |
| LLG-21-049 | LL3-1 | ENV | LL3_9_1 | 0 | - | 0 | - | | |
| LLG-21-050 | LL5-1 | ENV | LL5_9_1 | 0 | - | 0 | - | | |
| LLG-21-051 | Control | FC | LL1_9 | 0 | - | 0 | - | | |
| NECK_10132021 | NEFC | NEC | Negative Control without Filter | 0 | - | 0 | - | | |
| NECBF_10132021 | NEFC | NEC | Negative Control with Blank Filter | 0 | - | 0 | - | | |
| PEC_10132021 | NEFC | PEC | Positive extraction control | 8 | 30.3 | 8 | 31.5 | | |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| NECBF_07212021 | NEFC | NEC | Negative Control with Blank Filter | 0 | - | 0 | - |
| NECK_07212021 | NEFC | NEC | Negative Control without Filter | 0 | - | 0 | - |
| PEC_07212021 | NEFC | PEC | Positive extraction control | 8 | 29.7 | 8 | 29.8 |
| NECK_08062021 | NEFC | NEC | Negative Control without Filter | 0 | - | 0 | - |
| NECBF_08062021 | NEFC | NEC | Negative Control with Blank Filter | 0 | - | 0 | - |
| PEC_08062021 | NEFC | PEC | Positive extraction control | 8 | 29.9 | 8 | 30.5 |

(f) Wellman, D., F. Jernejcic, and J. Hedrick. 2008. Biological monitoring of aquatic communities of Cheat Lake, and Cheat River downstream of the Lake Lynn Hydro Station, 2008;

# BIOLOGICAL MONTIORING OF AQUATIC COMMUNITIES OF CHEAT LAKE, AND CHEAT RIVER DOWNSTREAM OF THE LAKE LYNN HYDRO STATION, 2008

FERC PROJECT NUMBER 2459

Prepared by:
David Wellman, Frank Jernejcic, and Jim Hedrick
West Virginia Division of Natural Resources
Wildlife Resources Section

2008

# Table of Contents

# List of Tables

# List of Figures

# List of Appendix I Tables

# Chapter 1: Introduction and Study Area

## Introduction

The Federal Energy Regulatory Commission (FERC) issued a renewal license to Allegheny Energy Supply, LLC (AES) for the Lake Lynn Project in December 1994, for a term of 30 years. A biomonitoring study of the aquatic resources of Cheat Lake, Cheat Lake embayments, the Cheat Lake tailwaters, and the Cheat River downstream of the dam to the confluence with the Monongahela River was required by FERC under the new license agreement.

The new license agreement prescribed two article changes to the operation of the Lake Lynn Project. Article 403 specified that target reservoir water level ranges be maintained throughout the year. Lake elevations must be held between 868 and 870 ft from May to October to enhance recreation. Elevations can fluctuate between 857 and 870 ft from November to March and between 863 and 870 ft during April to enhance early spawning of fishes.

Article 404 implemented a 212 cubic feet per second (cfs) minimum flow release to mitigate poor water quality downstream from the project. No minimum flow was required prior to 1995 when acidic tributaries caused acidic conditions downstream of the project during low flow conditions.

The biological monitoring plan was established to monitor the status of the aquatic resources. The resource agencies suggested the licensee conduct biomonitoring for two consecutive years starting in 1997 and every three years thereafter. During 2004 the West Virginia Division of Natural Resources (WVDNR) established an agreement with AES to conduct and coordinate the biomonitoring study with the Pennsylvania Fish and Boat Commission (PAFBC). State agencies and AES agreed to modify the plan and evaluate the status and population dynamics of specific game fish species in addition to whole community biomonitoring.

Due to modifications, the biomonitoring study scheduled for 2004 was not conducted until 2005. Species-specific monitoring and/or community wide biomonitoring will be conducted annually through 2009. The modification also included detailed water quality analyses. These analyses will monitor and evaluate the annual impacts of acid mine drainage on the Cheat River downstream of the Lake Lynn project through 2009.

The modified biomonitoring plan was divided into two sections. The biomonitoring and species-specific evaluations in West Virginia waters were conducted by the WVDNR. A private environmental consultant conducted evaluations and monitoring downstream from the Lake Lynn project in Pennsylvania waters.

The WVDNR, PAFBC, and AES established the following proposed tasks to continue biomonitoring, investigate species-specific impacts, and address impacts and remediation of water quality issues. Tasks were divided into a Cheat River and Cheat tailwater component (Tasks 1 – 3) and a Cheat Lake and Cheat embayment component (Tasks 4 – 7).

1. Fish biomonitoring downstream of Cheat Lake
2. Benthic macroinvertebrate resource biomonitoring downstream of Cheat Lake
3. Water quality biomonitoring downstream of Cheat Lake
4. Fish biomonitoring of Cheat Lake and Cheat embayments
5. Walleye population monitoring and stock assessment
6. Monitoring of adult walleye movement
7. Physical and chemical water quality characteristics of Cheat Lake

Either the WVDNR or a private consultant conducted research to address each of these tasks. The following five-year timeline for completing specific tasks was originally proposed.

## Five-Year Timeline

| | Years | | | | |
|---|---|---|---|---|---|
| **Tasks** | **2005** | **2006** | **2007** | **2008** | **2009** |
| **Cheat River and Tailwater Components** | | | | | |
| Task 1: Fish Biomonitoring Tailwater and Cheat River | | | | | |
| Task 2: Benthic Biomonitoring Tailwater and Cheat River | | | | | |
| Task 3: Water Quality Biomonitoring Tailwater and Cheat River | | | | | |
| **Cheat Lake and Embayment Components** | | | | | |
| Task 4: Fish Biomonitoring Cheat Lake and Embayments | | | | | |
| Task 5: Walleye Stocking Assessment | | | | | |
| Task 6: Adult Walleye Movement | | | | | |
| Task 7: Physical and Chemical Water Quality Characteristics | | | | | |

Research Environmental Industrial Consultant Inc. (REIC) conducted previous biomonitoring studies during 1997, 1998, and 2001. The WVDNR utilized information from these previous studies to monitor trends associated with the fisheries resources in Cheat Lake. Therefore, most analyses incorporate previous fisheries resource information and comparisons with the current study. The development of the 2005 work plan resulted in a name change for most stations investigated in previous studies. Therefore, careful attention should be given when attempting to make direct comparisons to previous studies (Table 1).

## Study Area Description

The Lake Lynn Hydro Project is located on Cheat River in Monongalia County, West Virginia (Figure 1). The hydro station is located on the Pennsylvania and West Virginia border and is 3.7 miles upstream from the confluence of the Cheat River with the Monongahela River. The concrete gravity-type dam is 1,000-ft long, 125-ft high and impounds 1,730 acres at an elevation of 870 feet. Maximum depth is about 90 feet near the dam. Four turbines, with a maximum output flow of 9,700 cfs, produce power and 26 tainter gates regulate additional discharge.

Cheat Lake was divided into three major study areas: the Cheat embayments (Rubles Run – 56 acres, and Morgan Run – 37 acres); lower Cheat Lake, downstream of I-68 bridge to Lake Lynn hydro station; and upper Cheat Lake upstream of the I-68 bridge to the headwaters. The 3.7-mile section of Cheat River downstream from the hydro station was defined as the Cheat tailwater area located in the first 1.1 miles, and Cheat River between the Cheat tailwater area and the confluence of Cheat River with the Monongahela River (lower 2.6 miles).

**Table 1.** Station name conversion key for comparison of 2005 biomonitoring study with previous investigations.

| **Cheat Lake and Embayments** | | **Cheat River** | | **Cheat Tailwater** | |
|---|---|---|---|---|---|
| Previous Station Name | New Station Name | Previous Station Name | New Station Name | Previous Station Name | New Station Name |
| 52C | E1 | 53A | R1 | 1 | T1 |
| 52D | E2 | 53B | R2 | 2 | T2 |
| 52L | L1 | 53C | R3 | 3 | T3 |
| 52I | L2 | | | NA | T4 |
| 52B | L3 | | | 5 | T5 |
| NA | L4 | | | 7A | T6 |
| NA | L5 | | | 8A | T7A |
| 51A | L6 | | | 8B | T7B |
| 52K | W1 | | | | |
| 52J | W2 | | | | |
| 51A | W3 | | | | |

# Cheat Lake, Monongalia County, West Virginia

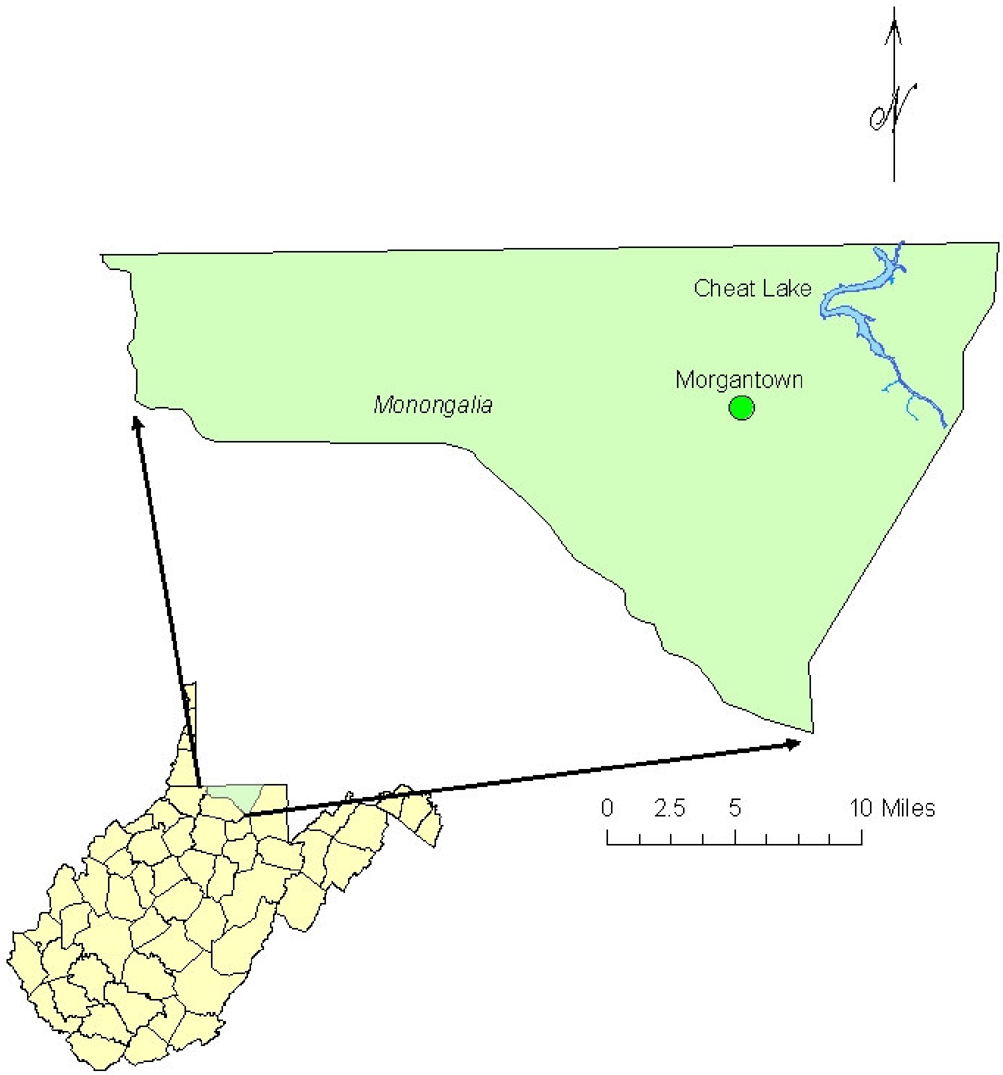


**Figure 1.** The Lake Lynn Hydro Project is located on Cheat Lake in Monongalia County, West Virginia. The hydro station is located on the Pennsylvania and West Virginia border and is 3.7 miles upstream from the confluence of the Cheat River with the Monongahela River.

# Chapter 2: Fish and Benthic Biomonitoring in Tailwaters and Downstream (Tasks 1-2)

Ecological Restoration, Inc. conducted surveys and investigations for Cheat River and Cheat tailwater. Sampling procedures and protocols can be found in the document entitled "Biological monitoring of the aquatic communities of the Cheat River downstream of the Lake Lynn Hydro Station; 2008 study" (Attachment 1).

# Chapter 3: Water Quality Monitoring of Cheat River (Task 3)

## Introduction

Monitoring for pH, conductivity, and temperature was established by the WVDNR, PAFBC, and AES to address impacts and remediation of water quality issues downstream of Cheat Lake dam. During periods of low flow from Cheat Lake, acid tributaries downstream of Cheat Lake drastically reduce Cheat River's pH, which limits fish movement into the Cheat tailwater and could impact the fishery from the hydro station to the confluence with Monongahela River.

## Methods

Temperature, conductivity, and pH were monitored from January through December at 30-minute intervals with three YSI Model 600 XLM continuous water quality monitors in Cheat River 1-mile downstream of Grassy Run, at the head of Cheat Lake, and at Albright on Cheat River (Figures 2 and 3). Monitoring was also conducted at the head of Cheat Lake and at Albright to determine the quality of water entering Cheat Lake. Monitors were cleaned, calibrated, and data were downloaded on a bi-monthly basis. Continuous water quality data was not collected in Grassy Run because the monitor was stolen in 2007.

Water samples were collected bi-monthly from the Cheat Lake tailwater, Grassy Run, and Cheat River downstream of Grassy Run (Figure 2). Water quality analyses were conducted at the National Research Center for Coal and Energy Analytical Laboratory at West Virginia University in Morgantown. The following parameters were measured: pH, alkalinity, acidity, conductivity, total aluminum (T. Al), dissolved aluminum (D. Al), calcium (Ca), magnesium (Mg), total iron (T. Fe), dissolved iron (D. Fe), dissolved manganese (D. Mn), total dissolved solids (TDS), total suspended solids (TSS), and hardness. A staff gauge placed in Grassy Run during 2006 was used to calculate stream flow. Acidity loads (lbs/day) were calculated on days water samples were collected.

## Results

### Grassy Run

From March through October, five water samples were taken from Grassy Run (Table 2). pH ranged from 3.1 to 3.8 and averaged 3.5. For all samples, alkalinity was 0. Conductivity averaged 1,606 µs/cm and ranged from 1,327 to 2,090 µs/cm. Acidity ranged from 178 to 336 mg/l and averaged 256 mg/l. Flow was either too high (spring) or low (summer/fall) to estimate on 3 of the 5 water sample dates with the 2006 staff gage rating.

Consequently, acid loads were only calculated for 2 of the 5 water samples (Table 3). Acid loads were 9,892 and 11,456 lbs/day.

## Cheat River Downstream of Grassy Run

From March through October, five water samples were collected downstream of Grassy Run to measure impacts on Cheat River (Table 4). pH ranged from 3.2 to 6.6 and averaged 4.4. Alkalinity for all samples was 0, except for one sample of 8 mg/l. Conductivity ranged from 141 to 1,719 µs/cm and averaged 983 µs/cm. Acidity ranged from 4 to 248 mg/l and averaged 148 mg/l.

Water quality monitoring (30-minute intervals) was also conducted from January through November 2008 in Cheat River downstream of Grassy Run with an YSI instrument. The YSI was out of service for maintenance from March 7 through April 22.

From January through October, the water temperature in the Cheat River downstream of Grassy Run averaged 60$^{o}$F and ranged from 34 to 92$^{o}$F (Table 5). The pH in Cheat River averaged 5.7 and ranged from 3.6 to 7.0. pH values <6.0 occurred on 55% of the days from January through the end of October. Specific conductivity averaged 203 µs/cm and ranged from 23 to 807 µs/cm.

Temperature, pH and conductivity varied widely on a daily basis depending on discharge fluctuations from Cheat Lake dam (Figures 4-6). Consequently, the influence of low pH flows from Grassy Run on Cheat River is most pronounced during minimum discharges from the dam. pH values at the Cheat River monitoring site were compared to the river stage at the tailwater. A recorded pH value of less than 4 on March 12, 2006 was used as an example (Figure 7). pH values of Cheat River drop with a lag time following reductions in river stage. The low pH values in Cheat River during times of minimum discharges from the hydro station and/or at low summer flows could potentially be a barrier to fish movement from the Monongahela River upstream to the Cheat Lake tailwater.

AES deployed a water quality monitor from April 1 to October 31 at the Cheat Lake tailwater and a second monitor 1.5 miles downstream on river left, downstream of the WVDNR monitor. The YSI monitors were deployed by the WVDNR. Review of AES data downstream of Grassy Run revealed that pH values <6.0 occurred on 43% of the days from April through September. During this period, minimum daily pH values were about 1 pH unit less than at the Cheat tailwater upstream. When combined with the low pH values measured on river right from Grassy run, a potential river-wide barrier to the upstream movement of fish from the Monongahela River exists during low tailwater flows.

## Cheat Tailwater

Five samples were collected from the Cheat tailwater from March through October to evaluate water quality upstream of the acid mine drainage tributaries on Cheat River (Table 6). pH ranged from 4.2 to 7.0 and averaged 5.8. Alkalinity ranged from 0 to 38 and averaged 18 mg/l. Conductivity ranged from 102 to 1,599 µs/cm and averaged 424 µs/cm. Acidity ranged from 1 to 133 mg/l and averaged 46 mg/l.

## Head of Cheat Lake

Water quality monitoring (30-minute intervals) was conducted with a YSI from January through December 2008 in Cheat River approximately 0.5-mile upstream of Cheat Lake (Figures 8 – 10). From January through December, the water temperature in the Cheat River averaged 55°F and ranged from 32 to 88°F (Table 5). Specific conductivity averaged 136 µs/cm and ranged from 41 to 295 µs/cm. The pH in Cheat River averaged 6.7 and ranged from 5.4 to 7.3. pH values <6.0 occurred on 15 of 317 (5%) recorded days from January through December. This pH depression occurred from October 18 – 31, during the lowest flows of the year, and was the first time a pH depression of this magnitude has been recorded since data collection began in 2004. Provisional data recorded at the U.S. Geological Survey's Rowlesburg gage station indicates that mean monthly flow for October 2008 (Figure 11) was the second lowest value of any month for this station over the past 10 years. To a lesser degree, pH depressions occurred in January and February during periods of high flow (Figure 11).

## Cheat River at Albright

Water quality monitoring (30-minute intervals) was conducted from January through June 2008 in Cheat River approximately 14 miles upstream of the head of Cheat Lake with a YSI instrument. The YSI was either stolen or lost sometime after June 22. From January through June, the water temperature in the Cheat River averaged 52°F and ranged from 32 to 87°F (Table 5). The pH in Cheat River averaged 6.9 and ranged from 6.4 to 7.3. Specific conductivity averaged 81 µS/cm and ranged from 41 to 153 µS/cm. In contrast to Cheat River downstream of Grassy Run, temperature, pH and conductivity values were stable on a daily basis (Figures 12-14).

## Conclusions

Continuous water quality monitoring of Grassy Run and Cheat River downstream of Cheat Lake dam indicates the potential for low pH conditions could block seasonal upstream fish movement from Monongahela River to the Cheat Lake tailwater at certain times of the year. Acid loads calculated from Grassy Run reveal that several tons of acid per year are entering Cheat River. AMD tributaries on the opposite side of Cheat River could also limit movement of fish into the Cheat tailwater, but to a lesser degree than Grassy Run. This information should be used by state agencies to develop AMD treatment options for improving water quality in Cheat River. Improving water quality, will improve not only the fisheries in Cheat tailwater, but the entire reach between the dam and its confluence with Monongahela River.

Water quality entering Cheat Lake (Table 5) is better than what is exiting Cheat Lake (Table 6). Typically, pH is 1.0 unit higher at the head of Cheat Lake than at the Cheat tailwater. This indicates that AMD sources existing within Cheat Lake are negatively impacting the water quality. AMD impacts to the aquatic community of Cheat Lake have not been quantified.

Conductivity and pH results of grab samples were similar to those observed with the continuous monitors. However, infrequent grab samples failed to measure pH lows and conductivity highs that were recorded by the continuous monitoring.

**Table 2.** Water quality analyses for Grassy Run, March through October, 2008. *T ≤0.5

| Sample Date | pH | Alk mg/L | Acidity mg/L | Cond µS/cm | T. Al mg/L | D. Al mg/L | Ca mg/L | Mg mg/L | T. Fe mg/L | D. Fe mg/L | D. Mn mg/L | SO4 mg/L | TDS mg/L | TSS mg/L | Hardness mg/L |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 13-Mar | 3.6 | 0 | 336 | 1435 | 15 | 15 | 101 | . | 8 | 4 | 1 | . | 878 | 74 | 421 |
| 29-Apr | 3.2 | 0 | 178 | 1459 | 11 | 10 | 87 | . | 12 | 2 | 1 | . | 910 | 32 | 343 |
| 26-Jun | 3.8 | 0 | 248 | 1719 | 18 | 19 | 143 | 47 | 14 | 14 | 2 | 774 | . | . | 550 |
| 5-Aug | 3.6 | 0 | 216 | 1327 | 9 | 8 | 142 | 39 | 11 | 3 | 1 | 570 | . | . | 513 |
| 24-Oct | 3.1 | 0 | 305 | 2090 | 32.8 | 19 | 276 | 81 | 25 | 16 | 2 | 1054 | . | . | 1017 |
| **Mean** | 3.5 | 0 | 256 | 1606 | 17 | 14 | 150 | 56 | 14 | 8 | 1 | 799 | 894 | 53 | 569 |
| **Std. Deviation** | 0.3 | 0 | 64 | 306 | 9 | 5 | 75 | 22 | 7 | 7 | 0 | 243 | 23 | 30 | 263 |

**Table 3.** Acid loads from Grassy Run, March through October, 2008.

| Acidity Sample Date | Flow cfs | Acidity mg/l | Acidity lbs/day |
|---|---|---|---|
| 13-Mar | NA | 336 | NA |
| 29-Apr | 10.31 | 178 | 9,892 |
| 26-Jun | NA | 248 | NA |
| 5-Aug | 9.84 | 216 | 11,456 |
| 24-Oct | NA | 305 | NA |

NA: flow was either too high or low for a satisfactory flow estimate based on the 2006 staff gage rating.

**Table 4.** Water quality analyses Cheat River downstream of Grassy Run, March through October, 2008. *T ≤ 0.5

| Sample Date | pH | Alk mg/L | Acidity mg/L | Cond µS/cm | T. Al mg/L | D. Al mg/L | Ca mg/L | Mg mg/L | T. Fe mg/L | D. Fe mg/L | D. Mn mg/L | SO4 mg/L | TDS mg/L | TSS mg/L | Hardness mg/L |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 13-Mar | 4.6 | 0 | 92 | 141 | * | * | 12 | . | * | * | * | . | 66 | 30 | 45 |
| 29-Apr | 3.2 | 0 | 178 | 1459 | 11.1 | 10.4 | 88 | . | 12 | 2.2 | 1.1 | . | 910 | 32 | 343 |
| 26-Jun | 3.8 | 0 | 248 | 1719 | 18.3 | 18.7 | 143 | 47 | 14 | 14.3 | 1.8 | 774 | . | . | 550 |
| 5-Aug | 3.6 | 0 | 216 | 1327 | 9.2 | 7.7 | 142 | 39 | 11.2 | 2.7 | 1 | 570 | . | . | 513 |
| 24-Oct | 6.6 | 8 | 4 | 271 | 2 | * | 33 | 8 | 1 | 0 | 0 | 69 | . | . | 122 |
| **Mean** | 4.4 | 2 | 148 | 983 | 10 | 12 | 84 | 31 | 9 | 5 | 1 | 471 | 488 | 31 | 315 |
| **Std. Deviation** | 1.3 | 4 | 99 | 725 | 7 | 6 | 60 | 21 | 6 | 6 | 1 | 363 | 597 | 1 | 227 |

**Table 5.** Yearly mean, maximum, and minimum values for YSI monitors in 2008. Measurements taken in 30-minute intervals.

| Parameter | Mean | Maximum | Minimum |
|---|---|---|---|
| | **Cheat River Downstream of Grassy Run** | | |
| **Temperature, F** | 60 | 92 | 34 |
| **pH** | 5.7 | 7.0 | 3.6 |
| **Specific conductivity, µS/cm** | 203 | 807 | 23 |
| | **Head of Cheat Lake** | | |
| **Temperature, F** | 55 | 88 | 32 |
| **pH** | 6.7 | 7.3 | 5.4 |
| **Specific conductivity µS/cm** | 136 | 295 | 41 |
| | **Cheat River at Albright*** | | |
| **Temperature, F** | 52 | 87 | 32 |
| **pH** | 6.9 | 7.3 | 6.4 |
| **Specific conductivity, µS/cm** | 81 | 153 | 41 |

* Data only recorded from January 1 through June 22, 2008 due to loss of YSI.

**Table 6.** Water quality analyses of the Cheat tailwater, January through October, 2008. *T ≤ 0.5

| Sample Date | pH | Alk mg/L | Acidity mg/L | Cond µS/cm | T. Al mg/L | D. Al mg/L | Ca mg/L | Mg mg/L | T. Fe mg/L | D. Fe mg/L | D. Mn mg/L | SO4 mg/L | TDS mg/L | TSS mg/L | Hardness mg/L |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 13-Mar | 4.2 | 0 | 92 | 102 | * | * | * | . | * | * | * | . | 0 | 30 | 30 |
| 29-Apr | 6.3 | 16 | 1 | 106 | * | * | 8 | . | * | * | * | . | 70 | 28 | 27 |
| 26-Jun | 6.1 | 17 | 3 | 125 | * | * | 13 | 3 | * | * | * | 28 | . | . | 44 |
| 5-Aug | 5.2 | 38 | 133 | 1599 | * | * | 10 | 4 | * | * | * | 42 | . | . | 40 |
| 24-Oct | 7.0 | 20 | 0 | 187 | * | * | 23 | 5 | * | * | * | 33 | . | . | 75 |
| **Mean** | 5.8 | 18 | 46 | 424 | * | * | 13 | 4 | * | * | * | 34 | 35 | 29 | 43 |
| **Std. Deviation** | 1.1 | 14 | 63 | 658 | * | * | 6 | 1 | * | * | * | 7 | 49 | 1 | 19 |

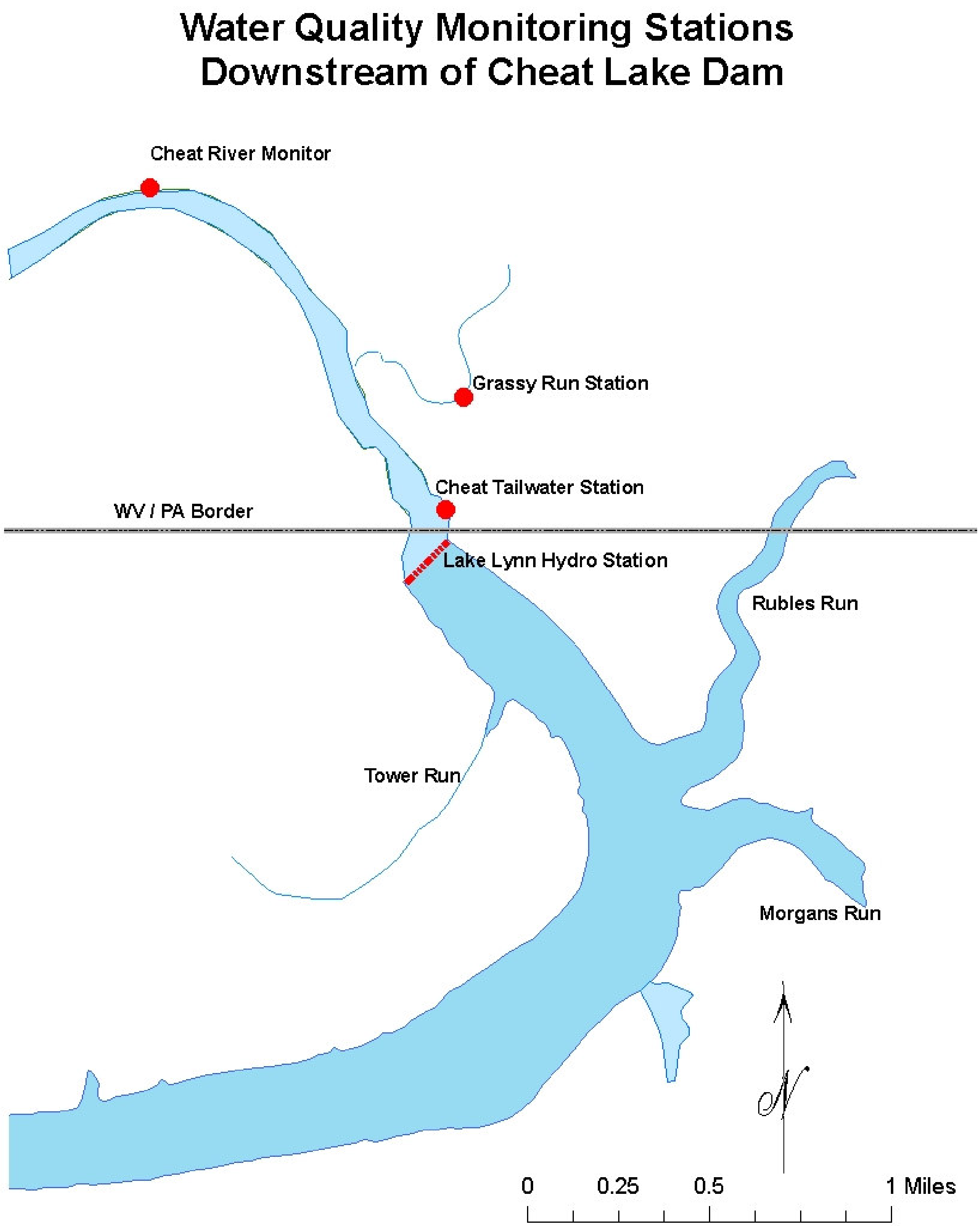


**Figure 2.** Approximate locations of WVDNR water quality stations on Cheat Lake tailwater, Grassy Run, and Cheat River downstream of tailwater.

# Continuous Water Quality Monitors Upstream of Cheat Lake

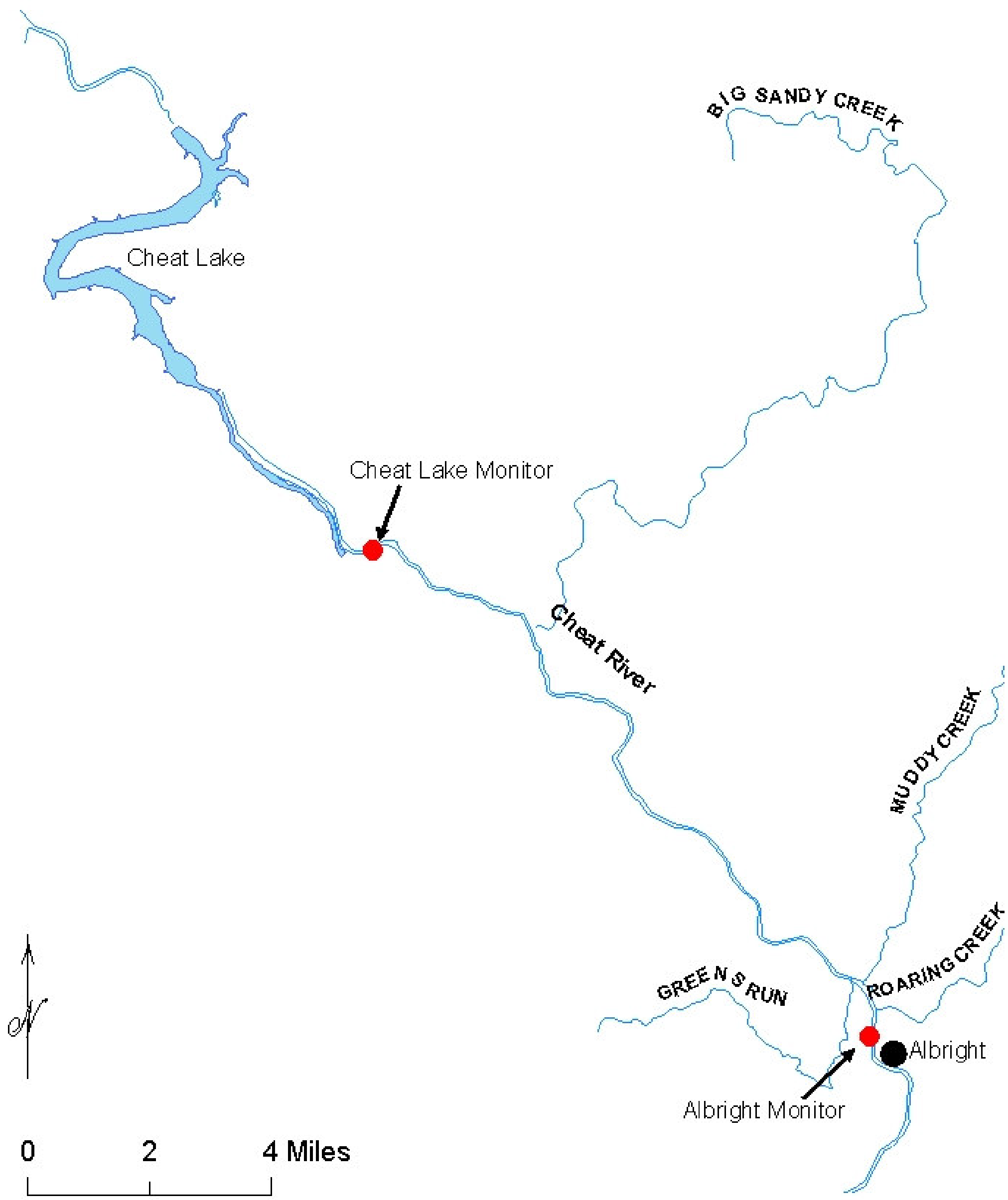


**Figure 3.** Approximate locations of WVDNR continuous water quality monitors upstream of Cheat Lake, 2008.

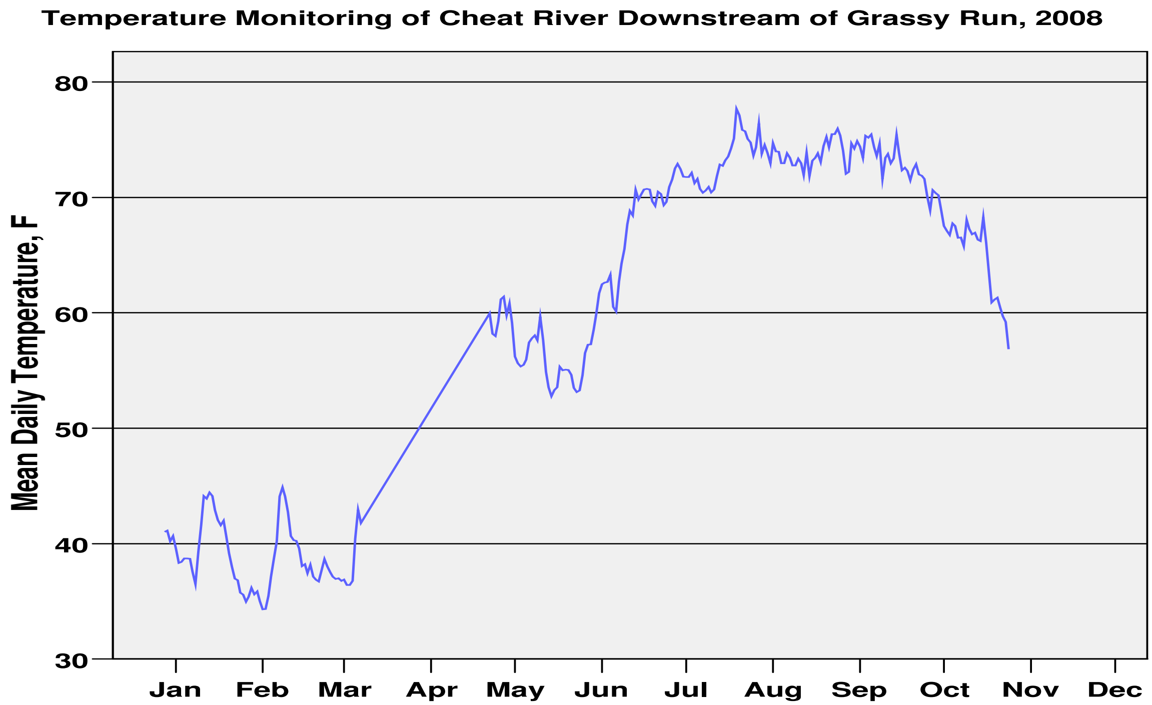


**Figure 4.** Mean daily temperature in Cheat River downstream of Grassy Run, January - November, 2008.

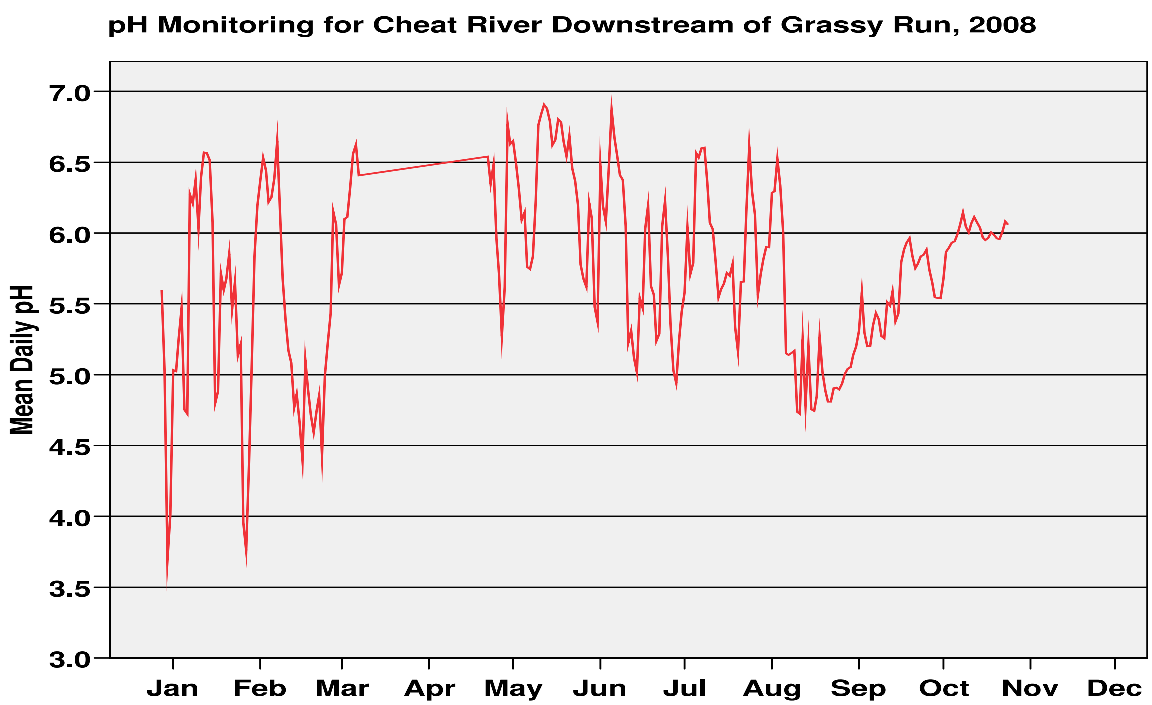


**Figure 5.** Mean daily pH in Cheat River downstream of Grassy Run, January - November, 2008.

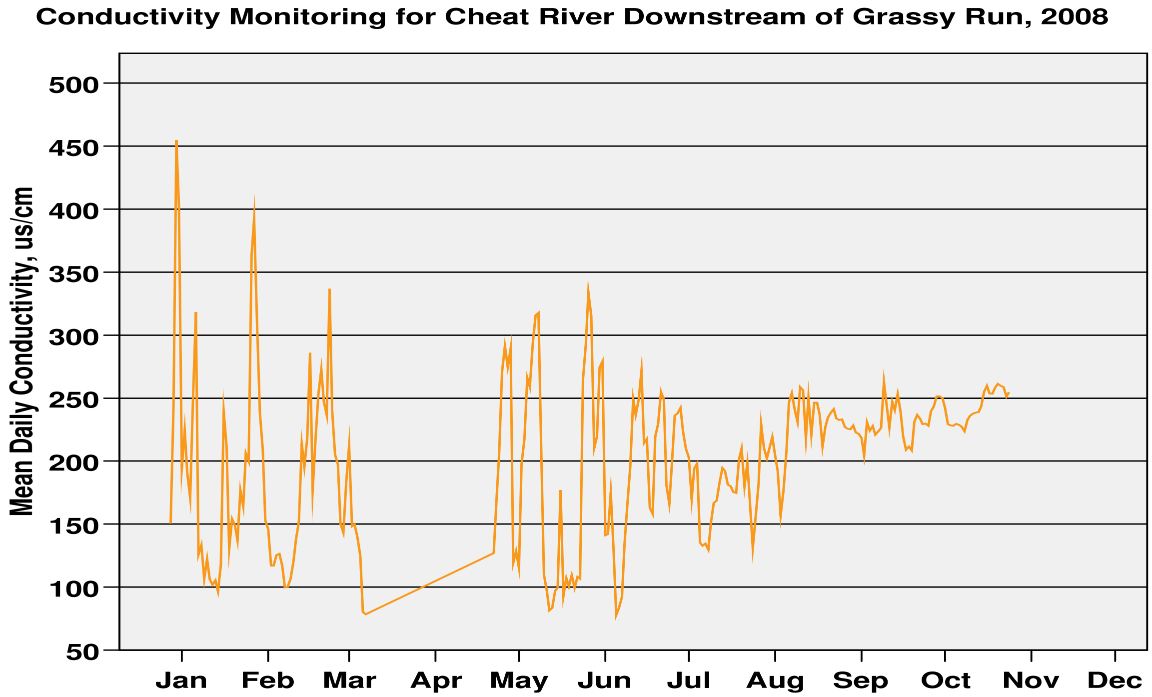


**Figure 6.** Mean daily conductivity in Cheat River downstream of Grassy Run, January - November, 2008.

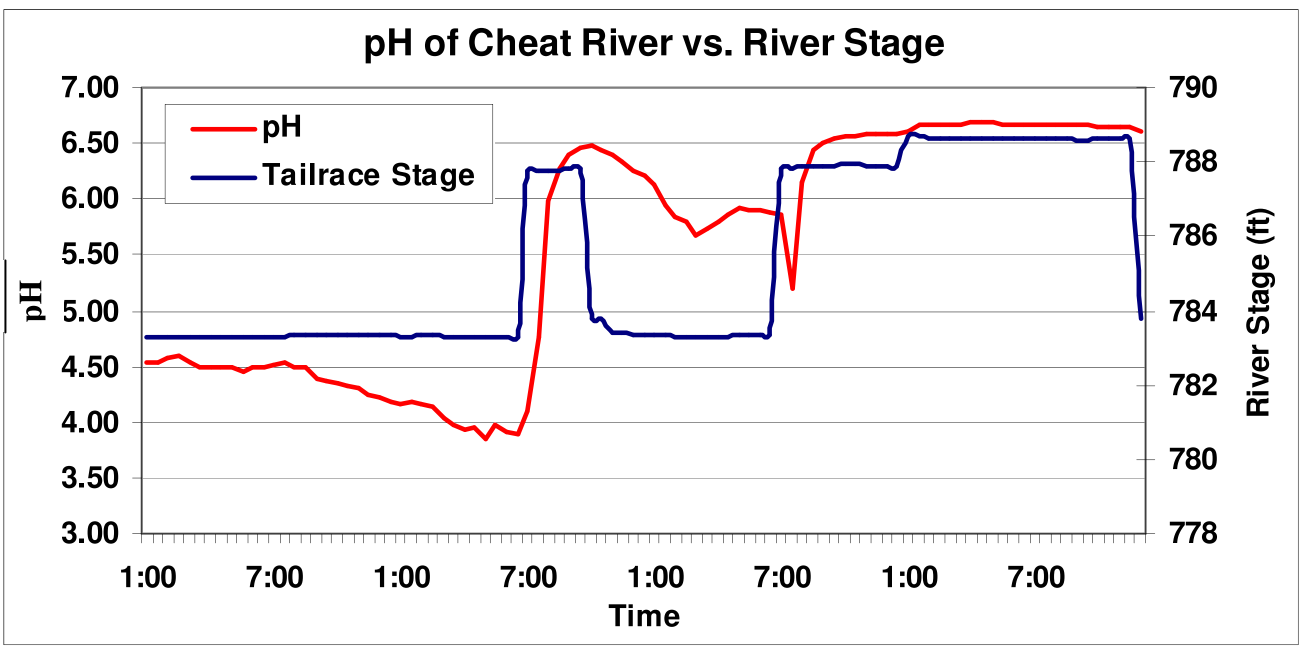


**Figure 7.** pH of Cheat River downstream of Grassy Run vs. river stage at Cheat tailwater, March 12 – 13, 2006.

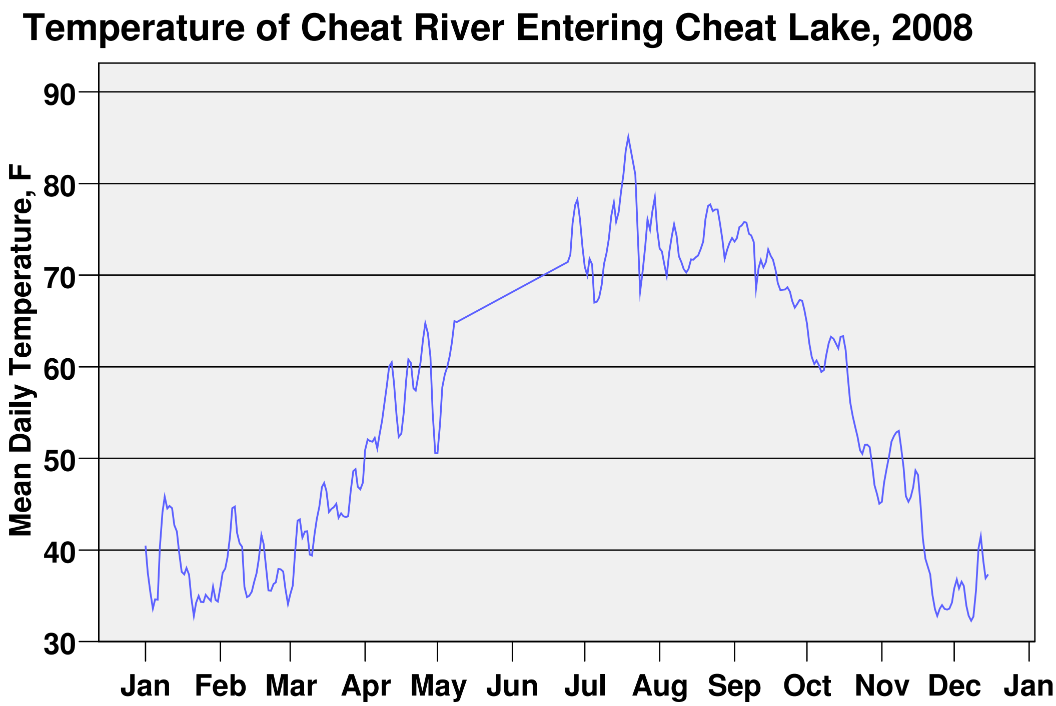


**Figure 8.** Mean daily temperatures of Cheat River entering Cheat Lake, January – December, 2008. The straight line from May to June indicates no data recording.

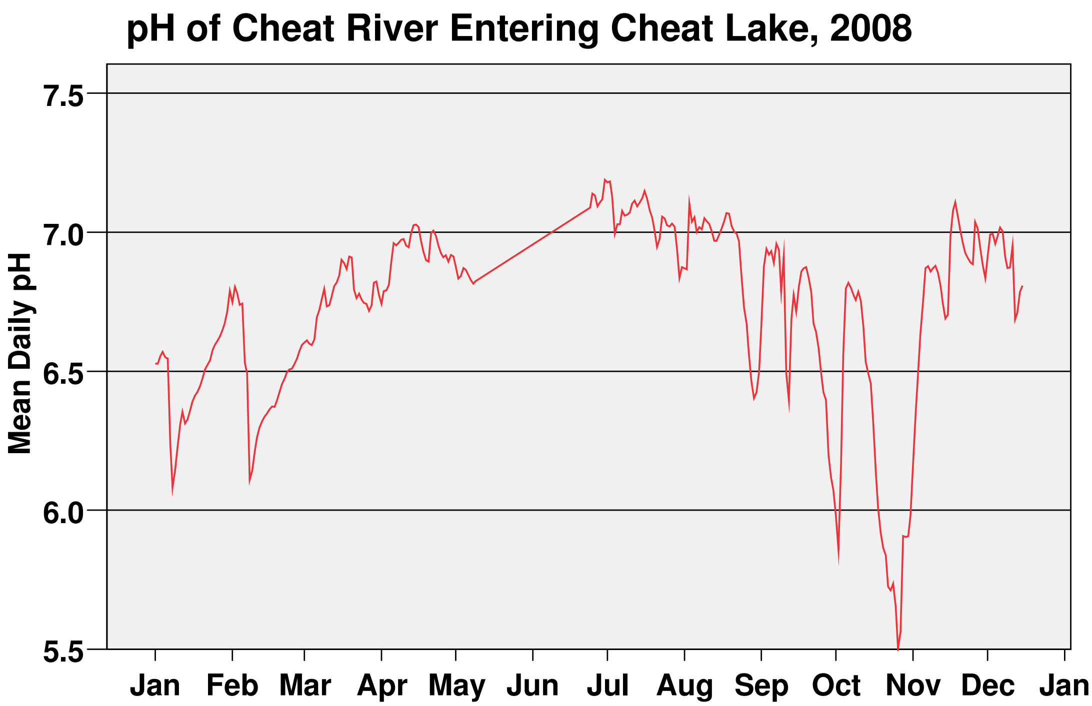


**Figure 9.** Mean daily pH of Cheat River entering Cheat Lake, January – December, 2008. The straight line from May to June indicates no data recording.

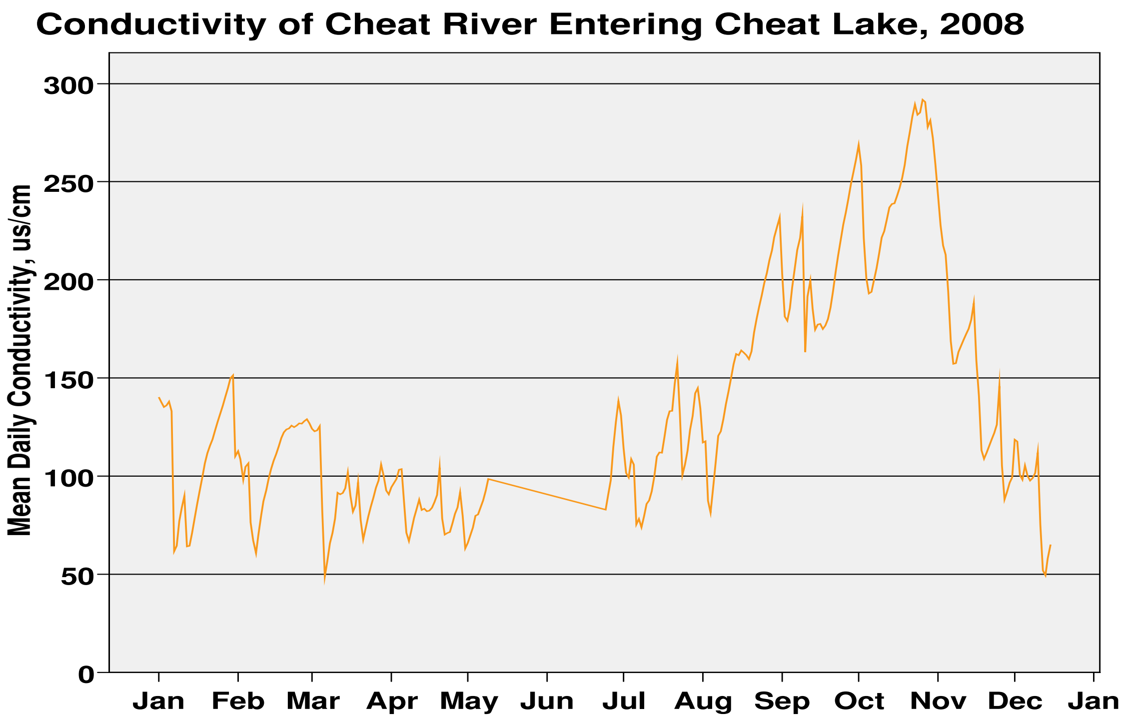


**Figure 10.** Mean daily conductivity of Cheat River entering Cheat Lake, January – December, 2008. The straight line from May to June indicates no data recording.

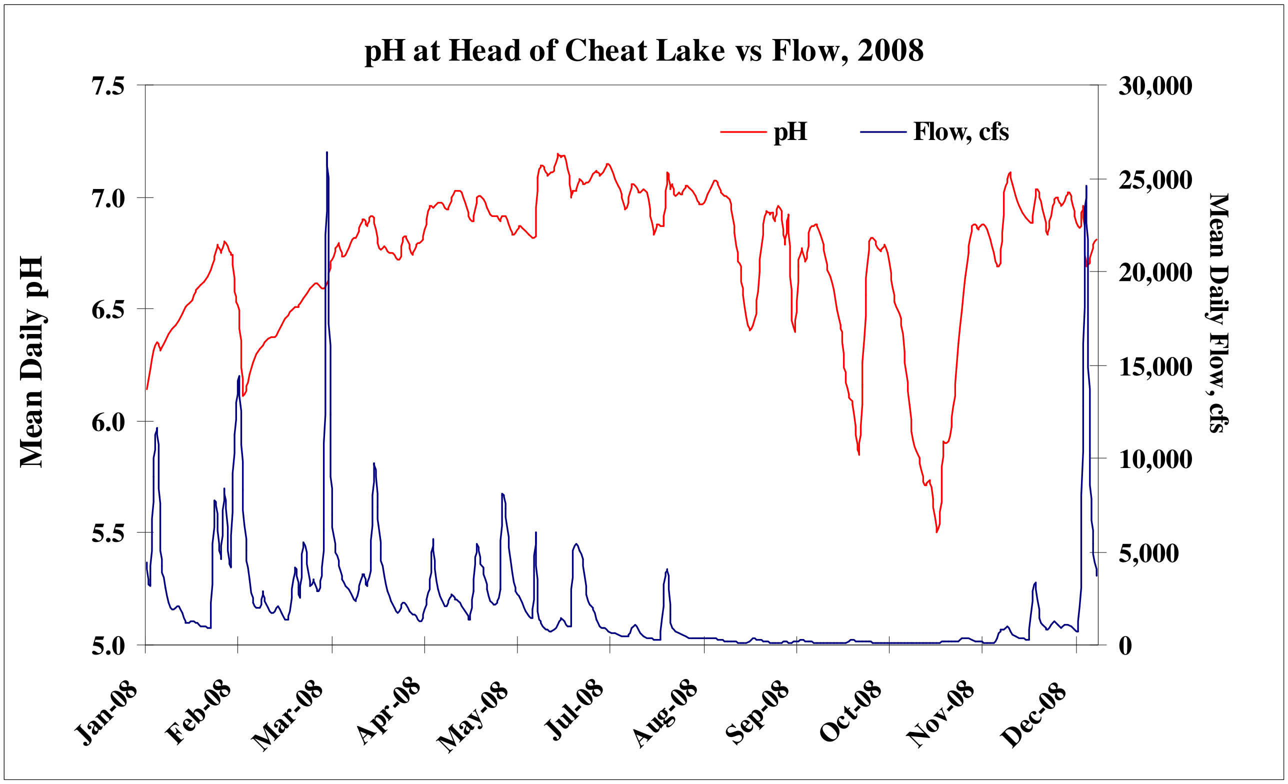


**Figure 11.** Mean daily pH entering Cheat Lake versus mean daily flow at Rowlesburg, January – December, 2008. Flow data from USGS is provisional.

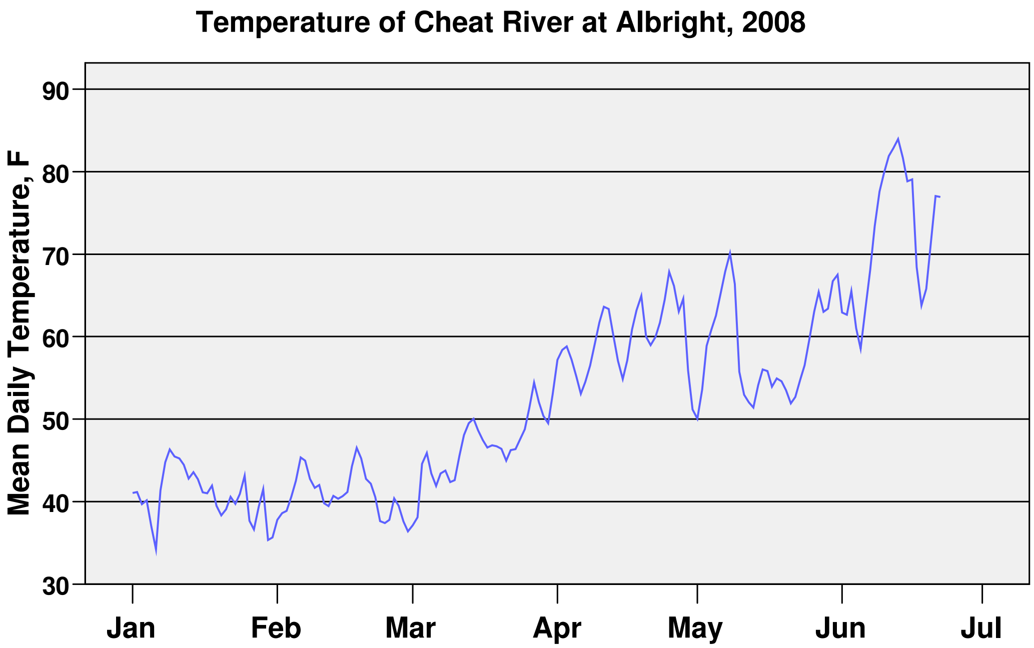


**Figure 12.** Mean daily temperature of Cheat River at Albright, January – June 2008. No data from July through December due to loss of YSI.

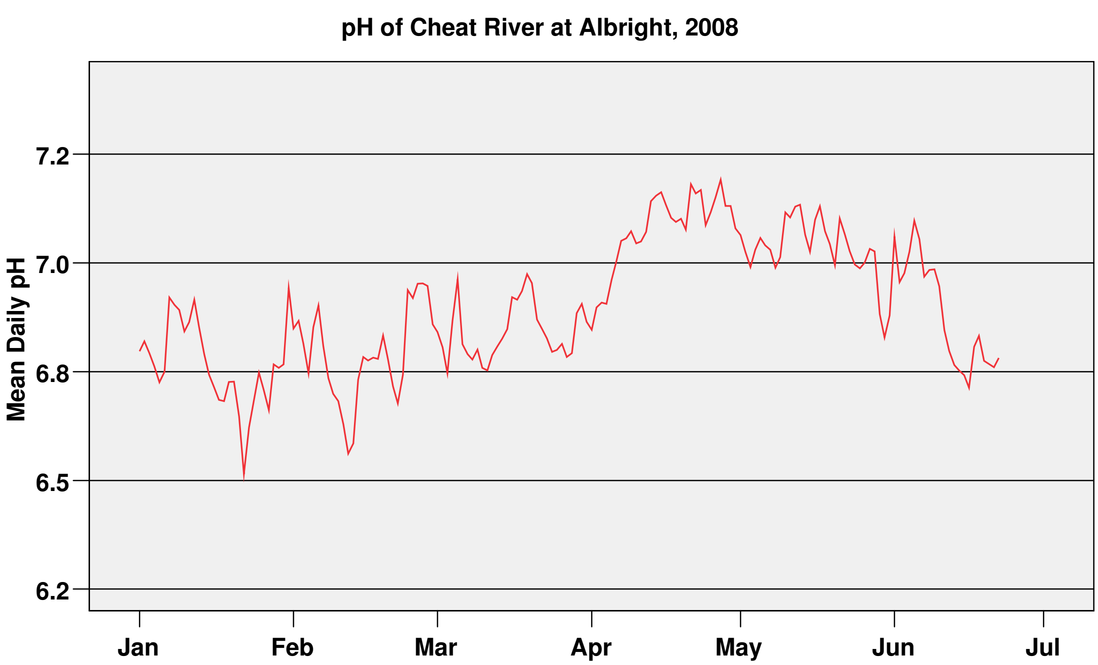


**Figure 13.** Mean daily pH of Cheat River at Albright, January – June 2008. No data from July through December due to loss of YSI.

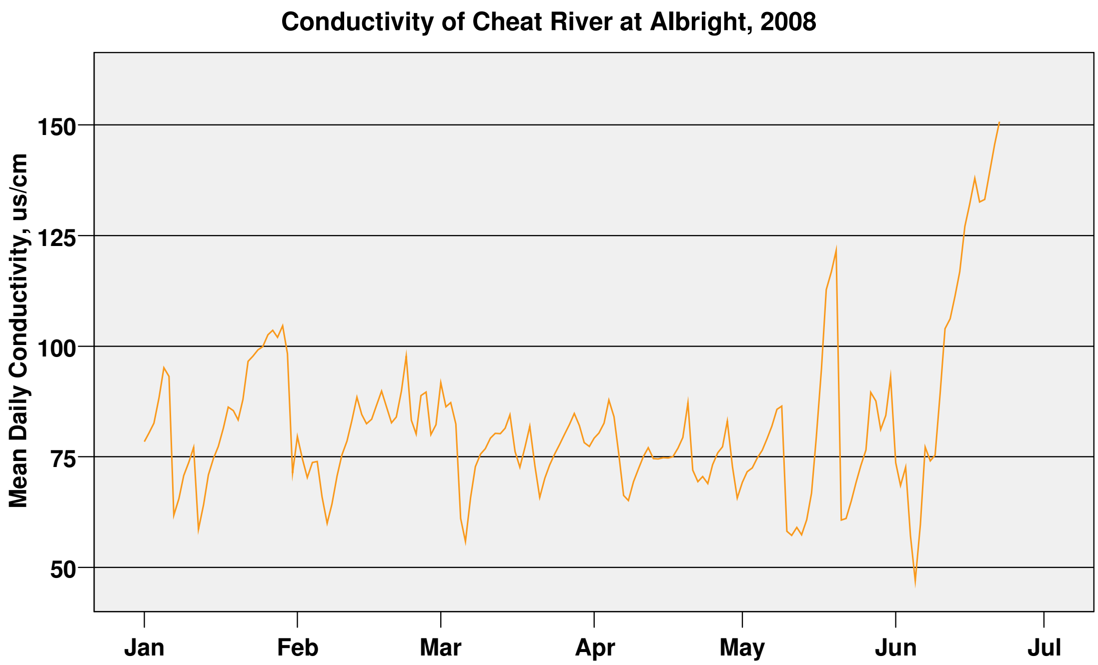


**Figure 14.** Mean daily conductivity of Cheat River at Albright, January – June 2008. No data from July through December due to loss of YSI.

# Chapter 4: Fish Biomonitoring in Cheat Lake and Embayments (Task 4)

## Introduction

FERC issued a renewal license to AES to produce hydropower in December 1994. A requirement of the renewed license agreement was that AES conduct biomonitoring studies of Cheat Lake's aquatic community to ensure negative impacts do not occur. WVDNR began biomonitoring in Cheat Lake and two embayments in 2005 and will continue through 2009. Consultants conducted biomonitoring in 1997, 1998, and 2001.

## Methods

Fishery surveys were conducted in Cheat Lake and two Cheat embayments using boat electrofishing and gill nets to ascertain species composition and abundance. Boat electrofishing surveys were conducted at stations L1, L2, L3, L4, L5, L6, E1, and E2 in July and October (Figure 15), but was cancelled in the spring due to excessive turbidity. Electrofishing was conducted at night using pulsed-DC gear (220-V, 2-4 A) with 10-minutes of effort at each station. Catch-per-unit-effort (CPUE) was based on fish per hour. Gill net surveys were conducted at all stations in May and October. Two 125-ft gill nets (6-ft deep with five equal panels of 0.75, 1.0, 1.5, 2.0, 2.5-inch bar length) were set before dark and retrieved after daylight at each station. Nets were set 300 ft apart at an angle perpendicular to the shoreline.

In addition to biomonitoring nets, walleye stocking assessment surveys were conducted in March/April (spring) and November (fall) using gill nets that were150-ft in length, 6-ft deep with six 25-ft. alternating panels of 1.5, 1.75, 2.0, 1.5, 1.75, 2.0-inch bar length mesh. These nets are referred to as walleye experimental gill nets. Six nets were set one night in March and April, and 2 nights in November for a total of 24 net-nights. Stations were the same as in biomonitoring except that gill nets were not set in the embayments.

Data were pooled for the biomonitoring and walleye stocking assessment surveys to illustrate overall catch in 2005 and 2008. However, data are also presented separately for comparisons with earlier study years when walleye experimental nets were not used.

Fishes were identified to species (Stauffer et al. 1995), and individual length to the nearest millimeter and weight to the nearest 2 grams was collected for each large fish. Small fish (mainly bluegills and minnows) were grouped into 10-mm size classes by species or taxa and batch weighed. Analysis included summary statistics and comparisons with previous biomonitoring studies. Summary statistics included mean length, mean weight, relative abundance, size range, and CPUE based on species, gear type, and lake area. Analysis also included relative weights (Wr) and proportional stock density (PSD).

Summary statistics of CPUE, Wr, and PSD were calculated for specific black bass (largemouth, smallmouth, and spotted), channel catfish, walleyes, and yellow perch. CPUE and PSD comparisons for black bass were based on spring electrofishing surveys. Spring electrofishing surveys collect a greater size-range of bass that appear most representative of these black bass populations. Comparisons of Wr for black bass were based on fall electrofishing surveys to avoid potential bias associated with gravid spawners collected during spring surveys. CPUE, PSD, and Wr comparisons for walleyes, yellow perch, and channel catfish were based on fall gill net surveys that collect these species in greater number than spring gill nets or electrofishing surveys.

## Results

### Fish Abundance

Gill net data is only presented for biomonitoring nets. However, pooled data for biomonitoring nets and walleye nets are provided in some of the tables. A total of 1,233 fishes representing 38 species were collected during the 2008 biomonitoring study on Cheat Lake and Cheat embayments (Table 7). Electrofishing produced a total of 910 fishes representing 31 species while gill nets produced 323 fishes representing 21 species. More species were collected in 2008 than in any other study year (Table 7). The 2008 survey combined total catch for both electrofishing and gill net surveys was less than the 2005 catch with similar effort. 2008 had the highest biomonitoring total catch for gill nets (Table 7) and CPUE (Table 8) of the 5 study years. The 2008 total catch for electrofishing was the lowest of the 5 study years (Table 7), while electrofishing CPUE was the second highest (Table 8).

Electrofishing can collect fish that are smaller than those caught in gill nets. These smaller fish can represent the forage component of the population and/or successful reproduction and survival of individual species. Emerald shiners and green sunfish were the only species substantially more abundant in 2008 electrofishing surveys than in 2005 (Table 9). Most other species were substantially less abundant than in previous electrofishing surveys. A single banded darter *Etheostoma zonale* was collected for the first time

Gill nets typically catch larger fishes than electrofishing gear, are selective for certain species, and can reveal the species available to the sport fishery. Channel catfish, gizzard shad, redhorse suckers, walleyes, and white bass were more abundant in biomonitoring nets during 2008 than in 2005 (Table 10). A comparison of the combined biomonitoring and walleye net collections for both years also substantiated a significant increase in redhorse suckers, walleyes, and white bass in 2008. Yellow perch were significantly less abundant in 2008. Smallmouth bass abundance was equal in 2005 to 2008 and only 3 were collected in previous net surveys (Table 10). Gizzard shad, which represents a potentially significant component of the forage population, were slightly more abundant than in previous samples. A single sauger *Sander canadensis* was captured in a gill net. Trends in relative abundance were similar to those observed in total abundance (Appendix Tables A1 – A2).

The increase in walleye abundance from 1997 to 2008 can be attributed to a stocking program initiated by the WVDNR. WVDNR stocked walleye fry in 1999 and 2000, and fingerling from 2004 through 2007. Increases in other game fish species over the past decade are attributed to improvements in water quality resulting from acid mine drainage abatement projects upstream of Cheat Lake. Limiting lake elevation fluctuations to 2-feet from May through October also improves reproductive success of species that spawn in May and June.

The average lengths of several game fish species have changed since the original 1997 study. Increases in mean length of channel catfish and yellow perch have occurred over the study period while the mean length of walleyes has decreased due to successful supplemental stockings resulting in greater abundance of younger walleyes. Information regarding the changes in mean length can be referenced in Appendix Tables A3 – A10.

## Catch-per-unit-effort

Electrofishing total CPUE in 2008 was nearly half of CPUE in 2005 (Table 8). The CPUE for only a few species, most significantly emerald shiners and green sunfish, were greater in 2008 than in 2005 (Table 11). Green sunfish, largemouth bass, rock bass, smallmouth bass spotted bass, white bass, and golden redhorse were all collected in densities higher than the 1997 - 2001 samples. Bluntnose minnows, gizzard shad, and walleye catches were below the range of 1997 – 2001 samples. Other species were within the range. Spring electrofishing was cancelled because of high turbidities in 2008 and summer electrofishing was not conducted in 2005. Therefore, seasonal comparisons are not being made. Seasonal CPUE is combined for each area of the lake (upper, lower, and embayments) by year to identify possible species distribution or area preferences.

The highest biomonitoring gill net CPUE occurred in 2008 (Table 8). As expected, trends were similar to changes in abundance. Channel catfish, gizzard shad, redhorse suckers, walleyes, and white bass CPUE increased from 2005 to 2008 (Table 12). The CPUE for spotted bass and yellow perch decreased in 2008, but were above the 1997-2001 ranges, indicating a positive trend in their populations. Largemouth bass were within the range, but are not a species adequately sampled with gill nets. A comparison of the combined biomonitoring and walleye net collections for 2005 and 2008 also revealed a substantial increase in walleye numbers since 1997 (Table 12).

### Cheat Embayments

An analysis of species distribution for the upper, lower, and embayment areas of the lake was conducted for electrofishing surveys from 1997 to 2008 (Tables 13 and 14). Species that were most common in the embayments were bluegills, bluntnose minnows, brook silversides, emerald shiners, green sunfish, largemouth bass, logperch, pumpkinseed sunfish, rock bass, and spotted bass. Most of these species, or their young, are the major forage component in the lake. Young-of-the year gizzard shad were scarce, although adults were caught throughout the lake. In contrast, a large number of juvenile smallmouth bass were collected in 2008 while adults were scarce in the embayments.

An analysis of species distribution for the upper, lower, and embayment areas of the lake was conducted for gill net survey from 1997 to 2008 (Tables 15 and 16). Black crappie, channel catfish, green sunfish, largemouth bass, pumpkinseed sunfish, rock bass and spotted bass were the most common adult fish caught in the embayments.

**Lower Cheat Lake**

The same species collected by electrofishing in the embayments were also found in lower Cheat Lake but in fewer numbers (Tables 13 and 14). Pumpkinseed sunfish were more abundant in the lower lake electrofishing samples than in the embayments.

Pumpkinseed sunfish, rock bass, walleyes, and yellow perch were most common in lower lake gill net collections than in the other areas of the lake. Smallmouth bass are becoming more common in the lower lake although most abundant in the upper lake area (Tables 15 and 16).

**Upper Cheat Lake**

Species collected by electrofishing in the lower lake and embayments were much less numerous or absent in the upper lake. Smallmouth bass and yellow perch were exceptions (Tables 13 and 14). Adult game fish were most abundant in the upper lake. Channel catfish, smallmouth bass, and white bass were more common than in other areas of the lake. Walleyes and yellow perch were of similar abundant in the lower lake. Gizzard shad and golden redhorse were also most abundant in the upper lake (Tables 15 and 16).

## Proportional Stock Density and Relative Weight

PSD was calculated for all years of the biomonitoring study for channel catfish, largemouth bass, smallmouth bass, spotted bass, walleye and yellow perch (Table 17). The PSD for largemouth, smallmouth, and spotted bass was calculated from the spring electrofishing surveys and may not be representative because of the smaller than recommended sample sizes. The importance of these fish to anglers warrants documentation; however these values should be interpreted with caution. Largemouth bass maintained a PSD between 50 and 70 since the 1997 study, which is within the recommended range of 40 – 70 established by fish managers (Table 17). The PSD for smallmouth bass has been consistently well below the recommend range of 30 – 60. Spotted bass PSD is being reported although the number of observations is low and no interpretation can be made from these data.

Walleyes and yellow perch are above the recommended PSD range (Table 17). PSD for channel catfish has been reported but recommended ranges have not been established. PSD values for channel catfish have increased each study year since 1997.

Relative weight (Wr) values were calculated for several game fish species between 1997 and 2008 (Table 18). The 2008 Wr values indicate healthy sport fish populations and sufficient forage. Wr for all selected species were the highest in 2008 than in any other study.

## Length-Frequency Analysis

Length-frequency of selected sport fish species were plotted to identify year class strengths and trends during the biomonitoring studies. Growth rates of young largemouth bass collected in 2008 appeared to be similar to those collected in 2005 (Figure 16). During 1997, estimated age-1 largemouth bass sampled in spring electrofishing surveys ranged from 50 – 125 mm in length. In 2005 and 2008, the length range for estimated age-1 largemouth was 100 – 150 mm, which suggests an increase in age-0 largemouth bass growth rates (Figure 16).

Similar to the 2005 results, all size-classes from 50 – 275 mm were represented in the 2008 spring electrofishing surveys for smallmouth bass (Figure 17). However, in contrast to previous study years, the estimated age-1 smallmouth bass were not the most abundant in spring electrofishing surveys. Nearly 60% of the 2008 sample was represented by smallmouth bass from the 175 – 225 mm size ranges, which are estimated to be 2 years of age.

Length frequency analysis of yellow perch collected during fall 2008 biomonitoring nets indicated that fewer fish were available to anglers in the 250 mm to 325 mm size range than in 2005 (Figure 18). However, more yellow perch in 2008 were available in the harvestable size range than in the previous study years. These results are consistent with angler reports during 2008 that slightly smaller and fewer yellow perch were being caught.

Length-frequency analysis revealed that all walleyes collected were of harvestable size and the majority was in the 400 mm size-class (Figure 19). Walleyes in the 200 – 250 mm size-classes, which would indicate successful reproduction, were not collected as they were in 2005 fall biomonitoring nets. Fingerling walleyes were not stocked in 2008. Frequent storms caused turbid water conditions during April, May, and June, which may have reduced walleye reproductive success.

Channel catfish length-frequency analysis for fall 2008 biomonitoring was similar to 2005 results. The majority of channel catfish collected were ≥ 350 mm and represent a significant portion of Cheat Lake's sport fishery.

## Conclusions

Increase in both the sport fishes and forage fishes have occurred for most species in Cheat Lake since the 1997 study. These increases have occurred in abundance and CPUE for important game fishes including largemouth bass, smallmouth bass, and walleyes. In 1997, brown bullheads were nearly 3 times more abundant than channel catfish. Remarkably, in 2008 channel catfish were 16 times more abundant in surveys than brown bullheads. Increases in sucker and forage species including golden redhorse, white sucker, bluegills, and several minnows also indicate improvements in the fishery resources at Cheat Lake. Adult gizzard shad are common, but do not appear to be providing a significant forage component. Enhancements in the fish resources are attributed to improvements in water quality from the Cheat River and operating protocols of the Lake Lynn hydro station. Future monitoring will continue to focus on abundance, CPUE, and condition of Cheat Lake's fish species.

**Table 7.** Fish abundance and species collected from 1997 to 2008 by gear type on Cheat Lake and embayments during biomonitoring surveys. Combined biomonitoring and walleye stocking assessment catches provided in parentheses.

| | Boat Electrofishing | | Gill Nets | | Combined | |
|---|---|---|---|---|---|---|
| **Survey Year** | **Catch** | **Taxa** | **Catch** | **Taxa** | **Catch** | **Taxa** |
| **1997** | 1,278 | 28 | 168 | 21 | 1,446 | 34 |
| **1998** | 1,018 | 27 | 121 | 17 | 1,139 | 32 |
| **2001** | 1,364 | 30 | 152 | 20 | 1,516 | 35 |
| **2005** | 1,596 | 28 | 256 (732) | 19 | 1,852 (2,328) | 31 |
| **2008** | 910 | 31 | 323 (701) | 21 | 1,233 (1,611) | 38 |

**Table 8.** Boat electrofishing (hours) and biomonitoring gill nets (net nights) sampling effort from 1997 to 2005 at Cheat Lake and embayments. Combined biomonitoring and walleye stocking assessment effort and CPUE provided in parentheses.

| | Boat Electrofishing | | Gill Nets | |
|---|---|---|---|---|
| **Survey Year** | **Effort / Hours** | **CPUE** | **Effort / Net-Night** | **CPUE** |
| **1997** | 6.00 | 213 | 24 | 7.0 |
| **1998** | 9.00 | 113 | 42 | 2.9 |
| **2001** | 10.50 | 130 | 42 | 3.6 |
| **2005** | 2.66 | 600 | 32 (50) | 8.0 (14.6) |
| **2008** | 2.67 | 341 | 32 (56) | 10.1 (12.5) |

**Table 9.** Scientific names, common names, and number of fish collected by electrofishing from 1997 to 2008 at Cheat Lake and embayments.

| Scientific Name | Common Name | 1997 | 1998 | 2001 | 2005 | 2008 | Total Catch |
|---|---|---|---|---|---|---|---|
| **Clupidae** | | | | | | | |
| Dorosoma cepedianum | Gizzard Shad | 0 | 17 | 21 | 5 | 2 | 45 |
| **Cyprinidae** | | | | | | | |
| Rhinichthys atratulus | Blacknose Dace | 10 | 1 | 0 | 0 | 0 | 11 |
| Cyprinella spiloptera | Spotfin Shiner | 0 | 6 | 20 | 21 | 10 | 57 |
| Cyprinus carpio | Common Carp | 0 | 3 | 4 | 1 | 1 | 9 |
| Nocomis micropogon | River Chub | 0 | 0 | 1 | 3 | 0 | 4 |
| Notemigonus crysoleucas | Golden Shiner | 2 | 0 | 1 | 0 | 0 | 3 |
| Notropis ariommus | Popeye Shiner | 0 | 0 | 0 | 1 | 9 | 10 |
| Notropis atherinoides | Emerald Shiner | 87 | 123 | 6 | 3 | 36 | 255 |
| Notropis photogenis | Silver Shiner | 0 | 0 | 14 | 19 | 4 | 37 |
| Notropis volucellus | Mimic Shiner | 1 | 0 | 15 | 498 | 36 | 550 |
| Pimephales notatus | Bluntnose Minnow | 48 | 19 | 41 | 37 | 4 | 149 |
| Semotilus atromaculatus | Creek Chub | 0 | 2 | 0 | 0 | 0 | 2 |
| **Catostomidae** | | | | | | | |
| Hypentilium nigricans | Northern Hogsucker | 0 | 7 | 3 | 4 | 0 | 14 |
| Moxostoma anisurum | Silver Redhorse | 1 | 0 | 0 | 0 | 0 | 1 |
| Moxostoma erythrurum | Golden Redhorse | 7 | 63 | 49 | 37 | 26 | 182 |
| **Ictaluridae** | | | | | | | 0 |
| Ameiurus natalis | Yellow Bullhead | 10 | 5 | 11 | 8 | 7 | 41 |
| Ameiurus nebulosus | Brown Bullhead | 1 | 0 | 1 | 0 | 1 | 3 |
| Ictalurus punctatus | Channel Catfish | 2 | 0 | 9 | 5 | 7 | 23 |
| Pylodictus olivaris | Flathead catfish | 1 | 0 | 0 | 0 | 0 | 1 |
| **Atherinidae** | | | | | | | |
| Labidesthes sicculus | Brook Silverside | 198 | 120 | 65 | 180 | 78 | 641 |
| **Moronidae** | | | | | | | |
| Morone chrysops | White Bass | 0 | 2 | 0 | 8 | 1 | 11 |
| **Centrachidae** | | | | | | | |
| Ambloplites rupestris | Rock Bass | 47 | 33 | 72 | 48 | 27 | 227 |
| Lepomis cyanellus | Green Sunfish | 28 | 15 | 96 | 71 | 158 | 368 |
| Lepomis gibbosus | Pumpkinseed | 29 | 24 | 15 | 35 | 18 | 121 |
| Lepomis macrochirus | Bluegill | 375 | 302 | 538 | 201 | 145 | 1561 |
| Lepomis megalotis | Longear sunfish | 1 | 1 | 0 | 0 | 0 | 2 |
| | Hybrid sunfish | 2 | 3 | 2 | 0 | 5 | 12 |
| Micropterus dolomieu | Smallmouth Bass | 34 | 34 | 30 | 138 | 68 | 304 |
| Micropterus punctulatus | Spotted Bass | 47 | 12 | 84 | 61 | 48 | 252 |
| Micropterus salmoides | Largemouth Bass | 38 | 77 | 70 | 48 | 28 | 261 |
| Pomoxis nigromaculatus | Black Crappie | 2 | 1 | 6 | 8 | 0 | 17 |
| **Percidae** | | | | | | | |
| Etheostoma blennioides | Greenside Darter | 0 | 0 | 1 | 0 | 1 | 2 |
| Etheostoma caeruluem | Rainbow Darter | 0 | 1 | 1 | 1 | 2 | 5 |

**Table 9.** continued.

| Scientific Name | Common Name | 1997 | 1998 | 2001 | 2005 | 2008 | Total Catch |
|---|---|---|---|---|---|---|---|
| Etheostoma flabellare | Fantail Darter | 4 | 0 | 0 | 0 | 0 | 4 |
| Etheostoma nigrum | Johnny Darter | 6 | 1 | 6 | 0 | 5 | 18 |
| Etheostoma zonale | Banded Darter | 0 | 0 | 0 | 0 | 1 | 1 |
| Percina caprodes | Logperch | 284 | 115 | 139 | 126 | 92 | 756 |
| Perca flavescens | Yellow Perch | 10 | 25 | 31 | 20 | 8 | 94 |
| Sander vitreus | Walleye | 0 | 0 | 12 | 8 | 1 | 21 |
| **Sciaenidae** | | | | | | | |
| Aplodinotus grunniens | Freshwater drum | 1 | 0 | 0 | 0 | 1 | 2 |
| **Unidentified** | | 2 | 6 | 0 | 0 | 0 | 8 |

**Table 10.** Scientific names, common names, and number of fish collected with gill nets from 1997 to 2008 at Cheat Lake and embayments. a = biomonitoring gill net catch only; b = biomonitoring and walleye stocking assessment gill net catch combined.

| Scientific Name | Common Name | 1997 | 1998 | 2001 | 2005-a | 2005-b | 2008-a | 2008-b | Total Catch-a | Total Catch-b |
|---|---|---|---|---|---|---|---|---|---|---|
| **Clupidae** | | | | | | | | | | |
| Dorosoma cepedianum | Gizzard Shad | 34 | 28 | 27 | 21 | 21 | 39 | 42 | 149 | 152 |
| **Cyprinidae** | | | | | | | | | | |
| Rhinichthys atratulus | Blacknose Dace | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 |
| Cyprinus carpio | Common Carp | 7 | 3 | 2 | 3 | 4 | 2 | 0 | 17 | 16 |
| **Catostomidae** | | | | | | | | | | |
| Catostomus commersoni | White Sucker | 0 | 2 | 5 | 3 | 19 | 7 | 12 | 17 | 38 |
| Hypentilium nigricans | Northern Hogsucker | 0 | 1 | 0 | 0 | 0 | 1 | 1 | 2 | 2 |
| Moxostoma anisurum | Silver Redhorse | 15 | 0 | 0 | 0 | 0 | 0 | 0 | 15 | 15 |
| Moxostoma erythrurum | Golden Redhorse | 15 | 7 | 17 | 27 | 51 | 37 | 106 | 103 | 196 |
| **Ictaluridae** | | | | | | | | | | |
| Ameiurus natalis | Yellow Bullhead | 3 | 2 | 5 | 4 | 32 | 1 | 2 | 15 | 44 |
| Ameiurus nebulosus | Brown Bullhead | 28 | 15 | 2 | 3 | 21 | 3 | 11 | 51 | 77 |
| Ictalurus punctatus | Channel Catfish | 9 | 8 | 33 | 33 | 207 | 48 | 124 | 131 | 381 |
| **Esocidae** | | | | | | | | | | |
| Esox lucius | Notheren Pike | 1 | 1 | 1 | 0 | 0 | 0 | 1 | 3 | 4 |
| Esox masquinongy | Muskellunge | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 1 |
| **Salmonidae** | | | | | | | | | | |
| Oncorhhynchus mykiss | Rainbow Trout | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 1 | 1 |
| Salmo trutta | Brown Trout | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 1 |
| **Percichthyidae** | | | | | | | | | | |
| Morone chrysops | White Bass | 7 | 4 | 8 | 23 | 42 | 67 | 91 | 109 | 152 |
| M. chrysops x M. saxatilis | Hybrid Striped Bass | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 1 | 1 |
| **Centrachidae** | | | | | | | | | | |
| Ambloplites rupestris | Rock Bass | 3 | 10 | 12 | 31 | 48 | 33 | 38 | 89 | 111 |
| Lepomis cyanellus | Green Sunfish | 0 | 0 | 0 | 1 | 3 | 4 | 42 | 5 | 45 |

**Table 10.** continued.

| Scientific Name | Common Name | 1997 | 1998 | 2001 | 2005-a | 2005-b | 2008-a | 2008-b | Total Catch-a | Total Catch-b |
|---|---|---|---|---|---|---|---|---|---|---|
| Lepomis gibbosus | Pumpkinseed | 8 | 6 | 2 | 5 | 16 | 3 | 13 | 24 | 45 |
| Lepomis macrochirus | Bluegill | 1 | 1 | 1 | 0 | 3 | 0 | 1 | 3 | 7 |
| Micropterus dolomieu | Smallmouth Bass | 1 | 0 | 2 | 19 | 56 | 19 | 64 | 41 | 123 |
| Micropterus punctulatus | Spotted Bass | 1 | 1 | 1 | 17 | 20 | 4 | 9 | 24 | 32 |
| Micropterus salmoides | Largemouth Bass | 11 | 6 | 3 | 4 | 14 | 5 | 13 | 29 | 47 |
| Pomoxis annularis | White Crappie | 1 | 3 | 9 | 0 | 0 | 0 | 0 | 13 | 13 |
| Pomoxis nigromaculatus | Black Crappie | 5 | 0 | 4 | 16 | 28 | 8 | 21 | 33 | 58 |
| **Percidae** | | | | | | | | | | |
| Perca flavescens | Yellow Perch | 15 | 23 | 7 | 28 | 108 | 21 | 38 | 94 | 191 |
| Sander canadensis | Sauger | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 1 |
| Sander vitreus | Walleye | 1 | 0 | 10 | 18 | 38 | 21 | 69 | 50 | 118 |
| **Sciaenidae** | | | | | | | | | | |
| Aplodinotus grunniens | Freshwater Drum | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 |
| | **Total** | **168** | **121** | **152** | **257** | **732** | **323** | | **1,021** | **1,874** |

**Table 11.** CPUE of species collected by electrofishing from 1997 to 2008 at Cheat Lake and embayments.

| | Catch-Per-Unit-Effort | | | | |
|---|---|---|---|---|---|
| **Species** | **1997** | **1998** | **2001** | **2005** | **2008** |
| Banded Darter | 0.0 | 0.0 | 0.0 | 0.0 | 0.4 |
| Black Crappie | 0.3 | 0.1 | 0.6 | 3.0 | 0.0 |
| Blacknose Dace | 1.7 | 0.1 | 0.0 | 0.0 | 0.0 |
| Bluegill | 62.5 | 33.4 | 51.2 | 75.5 | 54.3 |
| Bluntnose Minnow | 8.0 | 2.1 | 3.9 | 13.9 | 1.5 |
| Brook Silverside | 33.0 | 13.3 | 6.2 | 67.7 | 29.2 |
| Brown Bullhead | 0.2 | 0.0 | 0.1 | 0.0 | 0.4 |
| Channel Catfish | 0.3 | 0.0 | 0.9 | 1.9 | 2.6 |
| Common Carp | 0.0 | 0.3 | 0.4 | 0.4 | 0.4 |
| Creek Chub | 0.0 | 0.2 | 0.0 | 0.0 | 0.0 |
| Emerald Shiner | 14.5 | 13.7 | 0.6 | 0.4 | 13.5 |
| Fantail Darter | 0.7 | 0.0 | 0.0 | 0.0 | 0.0 |
| Flathead Catfish | 0.2 | 0.0 | 0.0 | 0.0 | 0.0 |
| Freshwater Drum | 0.2 | 0.0 | 0.0 | 0.4 | 0.0 |
| Gizzard Shad | 0.0 | 1.9 | 2.0 | 1.9 | 0.7 |
| Golden Redhorse | 1.2 | 7.0 | 4.7 | 13.9 | 9.7 |
| Golden Shiner | 0.3 | 0.0 | 0.1 | 0.0 | 0.0 |
| Green Sunfish | 4.7 | 1.7 | 9.1 | 26.3 | 59.2 |
| Greenside Darter | 0.0 | 0.0 | 0.1 | 0.0 | 0.4 |
| Hybrid Sunfish | 0.3 | 0.3 | 0.2 | 0.0 | 1.9 |
| Johnny Darter | 1.0 | 0.1 | 0.6 | 0.0 | 1.9 |
| Largemouth Bass | 6.3 | 8.6 | 6.7 | 18.0 | 10.5 |
| Logperch | 47.3 | 12.8 | 13.2 | 47.4 | 34.5 |
| Longear Sunfish | 0.2 | 0.1 | 0.0 | 0.0 | 0.0 |
| Mimic Shiner | 0.2 | 0.0 | 1.4 | 187.2 | 13.5 |
| Northern Hogsucker | 0.0 | 0.8 | 0.3 | 1.5 | 0.0 |
| Popeye Shiner | 0.0 | 0.0 | 0.0 | 0.4 | 3.4 |
| Pumpkinseed | 4.8 | 2.7 | 1.4 | 13.1 | 6.7 |
| Rainbow Darter | 0.0 | 0.1 | 0.1 | 0.4 | 0.7 |
| River Chub | 0.0 | 0.0 | 0.1 | 1.1 | 0.0 |
| Rock Bass | 7.8 | 3.7 | 6.8 | 18.0 | 10.1 |
| Silver Redhorse | 0.2 | 0.0 | 0.0 | 0.0 | 0.0 |
| Silver Shiner | 0.0 | 0.0 | 1.3 | 4.5 | 1.5 |
| Smallmouth Bass | 5.7 | 3.8 | 2.9 | 51.9 | 25.5 |
| Spotfin Shiner | 0.0 | 0.7 | 1.9 | 7.1 | 3.7 |
| Spotted Bass | 7.7 | 1.3 | 8.0 | 22.5 | 25.5 |
| Unidentified | 0.3 | 0.1 | 0.0 | 0.0 | 0.0 |
| Walleye | 0.0 | 0.0 | 1.1 | 3.0 | 0.4 |
| White Bass | 0.0 | 0.2 | 0.0 | 3.0 | 0.4 |
| Yellow Bullhead | 1.7 | 0.6 | 1.0 | 3.0 | 2.6 |
| Yellow Perch | 1.7 | 2.8 | 3.0 | 7.5 | 3.0 |

**Table 12**. CPUE of species collected from 1997 to 2008 with gill nets at Cheat Lake and embayments. a = biomonitoring gill nets; b = biomonitoring and walleye experimental gill nets; T < 0.05

| | Catch-Per-Unit-Effort | | | | | | |
|---|---|---|---|---|---|---|---|
| | | | | 2005 | | 2008 | |
| Species | 1997 | 1998 | 2001 | a | b | a | b |
| Black Crappie | 0.2 | 0.0 | 0.1 | 0.5 | 0.6 | 0.3 | 0.4 |
| Blacknose Dace | T | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| Bluegill | T | T | T | 0.0 | 0.1 | 0.0 | T |
| Brown Bullhead | 1.2 | 0.4 | 0.0 | 0.1 | 0.4 | 0.1 | 0.2 |
| Brown Trout | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | T |
| Channel Catfish | 0.4 | 0.2 | 0.8 | 1.0 | 3.7 | 1.5 | 2.2 |
| Common Carp | 0.3 | 0.1 | T | 0.1 | 0.1 | T | 0.0 |
| Freshwater Drum | T | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| Gizzard Shad | 1.4 | 0.7 | 0.6 | 0.7 | 0.4 | 1.2 | 0.8 |
| Golden Redhorse | 0.6 | 0.2 | 0.4 | 0.8 | 1.0 | 1.2 | 1.9 |
| Green Sunfish | 0.0 | 0.2 | 0.0 | T | 0.1 | 0.1 | 0.8 |
| Hybrid Striped Bass | 0.0 | 0.0 | T | 0.0 | 0.0 | 0.0 | 0.0 |
| Largemouth Bass | 0.5 | 0.1 | 0.1 | 0.1 | 0.3 | 0.2 | 0.2 |
| Muskellunge | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | T |
| Northern Hogsucker | 0.0 | T | 0.0 | 0.0 | 0.0 | T | T |
| Notheren Pike | T | T | T | 0.0 | 0.0 | 0.0 | T |
| Pumpkinseed | 0.3 | 0.1 | T | 0.2 | 0.3 | 0.1 | 0.2 |
| Rainbow Trout | 0.0 | 0.0 | 0.0 | T | T | 0.0 | 0.0 |
| Rock Bass | 0.1 | 0.2 | 0.3 | 1.0 | 1.0 | 1.0 | 0.7 |
| Sauger | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | T |
| Silver Redhorse | 0.6 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| Smallmouth Bass | T | 0.0 | T | 0.6 | 1.1 | 0.6 | 1.1 |
| Spotted Bass | T | T | T | 0.5 | 0.4 | 0.1 | 0.2 |
| Walleye | T | 0.0 | 0.2 | 0.6 | 0.8 | 0.7 | 1.2 |
| White Bass | 0.3 | 0.1 | 0.2 | 0.7 | 0.8 | 2.1 | 1.6 |
| White Crappie | T | 0.1 | 0.2 | 0.0 | 0.0 | 0.0 | 0.0 |
| White Sucker | 0.0 | T | 0.1 | 0.1 | 0.4 | 0.2 | 0.2 |
| Yellow Bullhead | 0.1 | T | 0.1 | 0.1 | 0.6 | T | T |
| Yellow Perch | 0.6 | 0.5 | 0.2 | 0.9 | 2.2 | 0.7 | 0.7 |

**Table 13.** Electrofishing total catch by each species for each lake area from 1997 through 2008.

| | Upper Cheat Lake | | | | | Lower Cheat Lake | | | | | Embayments | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Species** | **1997** | **1998** | **2001** | **2005** | **2008** | **1997** | **1998** | **2001** | **2005** | **2008** | **1997** | **1998** | **2001** | **2005** | **2008** |
| Banded Darter | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 |
| Black Crappie | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 1 | 0 | 2 | 0 | 6 | 0 | 0 |
| Blacknose Dace | 0 | 0 | 0 | 0 | 0 | 6 | 0 | 0 | 0 | 0 | 3 | 1 | 0 | 0 | 0 |
| Bluegill | 7 | 3 | 2 | 11 | 7 | 90 | 161 | 221 | 20 | 30 | 147 | 138 | 315 | 25 | 54 |
| Bluntnose Minnow | 0 | 0 | 3 | 0 | 2 | 11 | 5 | 18 | 0 | 1 | 0 | 14 | 20 | 0 | 1 |
| Brook Silverside | 21 | 2 | 2 | 10 | 5 | 36 | 68 | 36 | 2 | 2 | 108 | 50 | 27 | 5 | 14 |
| Brown Bullhead | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 1 | 0 | 1 | 0 | 0 | 0 | 0 | 0 |
| Channel Catfish | 0 | 0 | 2 | 2 | 2 | 2 | 0 | 5 | 2 | 0 | 0 | 0 | 2 | 0 | 5 |
| Common Carp | 0 | 0 | 0 | 0 | 0 | 0 | 3 | 4 | 0 | 1 | 0 | 0 | 0 | 0 | 0 |
| Creek Chub | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2 | 0 | 0 | 0 |
| Emerald Shiner | 0 | 20 | 2 | 1 | 9 | 37 | 24 | 3 | 0 | 4 | 48 | 79 | 1 | 0 | 1 |
| Fantail Darter | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 4 | 0 | 0 | 0 | 0 |
| Flathead catfish | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Freshwater drum | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 1 | 0 |
| Gizzard Shad | 0 | 4 | 6 | 0 | 0 | 0 | 6 | 5 | 2 | 2 | 0 | 7 | 10 | 0 | 0 |
| Golden Redhorse | 0 | 10 | 3 | 1 | 7 | 4 | 40 | 43 | 4 | 10 | 3 | 0 | 3 | 1 | 9 |
| Golden Shiner | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 2 | 13 | 0 | 0 | 0 |
| Green Sunfish | 0 | 0 | 6 | 3 | 0 | 8 | 11 | 72 | 11 | 66 | 14 | 4 | 18 | 12 | 75 |
| Greenside Darter | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 1 | 0 | 0 | 0 | 0 | 0 |
| Hybrid sunfish | 0 | 0 | 0 | 0 | 0 | 2 | 2 | 1 | 0 | 0 | 0 | 1 | 1 | 0 | 5 |
| Johnny Darter | 1 | 0 | 0 | 0 | 1 | 4 | 0 | 3 | 0 | 2 | 0 | 1 | 3 | 0 | 1 |
| Largemouth Bass | 2 | 4 | 1 | 0 | 1 | 10 | 22 | 29 | 12 | 11 | 11 | 51 | 40 | 5 | 15 |
| Logperch | 16 | 4 | 9 | 17 | 13 | 24 | 51 | 49 | 6 | 24 | 170 | 60 | 81 | 10 | 55 |
| Longear sunfish | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 |
| Mimic Shiner | 0 | 0 | 11 | 7 | 15 | 1 | 0 | 3 | 2 | 2 | 0 | 0 | 1 | 0 | 1 |

**Table 13.** continued.

| | Upper Cheat Lake | | | | | Lower Cheat Lake | | | | | Embayments | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Species** | **1997** | **1998** | **2001** | **2005** | **2008** | **1997** | **1998** | **2001** | **2005** | **2008** | **1997** | **1998** | **2001** | **2005** | **2008** |
| Northern Hogsucker | 0 | 3 | 0 | 1 | 0 | 0 | 0 | 1 | 2 | 0 | 0 | 4 | 2 | 0 | 0 |
| Popeye Shiner | 0 | 0 | 0 | 0 | 6 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Pumpkinseed | 4 | 1 | 0 | 7 | 1 | 16 | 21 | 12 | 4 | 14 | 7 | 2 | 3 | 1 | 3 |
| Rainbow Darter | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 1 | 1 | 1 | 1 |
| River Chub | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Rock Bass | 4 | 6 | 19 | 10 | 11 | 6 | 10 | 24 | 6 | 2 | 13 | 17 | 29 | 3 | 14 |
| Silver Redhorse | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Silver Shiner | 0 | 0 | 4 | 3 | 2 | 0 | 0 | 2 | 0 | 0 | 0 | 0 | 8 | 3 | 11 |
| Smallmouth Bass | 17 | 13 | 6 | 59 | 14 | 7 | 13 | 19 | 12 | 9 | 7 | 8 | 5 | 2 | 45 |
| Spotfin Shiner | 0 | 0 | 3 | 4 | 3 | 0 | 4 | 16 | 0 | 5 | 0 | 2 | 1 | 0 | 1 |
| Spotted Bass | 0 | 2 | 12 | 5 | 1 | 7 | 4 | 27 | 10 | 8 | 40 | 6 | 45 | 8 | 33 |
| Walleye | 0 | 0 | 2 | 3 | 1 | 0 | 0 | 6 | 5 | 0 | 0 | 0 | 4 | 0 | 0 |
| White Bass | 0 | 1 | 0 | 1 | 1 | 0 | 1 | 0 | 2 | 0 | 0 | 0 | 0 | 0 | 0 |
| Yellow Bullhead | 3 | 1 | 1 | 4 | 0 | 6 | 3 | 10 | 2 | 3 | 0 | 1 | 0 | 1 | 4 |
| Yellow Perch | 0 | 16 | 3 | 2 | 5 | 2 | 6 | 9 | 0 | 0 | 5 | 3 | 19 | 0 | 3 |
| Total | 75 | 90 | 97 | 151 | 107 | 282 | 456 | 622 | 105 | 200 | 585 | 466 | 645 | 78 | 351 |

**Table 14.** Electrofishing CPUE by each species for each lake area from 1997 through 2008.

| | Upper Cheat Lake | | | | | Lower Cheat Lake | | | | | Embayments | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Species** | **1997** | **1998** | **2001** | **2005** | **2008** | **1997** | **1998** | **2001** | **2005** | **2008** | **1997** | **1998** | **2001** | **2005** | **2008** |
| Banded Darter | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 1.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| Black Crappie | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.3 | 0.0 | 1.0 | 0.0 | 0.5 | 0.0 | 2.0 | 0.0 | 0.0 |
| Blacknose Dace | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 1.5 | 0.0 | 0.0 | 0.0 | 0.0 | 0.8 | 0.5 | 0.0 | 0.0 | 0.0 |
| Bluegill | 7.0 | 3.0 | 1.3 | 11.0 | 7.0 | 22.5 | 40.3 | 36.8 | 20.0 | 30.0 | 36.8 | 69.0 | 105.0 | 37.5 | 81.0 |
| Bluntnose Minnow | 0.0 | 0.0 | 2.0 | 0.0 | 2.0 | 2.8 | 1.3 | 3.0 | 0.0 | 1.0 | 0.0 | 7.0 | 6.7 | 0.0 | 1.5 |
| Brook Silverside | 21.0 | 2.0 | 1.3 | 10.0 | 5.0 | 9.0 | 17.0 | 6.0 | 2.0 | 2.0 | 27.0 | 25.0 | 9.0 | 7.5 | 21.0 |
| Brown Bullhead | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.3 | 0.0 | 0.2 | 0.0 | 1.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| Channel Catfish | 0.0 | 0.0 | 1.3 | 2.0 | 2.0 | 0.5 | 0.0 | 0.8 | 2.0 | 0.0 | 0.0 | 0.0 | 0.7 | 0.0 | 7.5 |
| Common Carp | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.8 | 0.7 | 0.0 | 1.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| Creek Chub | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 1.0 | 0.0 | 0.0 | 0.0 |
| Emerald Shiner | 0.0 | 20.0 | 1.3 | 1.0 | 9.0 | 9.3 | 6.0 | 0.5 | 0.0 | 4.0 | 12.0 | 39.5 | 0.3 | 0.0 | 1.5 |
| Fantail Darter | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 1.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| Flathead catfish | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.3 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| Freshwater drum | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.3 | 0.0 | 0.0 | 1.5 | 0.0 |
| Gizzard Shad | 0.0 | 4.0 | 4.0 | 0.0 | 0.0 | 0.0 | 1.5 | 0.8 | 2.0 | 2.0 | 0.0 | 3.5 | 3.3 | 0.0 | 0.0 |
| Golden Redhorse | 0.0 | 10.0 | 2.0 | 1.0 | 7.0 | 1.0 | 10.0 | 7.2 | 4.0 | 10.0 | 0.8 | 0.0 | 1.0 | 1.5 | 13.5 |
| Golden Shiner | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.2 | 0.0 | 0.0 | 0.5 | 6.5 | 0.0 | 0.0 | 0.0 |
| Green Sunfish | 0.0 | 0.0 | 4.0 | 3.0 | 0.0 | 2.0 | 2.8 | 12.0 | 11.0 | 66.0 | 3.5 | 2.0 | 6.0 | 18.0 | 112.4 |
| Greenside Darter | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.2 | 0.0 | 1.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| Hybrid sunfish | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.5 | 0.5 | 0.2 | 0.0 | 0.0 | 0.0 | 0.5 | 0.3 | 0.0 | 7.5 |
| Johnny Darter | 1.0 | 0.0 | 0.0 | 0.0 | 1.0 | 1.0 | 0.0 | 0.5 | 0.0 | 2.0 | 0.0 | 0.5 | 1.0 | 0.0 | 1.5 |
| Largemouth Bass | 2.0 | 4.0 | 0.7 | 0.0 | 1.0 | 2.5 | 5.5 | 4.8 | 12.0 | 11.0 | 2.8 | 25.5 | 13.3 | 7.5 | 22.5 |
| Logperch | 16.0 | 4.0 | 6.0 | 17.0 | 13.0 | 6.0 | 12.8 | 8.2 | 6.0 | 24.0 | 42.5 | 30.0 | 27.0 | 15.0 | 82.5 |
| Longear sunfish | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.3 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.5 | 0.0 | 0.0 | 0.0 |
| Mimic Shiner | 0.0 | 0.0 | 7.3 | 7.0 | 15.0 | 0.3 | 0.0 | 0.5 | 2.0 | 2.0 | 0.0 | 0.0 | 0.3 | 0.0 | 1.5 |

**Table 14.** continued.

| | Upper Cheat Lake | | | | | Lower Cheat Lake | | | | | Embayments | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Species** | **1997** | **1998** | **2001** | **2005** | **2008** | **1997** | **1998** | **2001** | **2005** | **2008** | **1997** | **1998** | **2001** | **2005** | **2008** |
| Northern Hogsucker | 0.0 | 3.0 | 0.0 | 1.0 | 0.0 | 0.0 | 0.0 | 0.2 | 2.0 | 0.0 | 0.0 | 2.0 | 0.7 | 0.0 | 0.0 |
| Popeye Shiner | 0.0 | 0.0 | 0.0 | 0.0 | 6.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| Pumpkinseed | 4.0 | 1.0 | 0.0 | 7.0 | 1.0 | 4.0 | 5.3 | 2.0 | 4.0 | 14.0 | 1.8 | 1.0 | 1.0 | 1.5 | 4.5 |
| Rainbow Darter | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 1.0 | 0.0 | 0.5 | 0.3 | 1.5 | 1.5 |
| River Chub | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.2 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| Rock Bass | 4.0 | 6.0 | 12.7 | 10.0 | 11.0 | 1.5 | 2.5 | 4.0 | 6.0 | 2.0 | 3.3 | 8.5 | 9.7 | 4.5 | 21.0 |
| Silver Redhorse | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| Silver Shiner | 0.0 | 0.0 | 2.7 | 3.0 | 2.0 | 0.0 | 0.0 | 0.3 | 0.0 | 0.0 | 0.0 | 0.0 | 2.7 | 4.5 | 16.5 |
| Smallmouth Bass | 17.0 | 13.0 | 4.0 | 59.0 | 14.0 | 1.8 | 3.3 | 3.2 | 12.0 | 9.0 | 1.8 | 4.0 | 1.7 | 3.0 | 67.5 |
| Spotfin Shiner | 0.0 | 0.0 | 2.0 | 4.0 | 3.0 | 0.0 | 1.0 | 2.7 | 0.0 | 5.0 | 0.0 | 1.0 | 0.3 | 0.0 | 1.5 |
| Spotted Bass | 0.0 | 2.0 | 8.0 | 5.0 | 1.0 | 1.8 | 1.0 | 4.5 | 10.0 | 8.0 | 10.0 | 3.0 | 15.0 | 12.0 | 49.5 |
| Walleye | 0.0 | 0.0 | 1.3 | 3.0 | 1.0 | 0.0 | 0.0 | 1.0 | 5.0 | 0.0 | 0.0 | 0.0 | 1.3 | 0.0 | 0.0 |
| White Bass | 0.0 | 1.0 | 0.0 | 1.0 | 1.0 | 0.0 | 0.3 | 0.0 | 2.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| Yellow Bullhead | 3.0 | 1.0 | 0.7 | 4.0 | 0.0 | 1.5 | 0.8 | 1.7 | 2.0 | 3.0 | 0.0 | 0.5 | 0.0 | 1.5 | 6.0 |
| Yellow Perch | 0.0 | 16.0 | 2.0 | 2.0 | 5.0 | 0.5 | 1.5 | 1.5 | 0.0 | 0.0 | 1.3 | 1.5 | 6.3 | 0.0 | 4.5 |

**Table 15.** Biomonitoring gill net total catch by each species for each lake area from 1997 through 2008. Walleye stocking assessment data is not included.

| | Upper Cheat Lake | | | | | Lower Cheat Lake | | | | | Embayments | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Species** | **1997** | **1998** | **2001** | **2005** | **2008** | **1997** | **1998** | **2001** | **2005** | **2008** | **1997** | **1998** | **2001** | **2005** | **2008** |
| Black Crappie | 0 | 0 | 0 | 4 | 2 | 2 | 0 | 1 | 5 | 2 | 3 | 0 | 3 | 7 | 4 |
| Bluegill | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 0 | 0 |
| Brown Bullhead | 1 | 0 | 0 | 2 | 1 | 26 | 14 | 1 | 0 | 2 | 1 | 1 | 0 | 1 | 0 |
| Channel Catfish | 0 | 3 | 15 | 28 | 37 | 1 | 2 | 7 | 2 | 9 | 8 | 3 | 3 | 3 | 4 |
| Common Carp | 0 | 0 | 1 | 1 | 0 | 3 | 0 | 0 | 1 | 0 | 4 | 3 | 1 | 1 | 0 |
| Freshwater Drum | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Gizzard Shad | 1 | 17 | 15 | 1 | 29 | 3 | 7 | 1 | 10 | 7 | 30 | 4 | 9 | 10 | 2 |
| Golden Redhorse | 5 | 0 | 4 | 15 | 32 | 4 | 7 | 5 | 5 | 3 | 6 | 0 | 2 | 7 | 2 |
| Green Sunfish | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 14 | 0 | 0 | 0 | 3 |
| Hybrid Striped Bass | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 |
| Largemouth Bass | 1 | 0 | 0 | 2 | 1 | 6 | 4 | 0 | 1 | 2 | 4 | 2 | 3 | 1 | 2 |
| Northern Hogsucker | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 |
| Notheren Pike | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Pumpkinseed | 3 | 0 | 0 | 1 | 0 | 3 | 4 | 1 | 1 | 3 | 2 | 2 | 1 | 3 | 0 |
| Rainbow Trout | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Rock Bass | 0 | 1 | 4 | 19 | 13 | 2 | 4 | 4 | 6 | 15 | 1 | 5 | 1 | 6 | 5 |
| Sauger | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |
| Silver Redhorse | 2 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 12 | 0 | 0 | 0 | 0 |

**Table 15.** continued.

| | Upper Cheat Lake | | | | | Lower Cheat Lake | | | | | Embayments | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Species** | **1997** | **1998** | **2001** | **2005** | **2008** | **1997** | **1998** | **2001** | **2005** | **2008** | **1997** | **1998** | **2001** | **2005** | **2008** |
| Smallmouth Bass | 0 | 0 | 1 | 12 | 10 | 1 | 0 | 0 | 4 | 8 | 0 | 0 | 0 | 3 | 1 |
| Spotted Bass | 0 | 0 | 0 | 14 | 0 | 0 | 0 | 0 | 1 | 1 | 1 | 1 | 0 | 2 | 3 |
| Walleye | 0 | 0 | 2 | 11 | 10 | 1 | 0 | 1 | 6 | 11 | 0 | 0 | 1 | 1 | 0 |
| White Bass | 0 | 0 | 2 | 16 | 60 | 2 | 4 | 0 | 5 | 5 | 5 | 0 | 5 | 2 | 2 |
| White Crappie | 0 | 0 | 0 | 0 | 0 | 0 | 3 | 0 | 0 | 0 | 1 | 0 | 9 | 0 | 0 |
| White Sucker | 0 | 0 | 0 | 3 | 6 | 0 | 1 | 1 | 0 | 0 | 0 | 1 | 3 | 0 | 1 |
| Yellow Bullhead | 1 | 0 | 0 | 1 | 0 | 2 | 1 | 3 | 1 | 1 | 0 | 1 | 1 | 2 | 0 |
| Yellow Perch | 2 | 3 | 0 | 20 | 9 | 13 | 19 | 4 | 4 | 10 | 0 | 1 | 2 | 4 | 2 |
| Total | 16 | 24 | 44 | 150 | 211 | 73 | 71 | 30 | 53 | 80 | 92 | 26 | 46 | 53 | 32 |

**Table 16.** Biomonitoring gill net CPUE by each species for each lake area from 1997 through 2008. Walleye stocking assessment data is not included.

| | Upper Cheat Lake | | | | | Lower Cheat Lake | | | | | Embayments | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Species** | **1997** | **1998** | **2001** | **2005** | **2008** | **1997** | **1998** | **2001** | **2005** | **2008** | **1997** | **1998** | **2001** | **2005** | **2008** |
| Black Crappie | 0.0 | 0.0 | 0.0 | 0.3 | 0.2 | 0.2 | 0.0 | 0.0 | 0.4 | 0.2 | 0.4 | 0.0 | 0.3 | 0.9 | 0.5 |
| Bluegill | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.1 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.1 | 0.1 | 0.0 | 0.0 |
| Brown Bullhead | 0.3 | 0.0 | 0.0 | 0.2 | 0.1 | 2.2 | 0.6 | 0.0 | 0.0 | 0.2 | 0.1 | 0.1 | 0.0 | 0.1 | 0.0 |
| Channel Catfish | 0.0 | 0.5 | 2.5 | 2.3 | 3.1 | 0.1 | 0.1 | 0.3 | 0.2 | 0.8 | 1.0 | 0.3 | 0.3 | 0.4 | 0.5 |
| Common Carp | 0.0 | 0.0 | 0.2 | 0.1 | 0.0 | 0.3 | 0.0 | 0.0 | 0.1 | 0.0 | 0.5 | 0.3 | 0.1 | 0.1 | 0.0 |
| Freshwater Drum | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.1 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| Gizzard Shad | 0.3 | 2.8 | 2.5 | 0.1 | 2.4 | 0.3 | 0.3 | 0.0 | 0.8 | 0.6 | 3.8 | 0.3 | 0.8 | 1.3 | 0.3 |
| Golden Redhorse | 1.3 | 0.0 | 0.7 | 1.3 | 2.7 | 0.3 | 0.3 | 0.2 | 0.4 | 0.3 | 0.8 | 0.0 | 0.2 | 0.9 | 0.3 |
| Green Sunfish | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.1 | 0.1 | 1.8 | 0.0 | 0.0 | 0.0 | 0.4 |
| Hybrid Striped Bass | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.1 | 0.0 | 0.0 |
| Largemouth Bass | 0.3 | 0.0 | 0.0 | 0.2 | 0.1 | 0.5 | 0.2 | 0.0 | 0.1 | 0.2 | 0.5 | 0.2 | 0.3 | 0.1 | 0.3 |
| Northern Hogsucker | 0.0 | 0.0 | 0.0 | 0.0 | 0.1 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.1 | 0.0 | 0.0 | 0.0 |
| Notheren Pike | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.1 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| Pumpkinseed | 0.8 | 0.0 | 0.0 | 0.1 | 0.0 | 0.3 | 0.2 | 0.0 | 0.1 | 0.3 | 0.3 | 0.2 | 0.1 | 0.4 | 0.0 |
| Rainbow Trout | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| Rock bass | 0.0 | 0.2 | 0.7 | 1.6 | 1.1 | 0.2 | 0.2 | 0.2 | 0.5 | 1.3 | 0.1 | 0.4 | 0.1 | 0.8 | 0.6 |
| Sauger | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.1 |
| Silver Redhorse | 0.5 | 0.0 | 0.0 | 0.0 | 0.0 | 0.1 | 0.0 | 0.0 | 0.0 | 0.0 | 1.5 | 0.0 | 0.0 | 0.0 | 0.0 |
| Smallmouth Bass | 0.0 | 0.0 | 0.2 | 1.0 | 0.8 | 0.1 | 0.0 | 0.0 | 0.3 | 0.7 | 0.0 | 0.0 | 0.0 | 0.4 | 0.1 |
| Spotted Bass | 0.0 | 0.0 | 0.0 | 1.2 | 0.0 | 0.0 | 0.0 | 0.0 | 0.1 | 0.1 | 0.1 | 0.1 | 0.0 | 0.3 | 0.4 |

**Table 16.** continued.

| | Upper Cheat Lake | | | | | Lower Cheat Lake | | | | | Embayments | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Species** | **1997** | **1998** | **2001** | **2005** | **2008** | **1997** | **1998** | **2001** | **2005** | **2008** | **1997** | **1998** | **2001** | **2005** | **2008** |
| Walleye | 0.0 | 0.0 | 0.3 | 0.9 | 0.8 | 0.1 | 0.0 | 0.0 | 0.5 | 0.9 | 0.0 | 0.0 | 0.1 | 0.1 | 0.0 |
| White Bass | 0.0 | 0.0 | 0.3 | 1.3 | 5.0 | 0.2 | 0.2 | 0.0 | 0.4 | 0.4 | 0.6 | 0.0 | 0.4 | 0.3 | 0.3 |
| White Crappie | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.1 | 0.0 | 0.0 | 0.0 | 0.1 | 0.0 | 0.8 | 0.0 | 0.0 |
| White Sucker | 0.0 | 0.0 | 0.0 | 0.3 | 0.5 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.1 | 0.3 | 0.0 | 0.1 |
| Yellow Bullhead | 0.3 | 0.0 | 0.0 | 0.1 | 0.0 | 0.2 | 0.0 | 0.1 | 0.1 | 0.1 | 0.0 | 0.1 | 0.1 | 0.3 | 0.0 |
| Yellow Perch | 0.5 | 0.5 | 0.0 | 1.7 | 0.8 | 1.1 | 0.8 | 0.2 | 0.3 | 0.8 | 0.0 | 0.1 | 0.2 | 0.5 | 0.3 |

**Table 17.** Proportional Stock Density (PSD) of selected species from 1997 to 2005 at Cheat Lake and embayments. BNGN = gill nets; BTEF = boat electrofishing

| Species | Year | Season | Gear | Total | Number of Quality Size | PSD | Recommended PSD Range |
|---|---|---|---|---|---|---|---|
| Channel catfish | 1997 | Fall | BNGN | 8 | 3 | 38 | * |
| Channel catfish | 1998 | Fall | BNGN | 3 | 0 | 0 | |
| Channel catfish | 2001 | Fall | BNGN | 9 | 5 | 56 | |
| Channel catfish | 2005 | Fall | BNGN | 147 | 113 | 77 | |
| Channel catfish | 2008 | Fall | BNGN | 15 | 10 | 86 | |
| Largemouth bass | 1997 | Spring | BTEF | 14 | 7 | 50 | 40 - 70 |
| Largemouth bass | 1998 | Spring | BTEF | 23 | 12 | 52 | |
| Largemouth bass | 2001 | Spring | BTEF | 11 | 6 | 55 | |
| Largemouth bass | 2005 | Spring | BTEF | 21 | 12 | 57 | |
| Largemouth bass | 2008 | Spring | BTEF | 16 | 5 | 70 | |
| Smallmouth bass | 1998 | Spring | BTEF | 8 | 1 | 13 | 30 - 60 |
| Smallmouth bass | 2005 | Spring | BTEF | 14 | 1 | 7 | |
| Smallmouth bass | 2008 | Spring | BTEF | 21 | 1 | 13 | |
| Spotted bass | 1998 | Spring | BTEF | 1 | 0 | 0 | * |
| Spotted bass | 2001 | Spring | BTEF | 6 | 0 | 0 | |
| Spotted bass | 2005 | Spring | BTEF | 9 | 1 | 11 | |
| Spotted bass | 2008 | Spring | BTEF | 10 | 0 | 0 | |
| Walleye | 1997 | Fall | BNGN | 1 | 1 | 100 | 30 - 60 |
| Walleye | 2001 | Fall | BNGN | 7 | 5 | 71 | |
| Walleye | 2005 | Fall | BNGN | 30 | 24 | 80 | |
| Walleye | 2008 | Fall | BNGN | 12 | 8 | 100 | |
| Yellow perch | 1997 | Fall | BNGN | 12 | 10 | 83 | 30 - 60 |
| Yellow perch | 1998 | Fall | BNGN | 8 | 8 | 100 | |
| Yellow perch | 2001 | Fall | BNGN | 1 | 0 | 0 | |
| Yellow perch | 2005 | Fall | BNGN | 97 | 93 | 96 | |
| Yellow perch | 2008 | Fall | BNGN | 13 | 4 | 92 | |

*PSD not established for these species

**Table 18.** Relative weights (Wr) of selected species collected with fall biomonitoring nets and fall electrofishing from 1997 to 2008 at Cheat Lake and embayments.

| Species | 1997 | 1998 | 2001 | 2005 | 2008 |
|---|---|---|---|---|---|
| Channel Catfish | 107 | 95 | 94 | 97 | 99 |
| Largemouth Bass | 86 | 87 | 90 | 91 | 101 |
| Smallmouth Bass | 98 | 90 | 85 | 87 | 100 |
| Spotted Bass | 95 | 84 | 83 | 93 | 129 |
| Walleye | 100 | . | 84 | 88 | 98 |
| Yellow Perch | 79 | 73 | 67 | 83 | 95 |

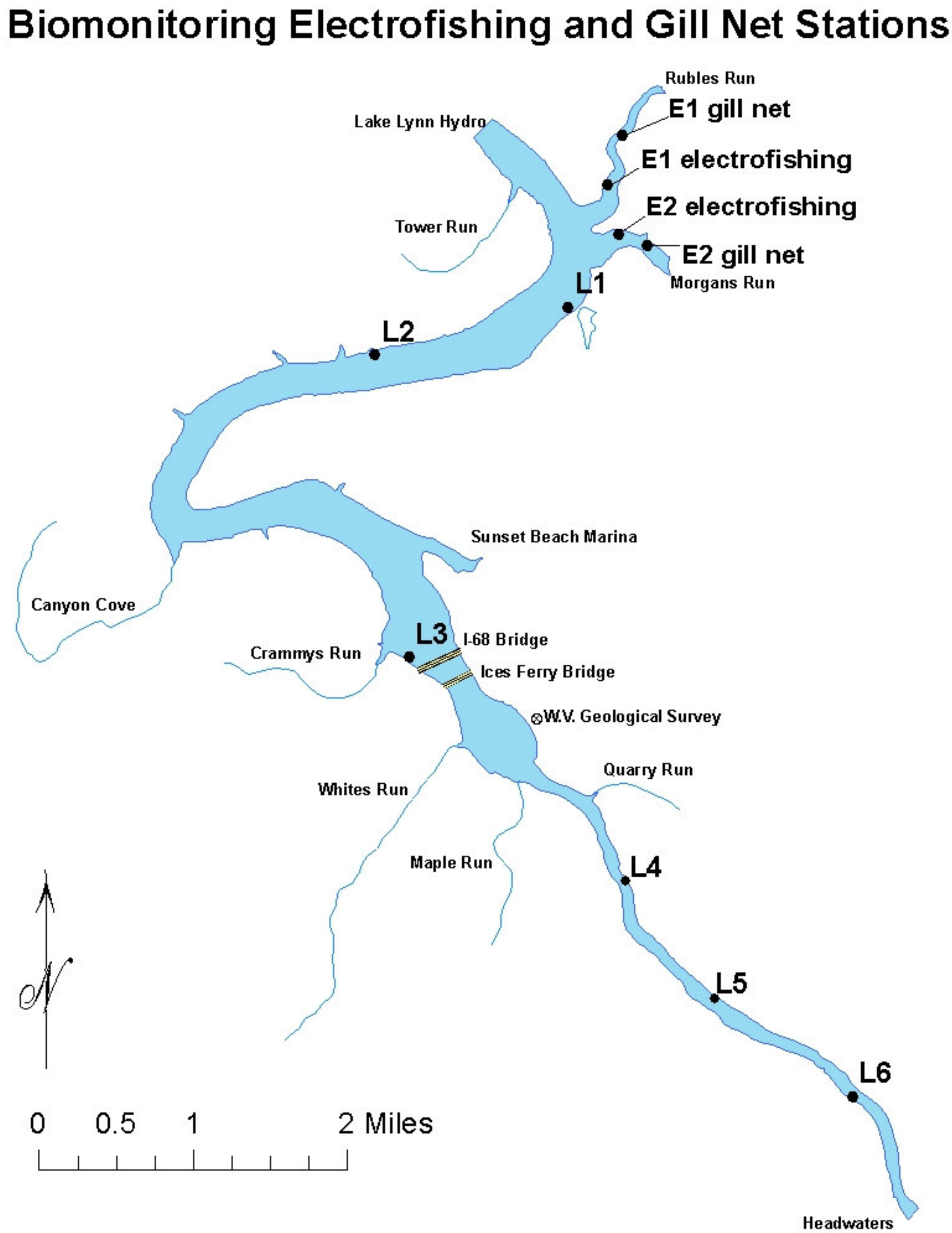


**Figure 15.** Cheat Lake biomonitoring stations, 2008. Electrofishing and gill net sets were conducted at all stations in the main body of Cheat Lake (L1 – L6).

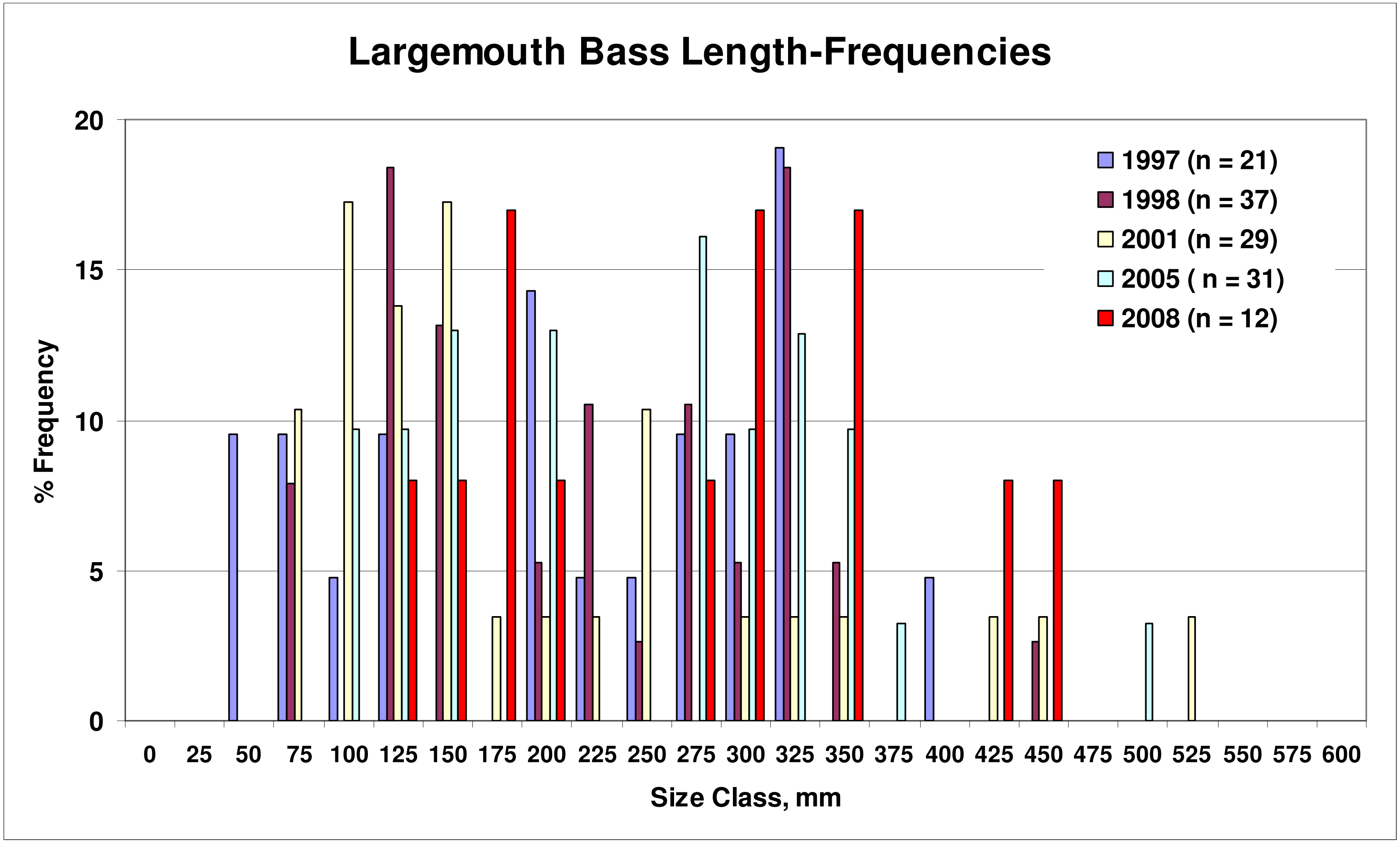


**Figure 16.** Length-frequencies for largemouth bass captured by spring electrofishing during Cheat Lake biomonitoring, 1997 - 2005**.** Due to high spring turbidities, summer electrofishing was conducted in 2008.

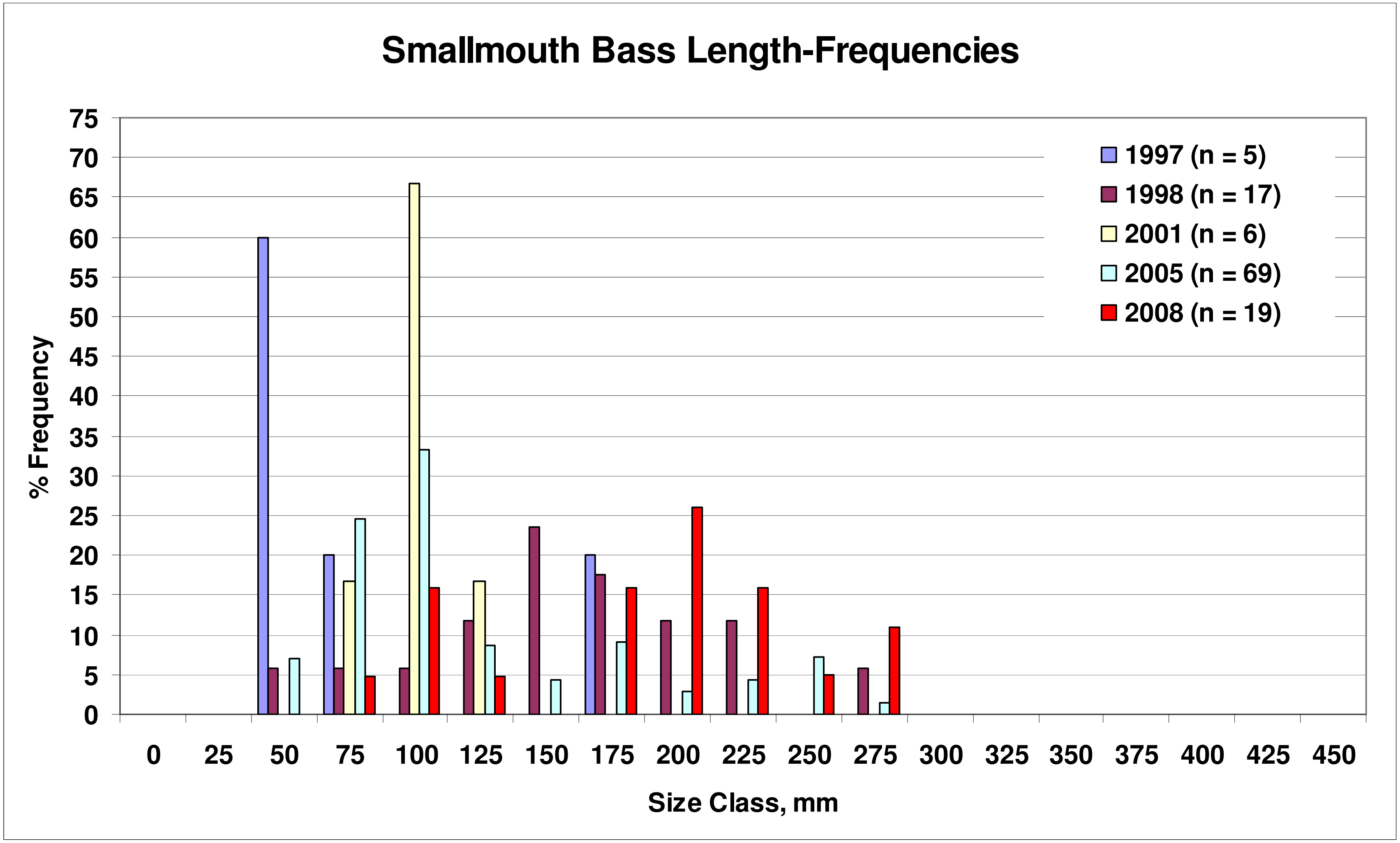


**Figure 17.** Length-frequencies for smallmouth bass captured by spring electrofishing during the Cheat Lake biomonitoring study, 1997 - 2005. Due to high spring turbidities, summer electrofishing was conducted in 2008.

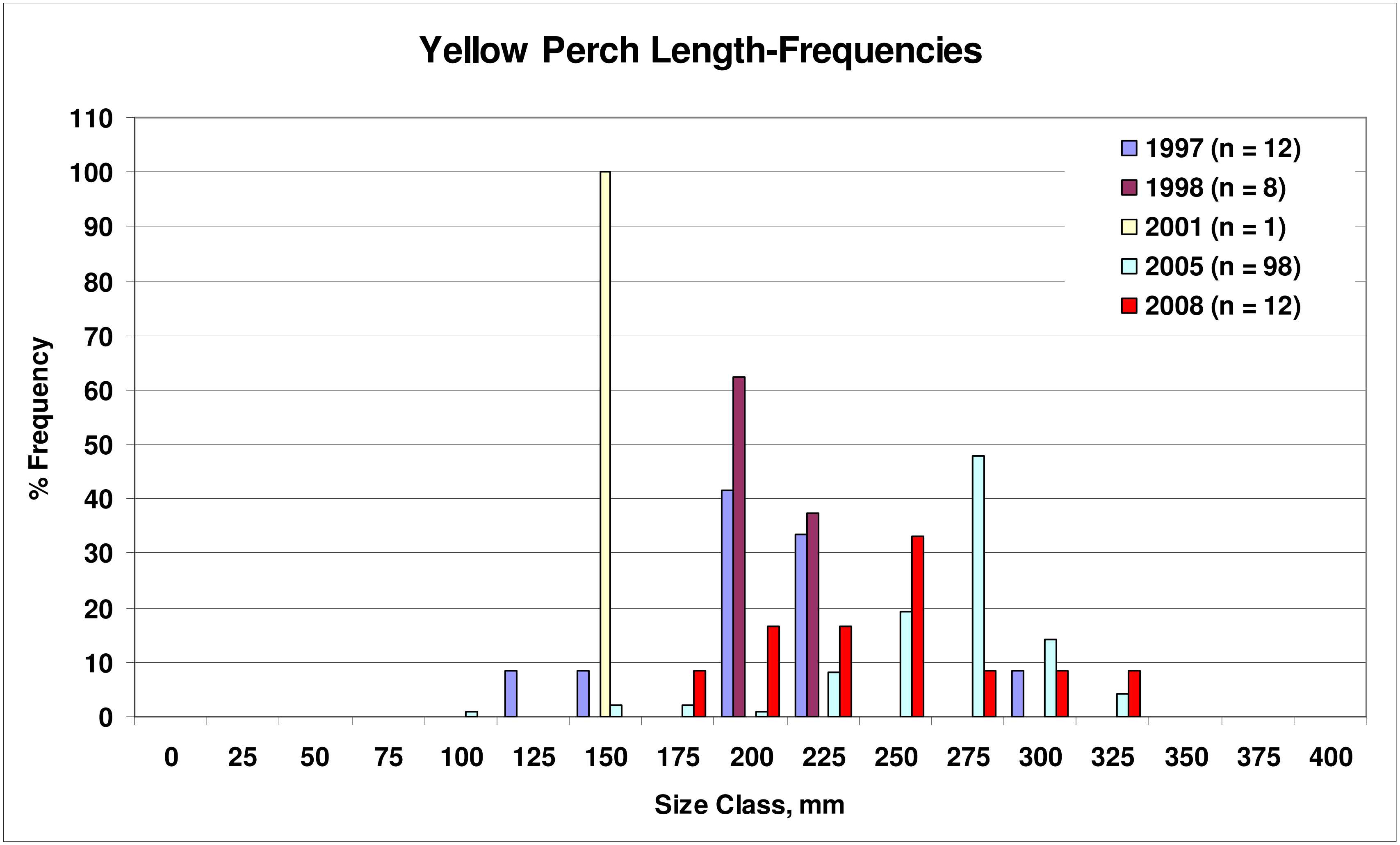


**Figure 18.** Length-frequencies for yellow perch captured with fall biomonitoring gill nets, 1997 - 2008.

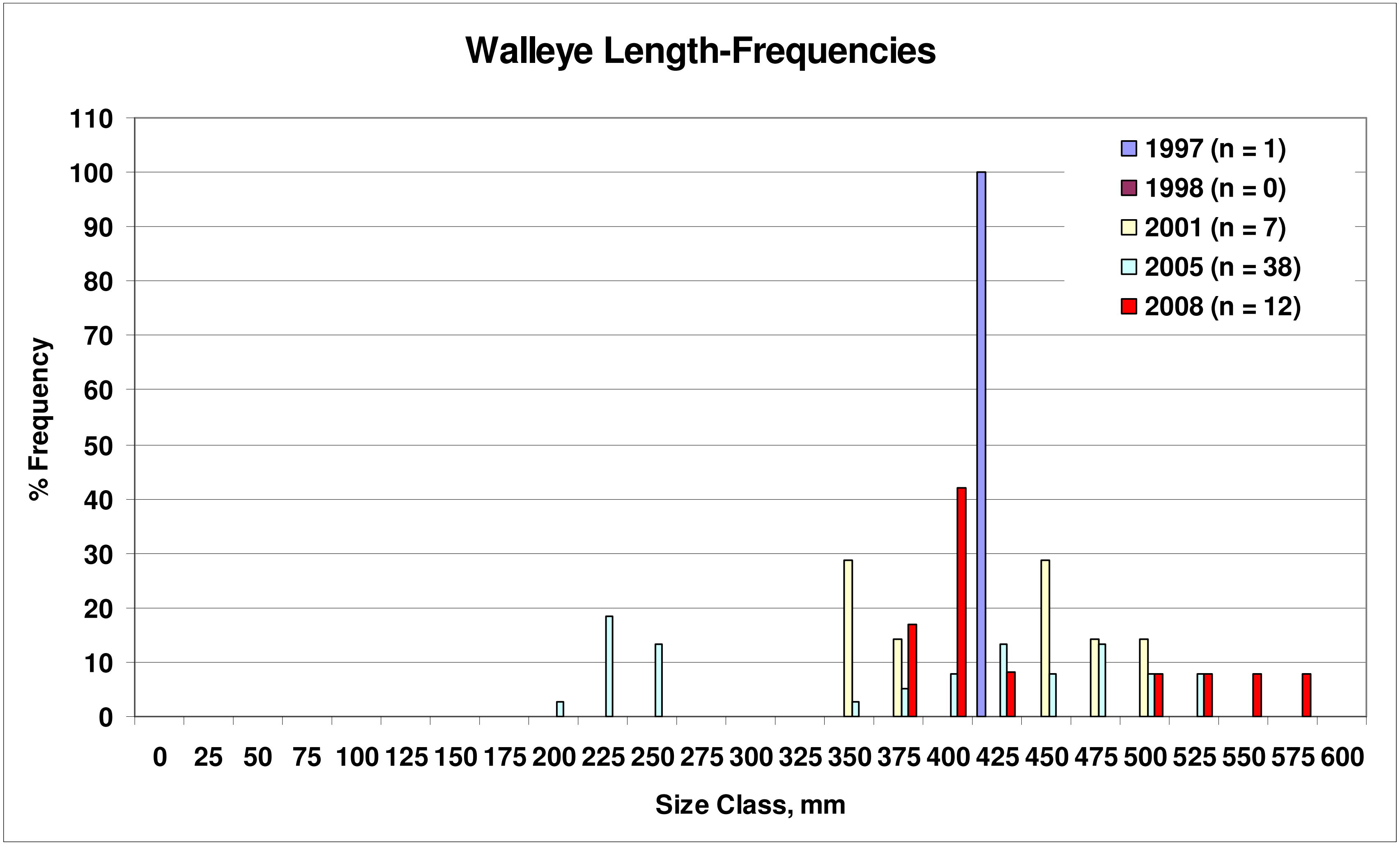


**Figure 19.** Length-frequencies for walleye captured with fall biomonitoring gill nets, 1997 - 2008.

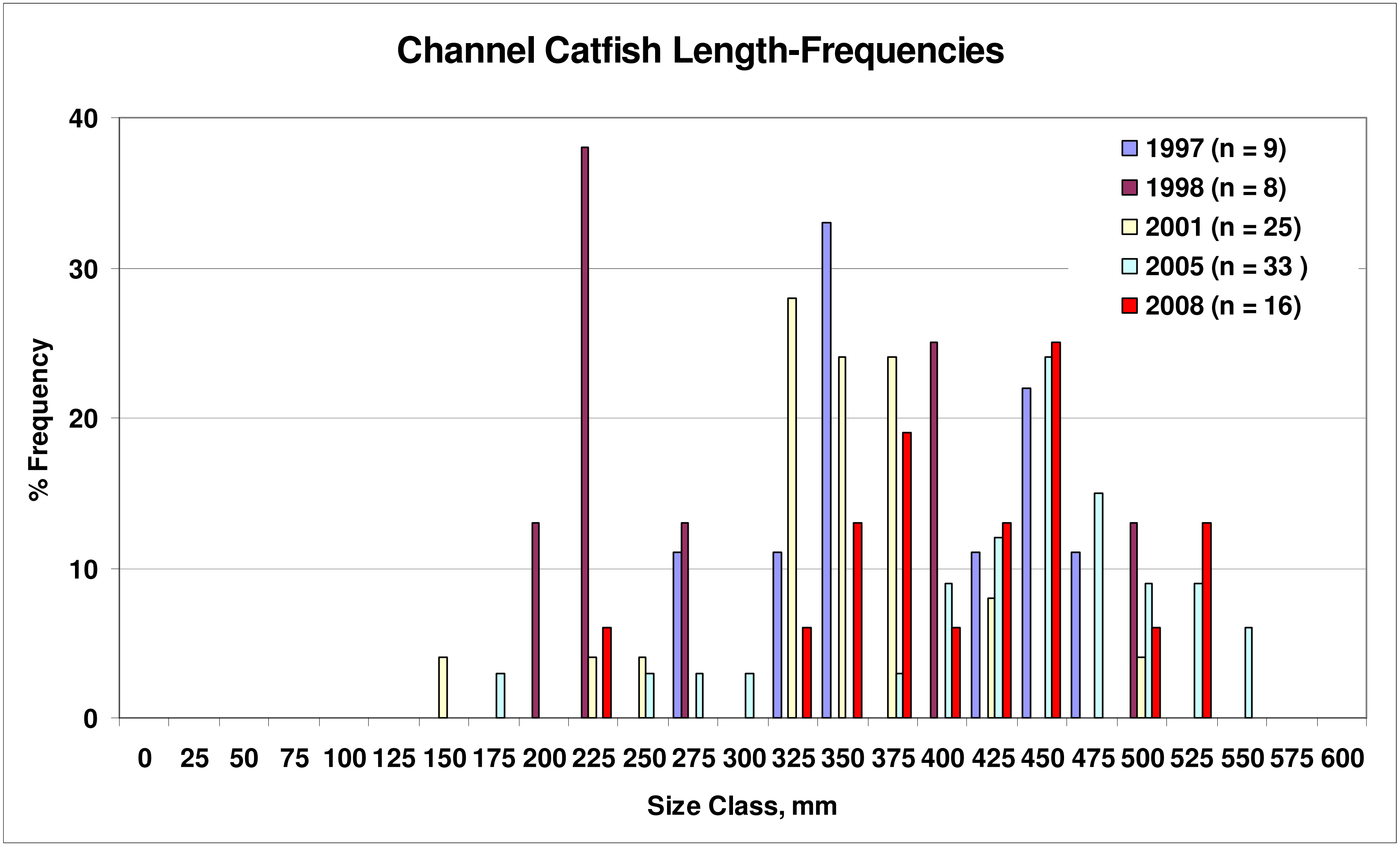


**Figure 20.** Length-frequencies for channel catfish captured with fall biomonitoring gill nets, 1997 - 2008.

# Chapter 5: Walleye Stocking Assessment (Task 5)

## Introduction

Walleye are a popular sport fish in West Virginia. However, West Virginia's reservoirs support limited walleye fisheries that were historically dependent upon periodic fry stockings. Construction of a new hatchery in 2003 resulted in a new capability of the WVDNR to raise and stock fingerling walleyes. A walleye restoration plan was developed for Cheat Lake based on existing habitat, lake elevation fluctuations, and improving water quality.

## Methods

Four walleye stocking assessment surveys were conducted using gill nets in March, April, and November. Nets were 150-ft in length (6-ft deep with 6 25-ft. panels of 1.5, 2.0, 2.5, 1.5, 2.0, 2.5-inch bar length) and were set perpendicular to the shoreline (Figure 21). Six gill nets were set during each sampling event and an overnight set was considered 1 net-night. Station location, frequency of sampling, and netting methodologies were consistent with the 2005, 2006, and 2007 walleye stocking assessments. Walleyes were measured to the nearest millimeter and weighed to the nearest 2 grams. To determine age and growth, otoliths were removed from walleyes that could not be released.

Analysis included Wr, PSD, and CPUE. Wr was determined using the equations of Anderson and Neumann (1996).

## Results

### Catch-Per-Unit-Effort (CPUE)

A total of 48 walleyes were collected during the spring and fall stocking assessment surveys. Mean CPUE for all surveys combined was 2.0 fish/net-night, which is greater than the 3 previous years of walleye stocking assessments (Table 19). As in previous surveys, mean CPUE varies by season. CPUE of the fall surveys was 100% greater than spring collections.

### Relative Weight (Wr) and Proportional Stock Density (PSD)

Fish condition was assessed during 2008 with Wr. The mean Wr observed for walleye was 81, suggesting fair condition and sufficient forage (Table 20). However, this is the lowest Wr for walleyes since walleye stocking assessments began in 2005. Mean

Wr for an entire sample can mask important length-related trends in fish condition (Murphy et al. 1991), therefore mean Wr was calculated for 25mm length groups and plotted against length groups (Figure 22). This analysis indicates a decrease in condition as Cheat Lake's walleyes increase in length. All Wr values represent fish collected in the fall so that spawning activities did not bias the results (Murphy and Willis 1996). Appropriate walleye forage may be unavailable for larger walleyes resulting in lower Wr.

PSD values were calculated for an indication of the quality of walleye population size structure (Table 21). Results indicate that 96% of walleyes collected in 2008 were ≥ 380 mm (≥ 15-inches), which is considered quality size for anglers. This is greater than the recommended range (30 – 60) by Anderson (1976) for a balanced population and is very similar to 2005 results. However, nearly 3 times as many walleye were collected in 2008 than in 2005.

Walleye experimental gill nets were not used during the fall of 2007. Instead, standard experimental gill nets (125-ft in length, 6-ft deep with 5 panels of 0.75, 1.00, 1.50, 1.75, and 2.00-inch bar length) were used as part of the WVDNR reservoir project. These nets are selective for smaller walleyes than the walleye experimental nets. Consequently, PSD results were significantly lower in 2007 than any other study year (Table 21).

## Length-Frequencies

Length-frequencies of walleyes captured during the walleye stocking assessment surveys were compared to previous stocking assessments (Figure 23). The length-frequency analysis for walleyes collected in 2008 was similar to the 2006 results, with the exception that walleyes were collected in larger length groups in 2008 than in previous years. In 2007, only standard experimental gill nets were used, which select for smaller walleyes. Those nets collected walleyes as small as 234 mm, representing natural reproduction or good survival of stocked fish.

## Population Age Structure

Otoliths were collected from 29 walleyes to complete the Cheat Lake age-key. Age and growth data are currently being processed and will be available in the 2009 report. Based on the WVDNR statewide walleye age-key in 2005 (Table 22), the population age structure for walleyes in Cheat Lake indicated that quality fish greater than 15-inches were available to anglers after 2 years of growth. Angler preferred walleyes, greater than 20-inches, can potentially occur within in 2 years, but most likely need at least 4 years of growth.

## Conclusions

Results of the 2008 walleye monitoring and assessment survey, as well as anecdotal angler reports, indicate a walleye sport fishery is developing in Cheat Lake. The contribution of stocked fish to the population cannot be determined at this time, although it is clear that natural reproduction is occurring. The two largest walleyes collected in each of the 2005-2008 assessment surveys were assigned a youngest possible age based on the statewide walleye age-key. All of these large walleyes were from the 2002-2005 year classes or earlier year classes if these fish were actually older than the age assigned. Walleyes were not stocked in 2001-2003; fry (Great Lakes strain) were stocked in 1999-2000 and fingerlings in 2004-2007 (Table 23).

Studies have shown that stocking walleyes in consecutive years can result in density-dependent decreases in walleye condition, growth, stocking survival, or abundance of adjacent year-classes (Li et al. 1996a; Li et al. 1996b). Walleyes were not stocked in 2008, but fingerlings will be stocked in 2009 at a rate of 30 per acre. A New River strain of walleyes has been stocked in the Cheat River upstream of Rowlesburg since 2005 and will be stocked again in 2009 (Table 23).

The 2008 CPUE was the highest since surveys started in 1997. Numbers of larger walleyes collected have increased and Wr of larger walleyes is less than Wr for smaller walleyes. PSD remains high and the largest number of walleyes was collected in 2008. Collectively, these observations substantiate the continued increase in the Cheat Lake walleye population.

Water level fluctuations during the spring and early summer are also important because of the effect on spawning success, egg survival, and availability of food for fry, fingerlings, and adults. Turbid water conditions and lake elevation fluctuations resulting from storm events in April and May might have reduced walleye reproductive success in 2008. Future walleye monitoring will continue to focus on abundance and age structure assessment, movement, and reproductive success based on the current water level regime.

**Table 19.** Comparisons of gill net CPUE for walleyes collected during the Cheat Lake walleye stocking assessments, 2005 - 2008.

| Species | 2005 | 2006 | 2007 | 2008 |
|---|---|---|---|---|
| Walleye | 1.3 | 0.4 | 0.8 | 2.0 |

2005, 2006, and 2008: walleye experimental gill nets; 2007: standard experimental gill nets.

**Table 20.** Relative weights (Wr) of walleyes collected during the Cheat Lake walleye stocking assessments, 2005 - 2008.

| Species | 2005 | 2006 | 2007 | 2008 |
|---|---|---|---|---|
| Walleye | 88 | 87 | 96 | 81 |

**Table 21.** Proportional Stock Density (PSD) of walleyes collected during the Cheat Lake walleye stocking assessments, 2005 – 2008. Quality size = 381mm (15-inches).

| Species | Year | Season | Total | Number of Quality Size | PSD | Recommended PSD Range |
|---|---|---|---|---|---|---|
| Walleye | 2005 | Fall | 30 | 24 | 80 | 30 - 60 |
| Walleye | 2006 | All | 18 | 18 | 100 | |
| Walleye | 2007 | All* | 19 | 5 | 28 | |
| Walleye | 2008 | All | 48 | 46 | 96 | |

*Walleyes collected only in the fall

**Table 22.** Statewide age-key for walleye developed by the WVDNR (percent by size class).

| Size Class mm | Age 0 (N=94) | Age 1 (N=175) | Age 2 (N=90) | Age 3 (N=41) | Age 4 (N=26) | Age 5 (N=11) | Age 6 (N=9) | Age 7 (N=4) | Age 8 (N=8) | Age 9 (N=1) |
|---|---|---|---|---|---|---|---|---|---|---|
| **75** | | | | | | | | | | |
| **100** | | | | | | | | | | |
| **125** | | | | | | | | | | |
| **150** | 1 | | | | | | | | | |
| **175** | 12 | | | 2 | | | | | | |
| **200** | 34 | 2 | | | | | | | | |
| **225** | 35 | 6 | 2 | | | | | | | |
| **250** | 17 | 13 | 11 | | | | | | | |
| **275** | 1 | 21 | 28 | | | | | | | |
| **300** | | 14 | 12 | 10 | 4 | | | | | |
| **325** | | 15 | 4 | 12 | 8 | | | | | |
| **350** | | 11 | 6 | 12 | 23 | 27 | 11 | | | |
| **375** | | 11 | 3 | 22 | 15 | 18 | 11 | | 25 | |
| **400** | | 4 | 8 | 12 | | 9 | | 25 | 12 | |
| **425** | | 3 | 6 | | 8 | 9 | | | | 100 |
| **450** | | 1 | 10 | 5 | 8 | 9 | 11 | 25 | 25 | |
| **475** | | | 8 | 10 | 4 | | | | | |
| **500** | | | 2 | 2 | 12 | | | 25 | | |
| **525** | | | | 5 | 4 | 18 | 33 | | | |
| **550** | | | | 7 | 8 | | 11 | | | |
| **575** | | | | | 8 | | 11 | | | |
| **600** | | | | | | 9 | | 25 | 12 | |
| **625** | | | | | | | | | 12 | |
| **650** | | | | | | | 11 | | 12 | |
| **% Total** | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 |

**Table 23.** Walleye fry and fingerling stocking of Cheat Lake and Cheat River, 1999 – 2008.

| Walleye Genetic Strain | 1999 - Fry | | 2000 - Fry | | 2004 - Fingerling | | 2005 - Fingerling | | 2006 - Fingerling | | 2007 - Fingerling | | 2008 - Fingerling | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Cheat Lake | Cheat River | Cheat Lake | Cheat River | Cheat Lake | Cheat River | Cheat Lake | Cheat River | Cheat Lake | Cheat River | Cheat Lake | Cheat River | Cheat Lake | Cheat River |
| New River | . | . | . | . | . | . | . | 8,961 | . | 3,259 | . | . | . | 609 |
| Great Lakes | 1.7 mil | . | 1.0 mil | . | 50,000 | . | 43,812 | . | 46,362 | . | 24,794 | . | . | . |

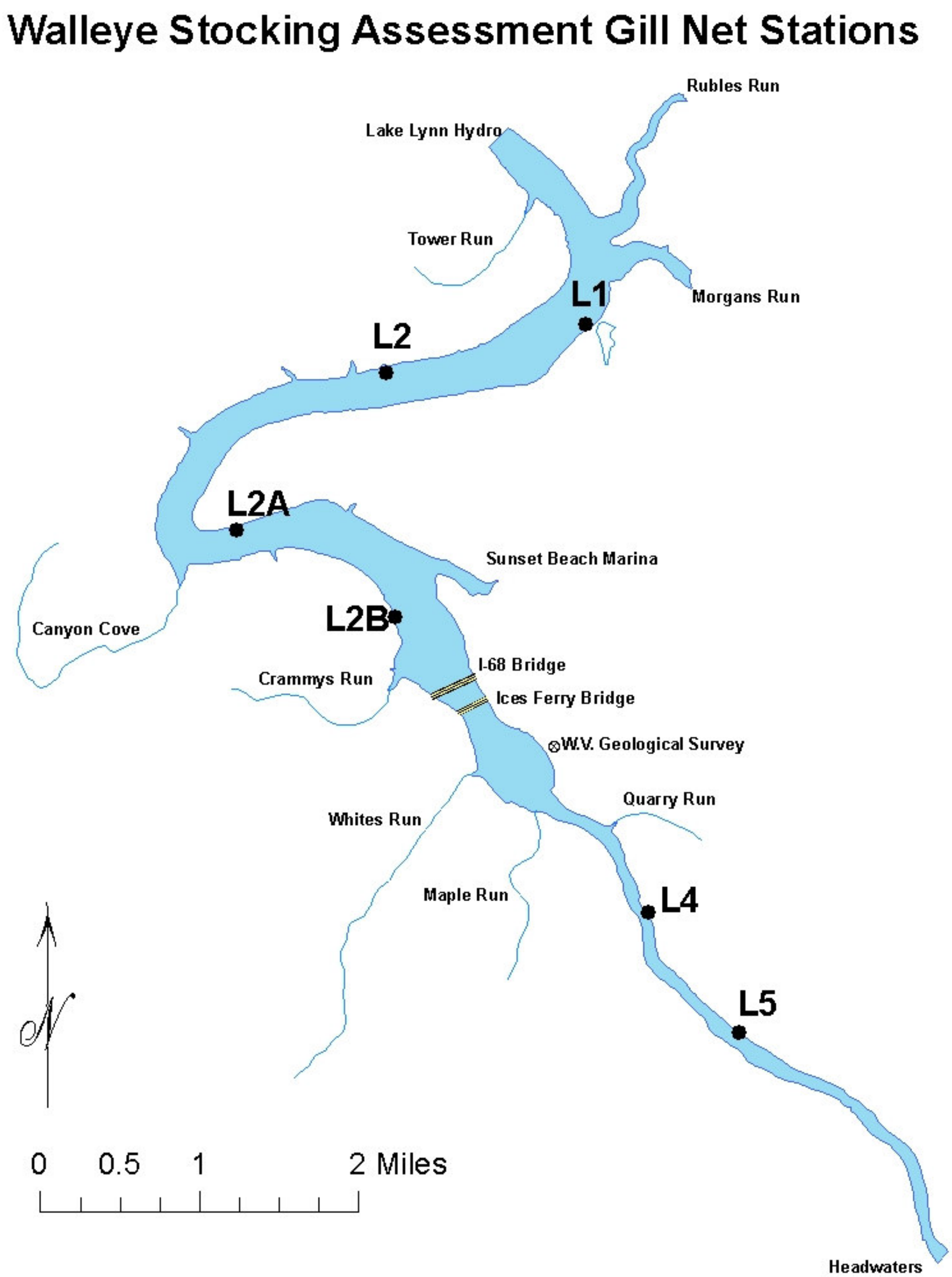


**Figure 21.** Cheat Lake walleye stocking assessment gill net sites, 2008.

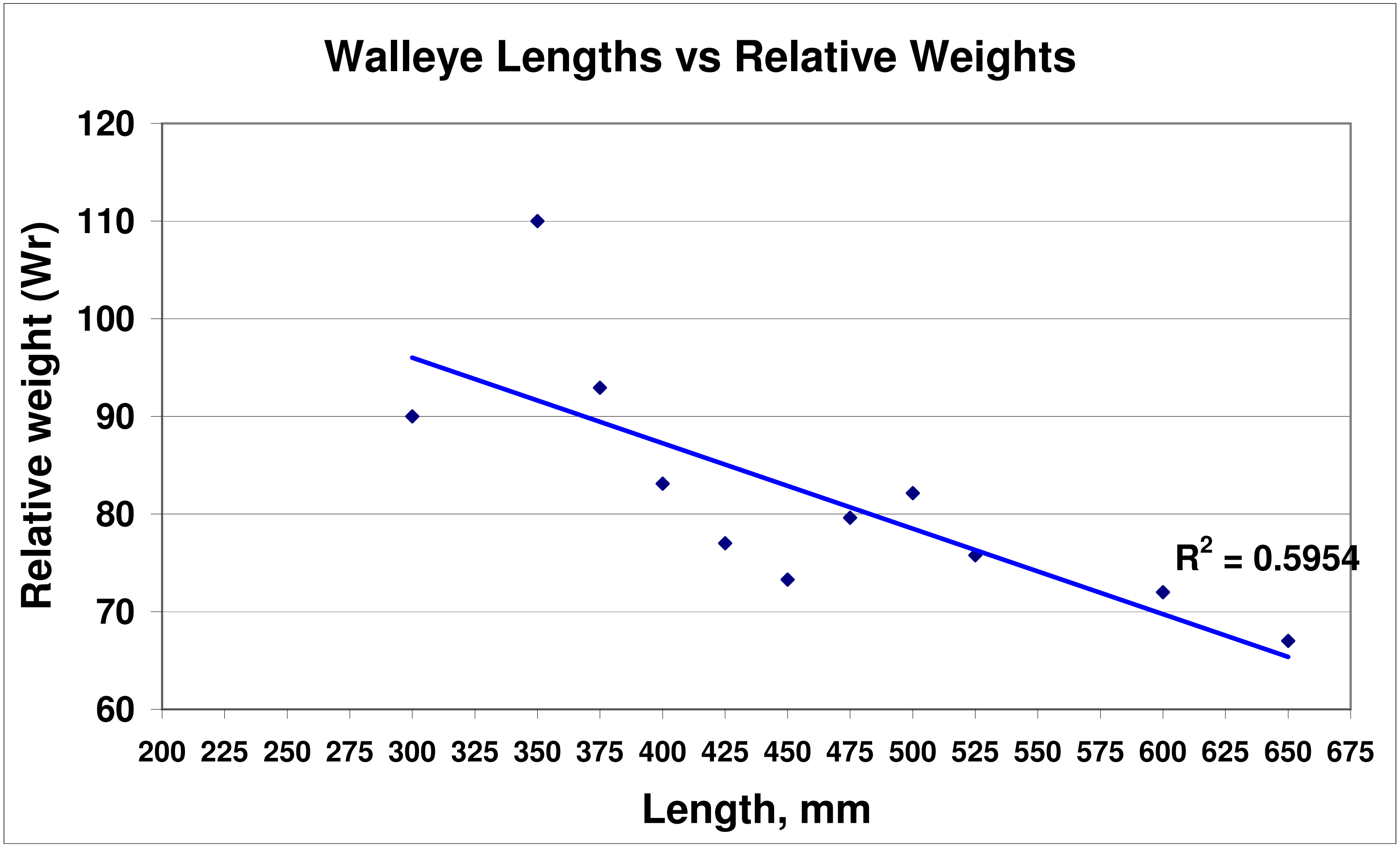


**Figure 22.** Relative weights plotted against 25mm length groups for walleyes collected during the 2008 walleye stocking assessment in Cheat Lake. Low Wr values for a given length group provides evidence of competition that may be negatively influencing condition.

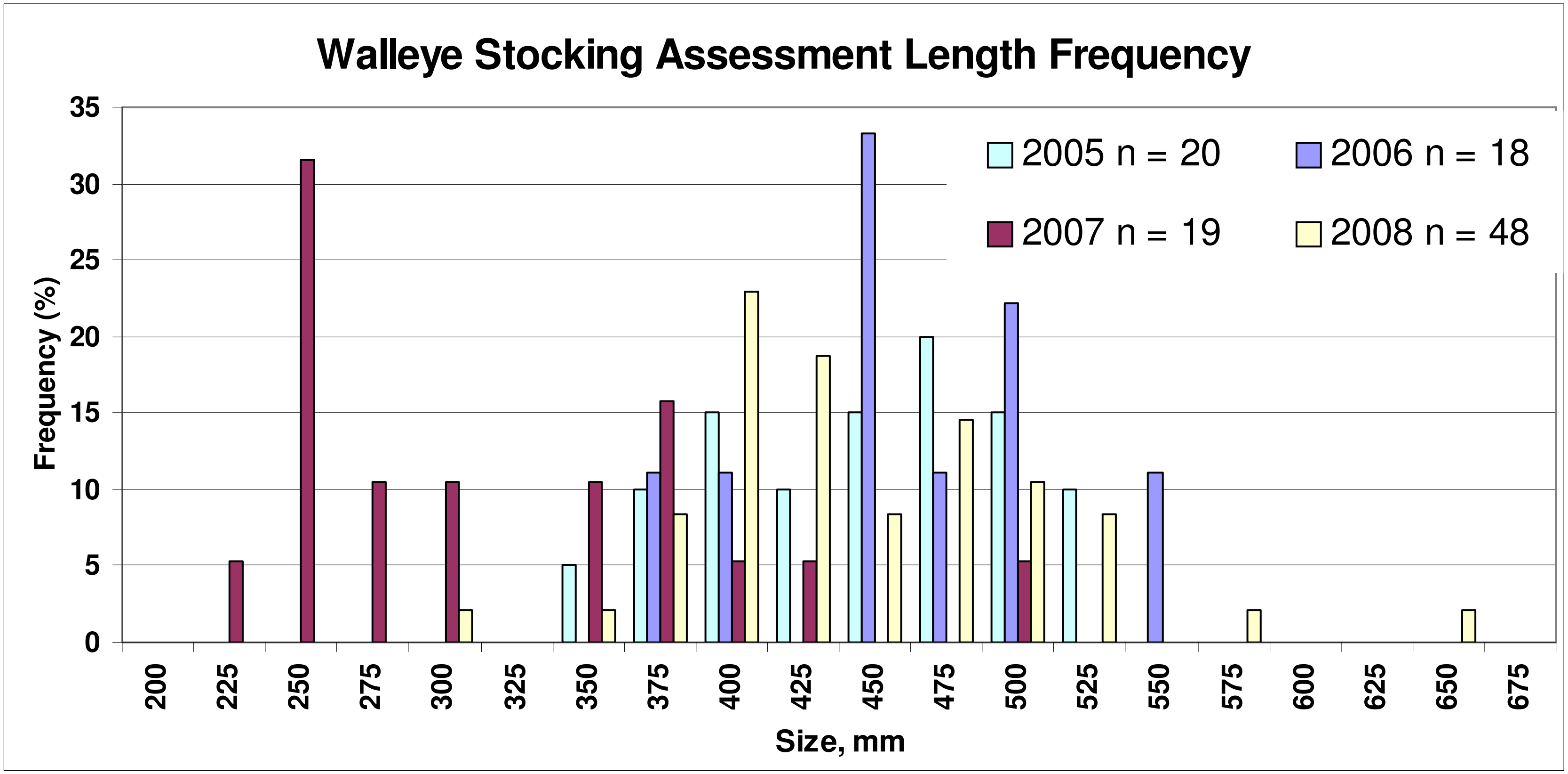


**Figure 23.** Length-frequencies for walleyes captured during walleye stocking assessment surveys from 2005 through 2008. Walleyes were collected with walleye experimental gill nets in 2005, 2006, and 2008. Standard experimental gill nets were used in 2007 as part of the WVDNR reservoir project.

# Chapter 6: Adult Walleye Movement (Task 6)

## Introduction

As part of the Cheat Lake walleye restoration plan, a telemetry study was initiated by the WVDNR in 2007 to provide insight into habitat use of walleyes in Cheat Lake and investigate the relationship between walleye location and lake elevation fluctuations.

## Methods

Walleyes greater than 225mm (12-inches) were tagged with anchor tags (T-Bar, Model T-104, Hallprint, Australia) that were color-coded and uniquely numbered. Each fish was retained for a minimum of 10 minutes after tagging to insure recovery. Fish that appeared stressed were not released. A reward was offered for each returned tag to encourage voluntary tag returns by anglers. Posters about the tagging program were placed at access sites around the lake, in the tailwater, and at area sporting good stores (Figure 24). Anglers were encouraged to return tags with information about capture location, date of capture, and whether the fish was released or harvested. Distance from tagging to recapture location was ascertained for each fish tagged and returned.

Four walleyes were collected in the spring of 2008 to implant Lotek™ MCFT Series coded microprocessor radio transmitters. Various collection methods were employed due to difficulty of collecting walleyes in the spring from Cheat Lake. Two walleyes were collected from the Tygart Lake tailwaters by electrofishing in April. Two more walleyes were provided later in April by Cheat Lake anglers. The transmitters provide both water temperature and depth of located fish. However, range is limited to approximately 12 meters in depth. Transmitters weigh 10g and should not exceed 2% of the weight of the fish to be implanted. Therefore, walleyes weighing a minimum of 500g were tagged. Following capture, the fish were transported to a West Virginia University (WVU) laboratory where transmitters were implanted following techniques described by Ross and Klein (1982). Walleyes were observed for 2 days prior to release to ensure recovery from capture, anesthesia, and transmitter implant.

Following observation, walleyes were released into Cheat Lake near Mont Chateau and tracked throughout the spring and summer with a Lotek™ SRX-600 receiver/datalogger. A 2-person boat crew conducted tracking by driving shoreline and mid-channel transects throughout Cheat Lake on a bi-weekly basis for the first 2 months and monthly thereafter. Tracking success was limited with the radio transmitters. Consequently, 3 more walleyes were collected with gill nets and were implanted with Lotek™ CAFT coded microprocessor acoustic transmitters in November. Though these transmitters do not provide depth and temperature of a located walleye, they do have greater range both horizontally and vertically (up to 400 meters) in the water column and require less scan time between frequencies, resulting in greater detection probability. Techniques described earlier were used to implant transmitters and track fish in the fall.

Lake elevation, water temperature, and tracking effort were recorded during telemetry surveys. When a walleye was located, depth and temperature were recorded. Location was also recorded with Global Positioning System (GPS). ArcMap was used to create location maps of observed walleyes.

## Results

### T-Bar Anchor Tags

In 2008, and additional 11 walleyes were tagged with T-bar tags for a total of 26 since 2005 (Table 24). As of December 2008, anglers have recaptured only 1 tagged walleye.

### Telemetry

During the 2-day observational period at the WVU laboratory following transmitter implantation, 1 walleye died and another's incision did not properly heal resulting in removal of its transmitter. The single mortality appeared to be due to gill net capture and not to transmitter implantation. Therefore, 5 walleyes were successfully implanted with transmitters and released back into Cheat Lake in 2008 (Table 25).

WVDNR personnel made 8 trips for a total of nearly 22 hours of radio telemetry tracking from April through December (Table 26). Seven trips and 18.5 hours were for walleyes implanted with radio transmitters, which as stated earlier, had a limited range. Only 2 of these trips were successful in locating an implanted walleye. Both detects were of the same walleye (Transmitter ID 12; Table 25) and in the area between Quarry Run and Ices Ferry Bridge on April 24 and May 1 (Figure 25). Movement of this particular walleye was approximately 1.0 and 1.5 miles downstream from the point of release. Depths of both locations were approximately 6-ft and water temperature was about 59$^{o}$ F.

## Conclusions

Due to the low success of locating radio tagged walleyes, no relationship between walleye movement, habitat, and or lake elevation fluctuations by the hydro station could be detected. Tracking will continue through 2009 with emphasis on the acoustic transmitters. WVDNR staff will attempt to collect three additional walleye to implant with acoustic transmitters in late winter or early spring 2009.

**Table 24.** Summary of walleyes tagged for the adult walleye movement study, 2005 - 2008.

| Species | Year Tagged | Length (mm) | Weight (g) | Tag Id Number | Tag Returned |
|---|---|---|---|---|---|
| Walleye | 2005 | 471 | 916 | 19500 | No |
| Walleye | 2005 | 429 | 722 | 19501 | No |
| Walleye | 2005 | 471 | 972 | 19502 | No |
| Walleye | 2005 | 509 | 1,182 | 19503 | No |
| Walleye | 2005 | 540 | 1,485 | 19550 | Yes |
| Walleye | 2005 | 509 | 1,260 | 19551 | No |
| Walleye | 2005 | 487 | 1,180 | 19552 | No |
| Walleye | 2006 | 515 | 1,400 | 19600 | No |
| Walleye | 2006 | 476 | 1,062 | 26191 | No |
| Walleye | 2006 | 465 | 1,060 | 26192 | No |
| Walleye | 2007 | 305 | 204 | 26250 | No |
| Walleye | 2007 | 285 | 174 | 26251 | No |
| Walleye | 2007 | 280 | 166 | 26253 | No |
| Walleye | 2007 | 286 | 168 | 26254 | No |
| Walleye | 2007 | 515 | 1,220 | 26264 | No |
| Walleye | 2008 | 410 | 592 | 26297 | No |
| Walleye | 2008 | 430 | 724 | 26298 | No |
| Walleye | 2008 | 570 | 1136 | 44208 | No |
| Walleye | 2008 | 544 | 1536 | 44209 | No |
| Walleye | 2008 | 446 | 696 | 44210 | No |
| Walleye | 2008 | 495 | 1330 | 19505 | No |
| Walleye | 2008 | 544 | 1490 | 19507 | No |
| Walleye | 2008 | 425 | . | 19509 | No |
| Walleye | 2008 | 368 | . | 19510 | No |
| Walleye | 2008 | 444 | . | 19511 | No |
| Walleye | 2008 | 457 | 808 | 19512 | No |

**Table 25.** Summary of walleyes implanted with transmitters and successfully released into Cheat Lake, 2008.

| Species | Date Captured | Date Released | Transmitter Type | Transmitter Id Number | T-Bar Number | Length, mm | Weight, g |
|---|---|---|---|---|---|---|---|
| Walleye | 3/27/08 | 4/1/08 | Radio | 14 | 4459 | 384 | 448 |
| Walleye | 3/27/08 | 4/1/08 | Radio | 12 | 4460 | 370 | 362 |
| Walleye | 4/6/08 | 4/7/08 | Radio | 11 | - | - | - |
| Walleye | 11/7/08 | 11/10/08 | Acoustic | Lotek code 14 | 19505 | 495 | 1330 |
| Walleye | 11/7/08 | 11/10/08 | Acoustic | Lotek code 11 | 19507 | 544 | 1490 |

**Table 26.** Summary of walleye telemetry for Cheat Lake, 2008.

| Date | Hours Tracked | Transmitter Type | ID Detected | Detection Location | GPS E (17 S) | GPS N | Depth, ft | Temp. F |
|---|---|---|---|---|---|---|---|---|
| 4/14/08 | 3 | Radio | None | NA | NA | NA | NA | NA |
| 4/24/08 | 2.75 | Radio | 12 | Mouth of Quarry Run | 059894 | 4390303 | 6 | 59 |
| 5/1/08 | 5 | Radio | 12 | Just upstream of Ices Ferry Bridge | 0598399 | 4390646 | 6 | 59 |
| 5/20/08 | 3.25 | Radio | None | NA | NA | NA | NA | NA |
| 7/2/08 | 2.5 | Radio | None | NA | NA | NA | NA | NA |
| 8/6/08 | 3 | Radio | None | NA | NA | NA | NA | NA |

**Table 26**. continued.

| Date | Hours Tracked | Transmitter Type | ID Detected | Detection Location | GPS E (17 S) | GPS N | Depth, ft | Temp. F |
|---|---|---|---|---|---|---|---|---|
| 8/14/08 | 4 | Radio | None | NA | NA | NA | NA | NA |
| 9/17/08 | 1 | Radio | None | NA | NA | NA | NA | NA |
| 12/15/08 | 4 | Acoustic | None | NA | NA | NA | NA | NA |

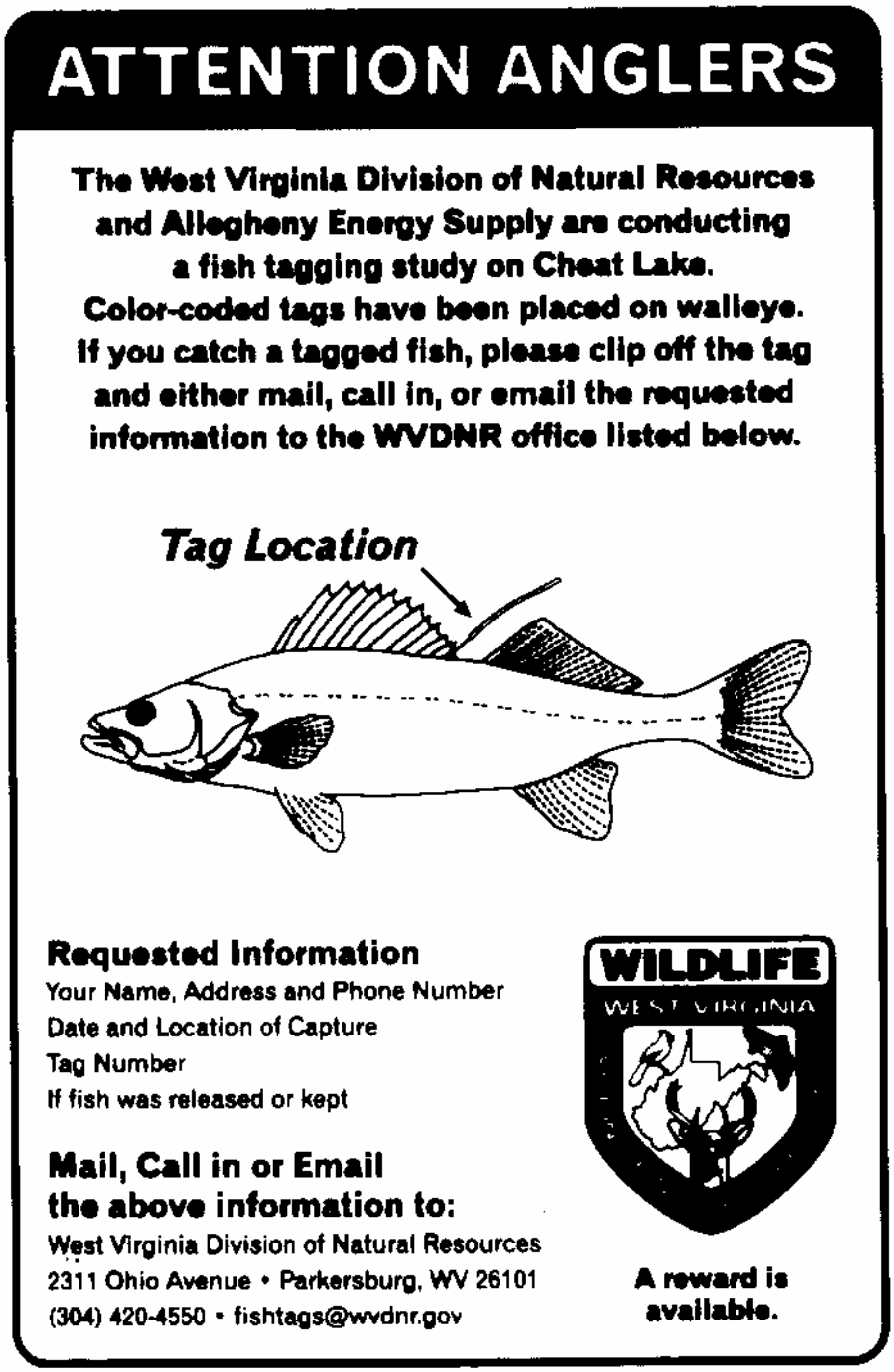


**Figure 24.** Example of signs posted at Cheat Lake access areas to inform anglers of the walleye movement study and provide information regarding tag returns and reward redemption.

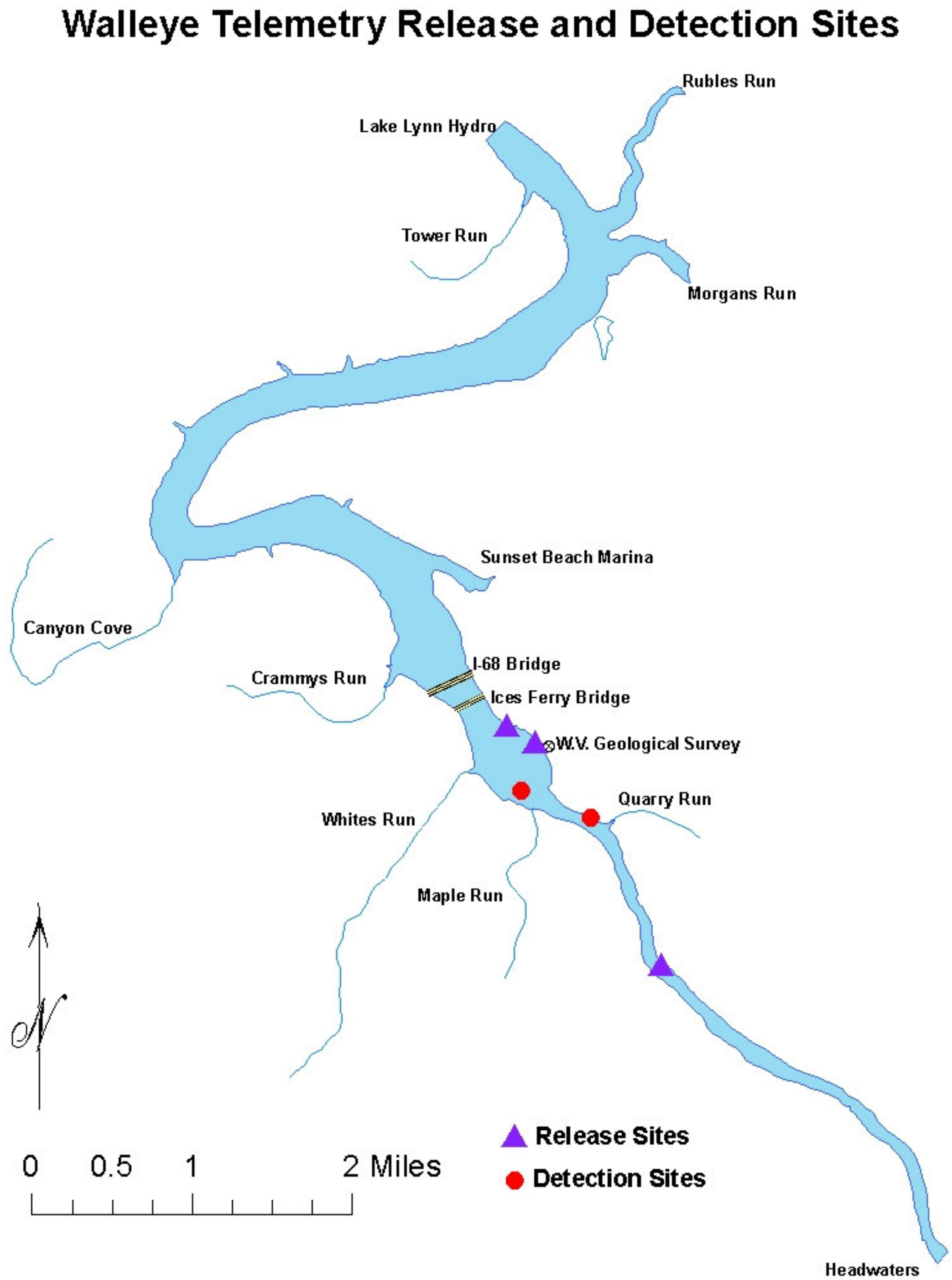


**Figure 25.** Release and detection sites for the Cheat Lake walleye telemetry study, 2008.

# Chapter 7: Physical and Chemical Water Quality Characteristics (Task 7)

## Introduction

As part of the FERC license agreement to address potential impacts from water withdrawal for hydropower, monitoring of dissolved oxygen and temperature was established by the WVDNR, PAFBC, and AES. In 2008 the WVDNR purchased a water quality meter that also measures pH and conductivity in addition to water temperature and dissolved oxygen. This was done to provide insight to the potential negative impacts that acid mine drainage sources within Cheat Lake have on water quality.

## Methods

Reservoir operations were monitored throughout the study period and compared with fish surveys and limnological characteristics. Temperature, dissolved oxygen, pH, and conductivity profiles were conducted in Cheat Lake at water quality stations W1, W1A, and W3 at 1 or 2-meter intervals 13 times from March through November (Figure 26). A hand-held water quality meter, Model WQC-24, made by DKK-TOA Corporation was used to conduct water quality profiles in 2008.

## Results

Temperature, dissolved oxygen, pH, and conductivity profiles were measured at 3 sites from March through November on 13 separate occasions. Station W1 located near the hydro station showed temperature stratification beginning in mid-April and continuing to the end of September (Table 27). Dissolved oxygen levels stayed relatively stable through 20 meters and then dropped below 5.0 mg/l at 16 meters during August (Table 28). The most severe stratification at station W1 occurred in September when oxygen fell below 3.0 mg/l at 7 meters. Cheat Lake fall turnover probably occurred in early October. pH ranged from 6.2 to 6.9 and was stable throughout the year (Table 29). Conductivity ranged from 37 to 203 and was consistently higher during late summer and early fall (Table 30). AES monitors daily conductivity, DO, temperature, and pH in Cheat River downstream of the dam from April through October in accordance with the FERC license. Their monitoring indicates that DO values in the tailwater may drop below 5.0 mg/l for several hours on some days during July, August, and September. The discharge depth is approximately 14 meters.

Station W1A experienced thermal stratification from mid-April through the end of May (Table 31). Profiles were not taken in June and July. From August through November, profiles showed very little temperature stratification at station W1A. Station W1A had sufficient levels of oxygen throughout the water column except for the bottom 2 meters in August and September and was not stratified throughout the rest of the year (Table 32). pH ranged from 6.9 to 7.2 and was typically 0.5 units higher than at station

W1 (Table 33). Conductivity ranged from 48 to 211 and was consistently higher during late summer and early fall (Table 34).

Station W3 is representative of the flowing Cheat River and did not show thermal or dissolved oxygen stratification (Tables 35 and 36). pH ranged from 6.7 to 7.1 and was similar to station W1A at mid-lake (Table 37). Conductivity ranged from 55 to 227 and was highest in September (Table 38).

## Conclusions

Water quality analysis indicated thermal stratification and low DO conditions do occur in Cheat Lake during the late summer and early fall months, specifically in the deepest part of the lake near the dam. These conditions are consistent with stratification conditions observed in other West Virginia reservoirs and do not appear to limit fish populations in the lake. Review of DO levels provided by AES indicated water releases from the lower strata of Cheat Lake during power generation did not cause anoxic conditions in the Cheat tailwater and Cheat River downstream from the hydro station. The reduction in the volume of oxygen-rich epilimnetic water from August through September reflects surface discharges during an extended period of low inflows.

Recorded pH values at the three water quality stations did not fall below 6.0 during 2008. However, pH values at the upper lake and mid-lake are typically 0.5 units higher than at the lower lake near the dam. This indicates acid mine drainage sources are entering lower Cheat Lake and may be impacting water quality, specifically pH. Due to the large dilution factor in Cheat Lake, negative impacts to the aquatic community from acid mine drainage are not obvious. Differences in conductivity were not observed among water quality stations, though they were elevated during later summer and early fall.

**Table 27.** Temperature profiles collected at station W1, March through November, 2008

| | Temperature (°F) | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **Depth (m)** | **10-Mar** | **1-Apr** | **14-Apr** | **1-May** | **20-May** | **29-May** | **24-Jun** | **14-Aug** | **15-Sep** | **22-Sep** | **6-Nov** |
| **Surface** | 44 | 51 | 58 | 63 | 56 | 69 | 78 | 76 | 70 | 73 | 60 |
| **1** | . | 50 | 58 | 63 | 56 | 65 | 76 | 76 | 69 | 73 | . |
| **2** | 43 | 49 | 58 | 62 | 56 | 64 | 76 | 75 | 69 | 73 | 59 |
| **3** | | 49 | 58 | 59 | 56 | 64 | 73 | 75 | 68 | 73 | . |
| **4** | 43 | 49 | 58 | 58 | 56 | 64 | 73 | 74 | 68 | 73 | 58 |
| **5** | . | 49 | 58 | 57 | 56 | 64 | 72 | 74 | 68 | 73 | . |
| **6** | 42 | 49 | 57 | 56 | 56 | 63 | 71 | 74 | 67 | 73 | 58 |
| **7** | . | 49 | 57 | 56 | 56 | 63 | 71 | 73 | 67 | 73 | . |
| **8** | 42 | 49 | 57 | 56 | 56 | 62 | 70 | 73 | 67 | 72 | 57 |
| **9** | . | 49 | 55 | 55 | 56 | 60 | 70 | 73 | 67 | 72 | . |
| **10** | 42 | 49 | 54 | 55 | 56 | 57 | 69 | 72 | 67 | 72 | 56 |
| **12** | 42 | 48 | 53 | 54 | 55 | 55 | 68 | 72 | 67 | 71 | 56 |
| **14** | 42 | 48 | 52 | 53 | 55 | 54 | 66 | 71 | 66 | 71 | 56 |
| **16** | 42 | 46 | 51 | 53 | 55 | 53 | 63 | 70 | 66 | 70 | 56 |
| **18** | 42 | 45 | 49 | 53 | 55 | 53 | 60 | 69 | 65 | 67 | 55 |
| **20** | 42 | 45 | . | 53 | 54 | 53 | 58 | 61 | 62 | 61 | 55 |
| **22** | . | 45 | . | 53 | 53 | 53 | 57 | 58 | 58 | 58 | 55 |
| **24** | . | . | . | . | . | . | 56 | 57 | 57 | 57 | 55 |

**Table 28.** Dissolved oxygen profiles collected at station W1 from March through November, 2008.

| | Dissolved Oxygen (mg/L) | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **Depth (m)** | **10-Mar** | **1-Apr** | **14-Apr** | **1-May** | **20-May** | **29-May** | **24-Jun** | **14-Aug** | **15-Sep** | **22-Sep** | **6-Nov** |
| **Surface** | 12.7 | 10.7 | 9.8 | 8.9 | 9.3 | 9.8 | 9.1 | 8.7 | 8.2 | 7.0 | 9.1 |
| **1** | | 11.2 | 9.7 | 8.9 | 9.4 | 9.2 | 9.2 | 8.6 | 8.0 | 6.9 | . |
| **2** | 12.9 | 11.2 | 9.7 | 8.9 | 9.5 | 9.1 | 9.0 | 7.3 | 7.8 | 6.9 | 9.2 |
| **3** | . | 11.0 | 9.6 | 8.9 | 9.8 | 9.1 | 9.2 | 7.1 | 7.8 | 6.8 | . |
| **4** | 12.9 | 11.0 | 9.7 | 9.2 | 10.5 | 9.0 | 8.2 | 7.0 | 7.6 | 6.8 | 9.1 |
| **5** | | 11.1 | 9.7 | 9.2 | 9.5 | 8.7 | 7.8 | 6.9 | 7.3 | 6.9 | . |
| **6** | 13.0 | 11.1 | 9.7 | 9.5 | 10.2 | 8.7 | 7.5 | 7.1 | 6.8 | 6.7 | 8.9 |
| **7** | . | 11.1 | 9.6 | 9.8 | 10.2 | 8.8 | 7.4 | 7.1 | 6.4 | 2.8 | . |
| **8** | 13.0 | 11.1 | 9.6 | 9.9 | 10.6 | 8.9 | 7.5 | 6.7 | 6.1 | 2.6 | 8.9 |
| **9** | 0.0 | 11.1 | 9.8 | 9.9 | 10.6 | 9.1 | 7.4 | 6.7 | 6.0 | 1.7 | . |
| **10** | 13.1 | 11.1 | 10.1 | 10.1 | 11.9 | 9.5 | 7.3 | 6.7 | 5.7 | 1.3 | 8.5 |
| **12** | 13.1 | 11.1 | 10.1 | 10.2 | 11.7 | 9.6 | 7.2 | 6.5 | 3.4 | 1.0 | 8.5 |
| **14** | 13.1 | 11.3 | 10.2 | 10.3 | 12.1 | 9.7 | 7.5 | 5.9 | 3.4 | 1.1 | 8.5 |
| **16** | 13.1 | 11.3 | 10.2 | 10.5 | 11.7 | 9.9 | 7.2 | 4.9 | 4.6 | 0.7 | 8.4 |
| **18** | 13.3 | 11.5 | 10.4 | 10.5 | 12.7 | 9.7 | 7.8 | 3.9 | 3.1 | 0.1 | 8.4 |
| **20** | 13.1 | 11.5 | . | 10.6 | 12.5 | 9.6 | 8.1 | 0.0 | 1.0 | 0.0 | 8.4 |
| **22** | . | 11.6 | . | 10.6 | 10.5 | 9.5 | 7.7 | 0.0 | 1.0 | 0.0 | 8.4 |
| **24** | . | . | . | . | . | . | 6.1 | 0.0 | 1.0 | 0.0 | 8.5 |

**Table 29.** pH profiles collected at station W1 from March through November, 2008.

| | pH | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **Depth (m)** | **10-Mar** | **1-Apr** | **14-Apr** | **1-May** | **20-May** | **29-May** | **24-Jun** | **14-Aug** | **15-Sep** | **22-Sep** | **6-Nov** |
| **Surface** | 6.8 | 6.8 | 6.9 | 6.8 | 6.5 | 6.8 | 6.8 | 6.7 | 6.8 | 6.8 | 6.6 |
| **1** | . | 6.6 | 6.8 | 6.7 | 6.5 | 6.7 | 6.7 | 6.6 | 6.6 | 6.5 | . |
| **2** | 6.7 | 6.6 | 6.8 | 6.7 | 6.5 | 6.7 | 6.7 | 6.4 | 6.5 | 6.5 | 6.6 |
| **3** | . | 6.6 | 6.8 | 6.8 | 6.6 | 6.7 | 6.5 | 6.3 | 6.4 | 6.4 | . |
| **4** | 6.6 | 6.5 | 6.7 | 6.8 | 6.6 | 6.6 | 6.4 | 6.3 | 6.4 | 6.4 | 6.5 |
| **5** | . | 6.5 | 6.7 | 6.7 | 6.6 | 6.6 | 6.3 | 6.2 | 6.4 | 6.3 | . |
| **6** | 6.6 | 6.5 | 6.7 | 6.7 | 6.6 | 6.6 | 6.2 | 6.2 | 6.4 | 6.3 | 6.5 |
| **7** | . | 6.5 | 6.7 | 6.7 | 6.6 | 6.6 | 6.2 | 6.3 | 6.3 | 6.1 | . |
| **8** | 6.6 | 6.5 | 6.7 | 6.7 | 6.6 | 6.6 | 6.2 | 6.3 | 6.3 | 6.0 | 6.5 |
| **9** | . | 6.5 | 6.7 | 6.7 | 6.6 | 6.5 | 6.3 | 6.3 | 6.3 | 6.0 | . |
| **10** | 6.7 | 6.5 | 6.6 | 6.7 | 6.6 | 6.6 | 6.3 | 6.3 | 6.3 | 6.0 | 6.4 |
| **12** | 6.6 | 6.5 | 6.5 | 6.7 | 6.5 | 6.6 | 6.3 | 6.3 | 6.2 | 6.0 | 6.4 |
| **14** | 6.6 | 6.5 | 6.4 | 6.7 | 6.5 | 6.5 | 6.2 | 6.3 | 6.2 | 6.0 | 6.4 |
| **16** | 6.6 | 6.4 | 6.4 | 6.7 | 6.5 | 6.5 | 6.2 | 6.3 | 6.2 | 6.2 | 6.3 |
| **18** | 6.5 | 6.4 | 6.5 | 6.7 | 6.5 | 6.5 | 6.4 | 6.3 | 6.2 | 6.2 | 6.4 |
| **20** | 6.6 | 6.3 | . | 6.7 | 6.5 | 6.5 | 6.4 | 6.2 | 6.2 | 6.2 | 6.3 |
| **22** | . | 6.9 | . | 6.6 | 6.4 | 6.7 | 6.3 | 6.3 | 6.4 | 6.3 | 6.3 |
| **24** | . | . | . | . | . | . | . | 6.7 | 6.6 | 6.6 | 6.3 |

**Table 30.** Conductivity profiles collected at station W1 from March through November, 2008.

| | Conductivity (µS/cm) | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **Depth (m)** | **10-Mar** | **1-Apr** | **14-Apr** | **1-May** | **20-May** | **29-May** | **24-Jun** | **14-Aug** | **15-Sep** | **22-Sep** | **6-Nov** |
| **Surface** | 61 | 91 | 64 | 72 | 62 | 90 | 115 | 130 | 172 | 167 | 179 |
| **1** | . | 89 | 66 | 73 | 61 | 91 | 113 | 132 | 183 | 162 | . |
| **2** | 61 | 91 | 66 | 75 | 61 | 87 | 113 | 121 | 183 | 161 | 178 |
| **3** | . | 89 | 66 | 94 | 60 | 83 | 116 | 117 | 184 | 160 | . |
| **4** | 62 | 91 | 66 | 83 | 60 | 84 | 104 | 110 | 184 | 160 | 176 |
| **5** | . | 91 | 66 | 68 | 57 | 86 | 107 | 112 | 183 | 159 | . |
| **6** | 61 | 92 | 66 | 63 | 56 | 87 | 106 | 105 | 179 | 152 | 173 |
| **7** | . | 92 | 66 | 61 | 55 | 86 | 105 | 99 | 178 | 142 | . |
| **8** | 58 | 90 | 66 | 61 | 53 | 78 | 97 | 100 | 176 | 133 | 170 |
| **9** | . | 84 | 72 | 61 | 50 | 71 | 96 | 97 | 176 | 134 | . |
| **10** | 58 | 84 | 70 | 54 | 49 | 63 | 82 | 92 | 176 | 124 | 167 |
| **12** | 56 | 77 | 71 | 52 | 46 | 57 | 73 | 88 | 178 | 98 | 169 |
| **14** | 53 | 78 | 76 | 46 | 45 | 57 | 69 | 89 | 178 | 90 | 166 |
| **16** | 55 | 65 | 81 | 44 | 42 | 50 | 53 | 95 | 184 | 92 | 166 |
| **18** | 51 | 64 | 85 | 42 | 41 | 49 | 47 | 121 | 179 | 107 | 167 |
| **20** | 63 | 66 | . | 41 | 41 | 49 | 81 | 84 | 119 | 100 | 169 |
| **22** | . | 125 | . | 41 | 37 | 55 | 83 | 88 | 139 | 110 | 168 |
| **24** | . | . | . | . | . | . | . | 124 | 203 | 159 | 167 |

**Table 31.** Temperature profiles collected at station W1A from March through November, 2008.

| | Temperature ($^{O}F$) | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| **Depth (m)** | **10-Mar** | **1-Apr** | **14-Apr** | **1-May** | **20-May** | **29-May** | **14-Aug** | **22-Sep** | **6-Nov** |
| **Surface** | 41 | 48 | 60 | 62 | 55 | 70 | 76 | 74 | 60 |
| **1** | 41 | 48 | 60 | 62 | 55 | 67 | 76 | 74 | . |
| **2** | 40 | 48 | 60 | 61 | 55 | 65 | 76 | 74 | 59 |
| **3** | 40 | 48 | 60 | 60 | 55 | 64 | 75 | 74 | . |
| **4** | 41 | 48 | 60 | 60 | 55 | 64 | 74 | 73 | 59 |
| **5** | 40 | 47 | 59 | 57 | 55 | 64 | 74 | 73 | . |
| **6** | 40 | 47 | 59 | 56 | 55 | 63 | 73 | 73 | 59 |
| **7** | 40 | 47 | 59 | 55 | 55 | 62 | 73 | 73 | . |
| **8** | 40 | 46 | 59 | 53 | 55 | 61 | 73 | 73 | 58 |
| **9** | 40 | 46 | 58 | 52 | 55 | 60 | 73 | 73 | . |
| **10** | 40 | 46 | 57 | 52 | 55 | 57 | 73 | 72 | 57 |
| **11** | . | . | . | . | . | 55 | . | . | . |
| **12** | 40 | 46 | 54 | 51 | 55 | 53 | 72 | 71 | 56 |
| **13** | . | . | . | 51 | . | 53 | 71 | . | . |
| **14** | . | . | . | . | 55 | . | . | 71 | 54 |
| **15** | . | . | . | . | . | . | . | 70 | . |

**Table 32.** Dissolved oxygen profiles collected at station W1A from March through November, 2008.

| | Dissolved Oxygen (mg/L) | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| **Depth (m)** | **10-Mar** | **1-Apr** | **14-Apr** | **1-May** | **20-May** | **29-May** | **14-Aug** | **22-Sep** | **6-Nov** |
| **Surface** | 12.7 | 10.8 | 9.6 | 9.8 | 10.5 | 9.6 | 8.9 | 8.4 | 8.2 |
| **1** | 13.3 | 11.2 | 9.4 | 8.8 | 10.6 | 9.2 | 8.9 | 8.4 | . |
| **2** | 13.8 | 11.4 | 9.4 | 8.8 | 10.5 | 8.9 | 8.9 | 8.3 | 8.7 |
| **3** | 13.9 | 11.4 | 9.3 | 8.8 | 10.5 | 8.9 | 7.7 | 8.2 | . |
| **4** | 13.9 | 11.4 | 9.3 | 8.8 | 10.5 | 8.9 | 7.4 | 7.9 | 8.9 |
| **5** | 14.0 | 11.5 | 9.4 | 9.0 | 10.5 | 8.9 | 7.0 | 7.4 | . |
| **6** | 14.0 | 11.5 | 9.3 | 9.4 | 10.5 | 8.9 | 6.2 | 6.3 | 9.0 |
| **7** | 13.9 | 11.5 | 9.3 | 9.6 | 10.5 | 9.0 | 5.8 | 6.2 | . |
| **8** | 13.9 | 11.5 | 9.2 | 10.0 | 10.5 | 9.0 | 5.5 | 6.6 | 9.0 |
| **9** | 13.9 | 11.5 | 9.4 | 10.4 | 10.5 | 8.9 | 5.4 | 6.9 | . |
| **10** | 13.9 | 11.6 | 9.7 | 10.4 | 10.5 | 8.8 | 5.6 | 7.1 | 9.0 |
| **11** | . | . | . | . | . | 9.5 | . | | . |
| **12** | 14.0 | 11.7 | 9.8 | 10.6 | 10.5 | 9.5 | 5.7 | 6.3 | 9.2 |
| **13** | . | . | . | 10.1 | . | 8.4 | . | . | . |
| **14** | . | . | . | . | 10.1 | . | 3.5 | 0.1 | 9.4 |
| **15** | . | . | . | . | . | . | 3.1 | 0.0 | . |

**Table 33.** pH profiles collected at station W1A from March through November, 2008.

| | pH | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| **Depth (m)** | **10-Mar** | **1-Apr** | **14-Apr** | **1-May** | **20-May** | **29-May** | **14-Aug** | **22-Sep** | **6-Nov** |
| **Surface** | 6.6 | 6.9 | 6.7 | 6.8 | 6.9 | 7.1 | 6.7 | 6.6 | 6.6 |
| **1** | 6.6 | 6.7 | 6.7 | 6.8 | 6.8 | 6.8 | 6.7 | 6.4 | . |
| **2** | 6.5 | 6.7 | 6.6 | 6.7 | 6.8 | 6.8 | 6.6 | 6.4 | 6.7 |
| **3** | 6.5 | 6.6 | 6.6 | 6.7 | 6.8 | 6.7 | 6.4 | 6.4 | . |
| **4** | 6.5 | 6.6 | 6.6 | 6.7 | 6.7 | 6.7 | 6.3 | 6.4 | 6.6 |
| **5** | 6.4 | 6.5 | 6.6 | 6.6 | 6.7 | 6.6 | 6.3 | 6.3 | . |
| **6** | 6.4 | 6.4 | 6.6 | 6.6 | 6.7 | 6.6 | 6.3 | 6.2 | 6.6 |
| **7** | 6.4 | 6.4 | 6.4 | 6.4 | 6.6 | 6.5 | 6.2 | 6.1 | . |
| **8** | 6.3 | 6.4 | 6.3 | 6.5 | 6.6 | 6.5 | 6.1 | 6.2 | 6.5 |
| **9** | 6.3 | 6.4 | 6.4 | 6.6 | 6.4 | 6.4 | 6.1 | 6.2 | . |
| **10** | 6.2 | 6.3 | 6.2 | 6.6 | 6.4 | 6.3 | 6.1 | 6.2 | 6.5 |
| **11** | . | . | . | . | . | 6.2 | . | | . |
| **12** | 6.1 | 6.3 | 6.2 | 6.7 | 6.1 | 6.2 | 6.2 | 6.2 | 6.5 |
| **13** | . | . | . | 6.8 | . | 6.6 | . | | . |
| **14** | . | . | . | . | 5.8 | . | 6.1 | 6.1 | 6.4 |
| **15** | . | . | . | . | . | . | 6.7 | 6.5 | . |

**Table 34.** Conductivity profiles collected at station W1A from March through November, 2008.

| | Conductivity (µS/cm) | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| **Depth (m)** | **10-Mar** | **1-Apr** | **14-Apr** | **1-May** | **20-May** | **29-May** | **14-Aug** | **22-Sep** | **6-Nov** |
| **Surface** | 71 | 72 | 81 | 74 | 59 | 99 | 131 | 173 | 178 |
| **1** | 70 | 88 | 82 | 74 | 58 | 101 | 130 | 170 | . |
| **2** | 73 | 9 | 80 | 74 | 57 | 99 | 125 | 170 | 177 |
| **3** | 75 | 91 | 80 | 77 | 54 | 99 | 119 | 170 | . |
| **4** | 79 | 90 | 79 | 77 | 54 | 100 | 124 | 172 | 175 |
| **5** | 79 | 87 | 78 | 72 | 53 | 104 | 118 | 173 | . |
| **6** | 79 | 87 | 78 | 71 | 51 | 104 | 121 | 175 | 175 |
| **7** | 79 | 84 | 83 | 79 | 51 | 101 | 112 | 185 | . |
| **8** | 79 | 82 | 90 | 57 | 51 | 98 | 106 | 179 | 179 |
| **9** | 79 | 81 | 71 | 50 | 62 | 90 | 97 | 178 | . |
| **10** | 79 | 78 | 81 | 46 | 48 | 84 | 95 | 178 | 179 |
| **11** | . | . | . | | . | 76 | . | | . |
| **12** | 79 | 74 | 69 | 43 | 63 | 67 | 82 | 177 | 187 |
| **13** | . | . | . | 43 | . | 100 | . | | . |
| **14** | . | . | . | . | 60 | . | 79 | 118 | 211 |
| **15** | . | . | . | . | | . | 78 | 109 | . |

**Table 35.** Temperature profiles collected at station W3 from March through November, 2008.

| | Temperature ($^{O}F$) | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| **Depth (m)** | **10-Mar** | **1-Apr** | **14-Apr** | **1-May** | **20-May** | **29-May** | **6-Aug** | **22-Sep** | **6-Nov** |
| **Surface** | 41 | 51 | 55 | 50 | 53 | 63 | 74 | 68 | 53 |
| **1** | 41 | 51 | 55 | 50 | 53 | 63 | 74 | 68 | |
| **2** | 41 | 51 | 55 | 50 | 53 | 63 | 74 | 68 | 53 |
| **3** | 41 | 51 | 55 | 50 | . | 63 | 74 | 67 | . |
| **4** | . | . | 55 | 50 | . | 63 | 74 | 68 | 53 |
| **5** | . | . | 55 | 50 | 53 | 63 | . | . | 52 |
| **6** | . | . | . | 50 | . | . | . | . | . |

**Table 36.** Dissolved oxygen profiles collected at station W3 from March through November, 2008.

| | Dissolved Oxygen (mg/L) | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| **Depth (m)** | **10-Mar** | **1-Apr** | **14-Apr** | **1-May** | **20-May** | **29-May** | **6-Aug** | **22-Sep** | **6-Nov** |
| **Surface** | 9.7 | 10.6 | 10.7 | 10.3 | 10.8 | 10.0 | 9.6 | 10.4 | 11.6 |
| **1** | 11.5 | 10.9 | 10.4 | 11.1 | 10.8 | 9.6 | 9.4 | 9.9 | . |
| **2** | 12.6 | 11.0 | 10.4 | 11.3 | 10.8 | 9.2 | 9.3 | 10.3 | 11.7 |
| **3** | 12.8 | 11.0 | 10.4 | 11.4 | . | 9.2 | 9.3 | 10.9 | . |
| **4** | . | . | 10.4 | 11.4 | . | 9.2 | 8.8 | 11.5 | 11.9 |
| **5** | . | . | 10.4 | 11.4 | 10.8 | 9.2 | . | . | 11.9 |
| **6** | . | . | . | 11.4 | . | . | . | . | . |

**Table 37.** pH profiles collected at station W3 from March through November, 2008.

| | pH | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| **Depth (m)** | **10-Mar** | **1-Apr** | **14-Apr** | **1-May** | **20-May** | **29-May** | **6-Aug** | **22-Sep** | **6-Nov** |
| **Surface** | 7.2 | 7.1 | 7.3 | 6.7 | 6.9 | 6.8 | 7.3 | 7.1 | 7.0 |
| **1** | 7.0 | 6.9 | 7.1 | 6.7 | 6.8 | 6.9 | 7.0 | 7.0 | . |
| **2** | 7.0 | 6.9 | 7.1 | 6.7 | 6.8 | 6.8 | 7.0 | 7.0 | 7.0 |
| **3** | 6.9 | 6.8 | 7.0 | 6.7 | . | 6.8 | 6.9 | 7.0 | 7.0 |
| **4** | . | . | 7.0 | 6.8 | . | 6.8 | 7.0 | 6.7 | . |
| **5** | . | . | 7.0 | 6.8 | 6.7 | 6.8 | . | . | 7.0 |
| **6** | . | . | . | 6.8 | . | . | . | . | . |

**Table 38.** Conductivity profiles collected at station W3 from March through November, 2008.

| | Conductivity (µS/cm) | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| **Depth (m)** | **10-Mar** | **1-Apr** | **14-Apr** | **1-May** | **20-May** | **29-May** | **6-Aug** | **22-Sep** | **6-Nov** |
| **Surface** | 72 | 82 | 67 | 52 | 61 | 81 | 96 | 204 | 167 |
| **1** | 79 | 82 | 80 | 52 | 60 | 79 | 95 | 210 | . |
| **2** | 87 | 84 | 79 | 52 | 58 | 81 | 95 | 217 | 170 |
| **3** | 87 | 84 | 79 | 50 | . | 81 | 95 | 227 | 172 |
| **4** | | | 79 | 50 | . | 79 | 100 | 227 | . |
| **5** | | | 76 | 50 | 55 | 79 | . | . | . |
| **6** | | | | 49 | . | . | . | . | . |

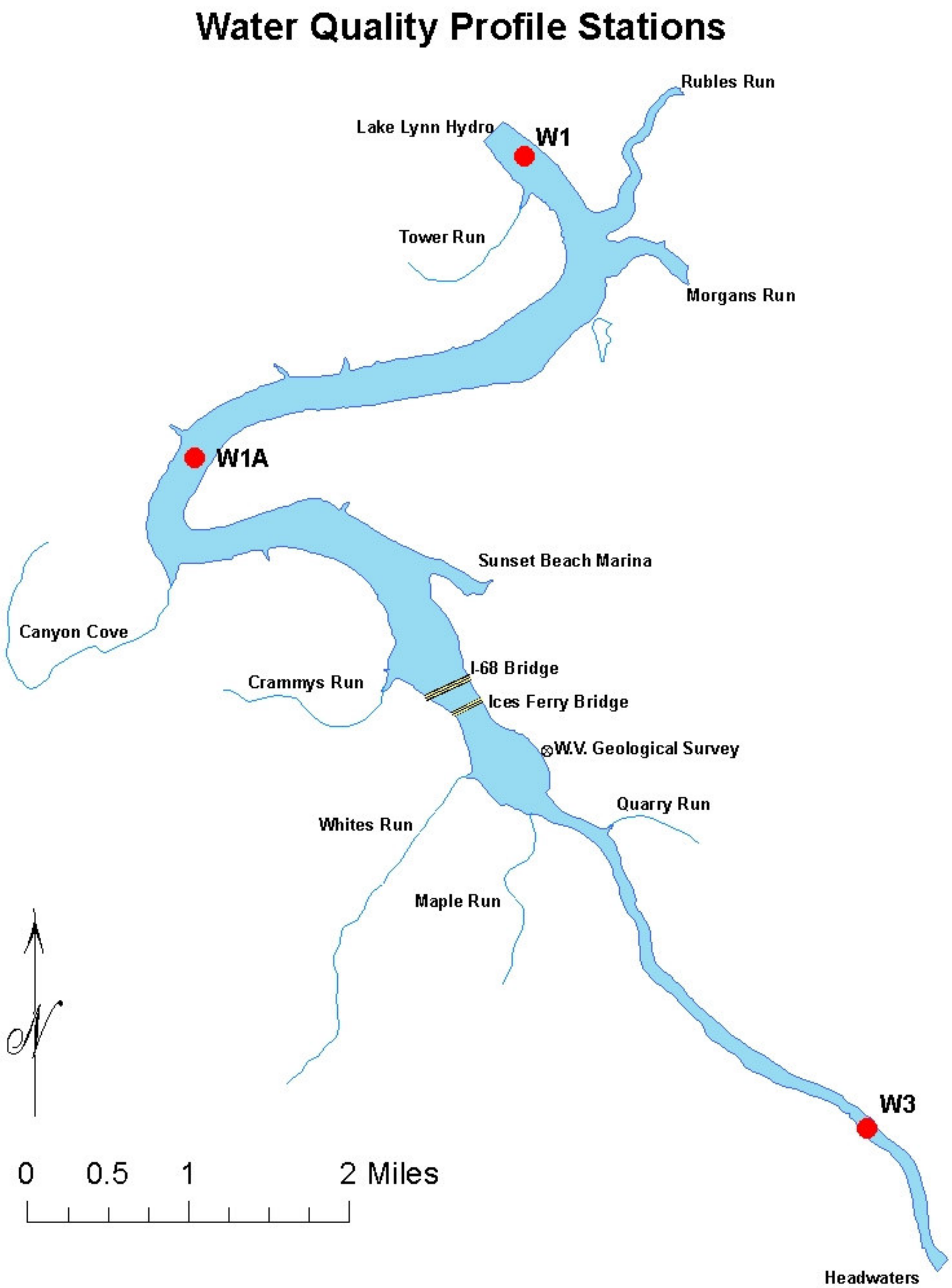


**Figure 26.** Cheat Lake water quality profile stations, 2008.

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# Appendix I

**Table A1.** Relative abundance of species collected by boat electrofishing at Cheat Lake, 1997 – 2008.

| Scientific Name | Common Name | 1997 | 1998 | 2001 | 2005 | 2008 |
|---|---|---|---|---|---|---|
| **Clupidae** | | | | | | |
| Dorosoma cepedianum | Gizzard Shad | 0.0 | 1.7 | 1.5 | 0.3 | 0.2 |
| **Cyprinidae** | | | | | | |
| Rhinichthys obtusus | Blacknose Dace | 0.8 | 0.1 | 0.0 | 0.0 | 0.0 |
| Cyprinella spiloptera | Spotfin Shiner | 0.0 | 0.6 | 1.5 | 1.3 | 1.1 |
| Cyprinus carpio | Common Carp | 0.0 | 0.3 | 0.3 | 0.1 | 0.1 |
| Nocomis micropogon | River Chub | 0.0 | 0.0 | 0.1 | 0.2 | 0.0 |
| Notemigonus crysoleucas | Golden Shiner | 0.2 | 0.0 | 0.1 | 0.0 | 0.0 |
| Notropis ariommus | Popeye Shiner | 0.0 | 0.0 | 0.0 | 0.1 | 1.0 |
| Notropis atherinoides | Emerald Shiner | 6.8 | 12.1 | 0.4 | 0.2 | 4.0 |
| Notropis photogenis | Silver Shiner | 0.0 | 0.0 | 1.0 | 1.2 | 0.4 |
| Notropis volucellus | Mimic Shiner | 0.1 | 0.0 | 1.1 | 31.2 | 4.0 |
| Pimephales notatus | Bluntnose Minnow | 3.8 | 1.9 | 3.0 | 2.3 | 0.4 |
| Semotilus atromaculatus | Creek Chub | 0.0 | 0.2 | 0.0 | 0.0 | 0.0 |
| **Catostomidae** | | | | | | |
| Hypentilium nigricans | Northern Hogsucker | 0.0 | 0.7 | 0.2 | 0.3 | 0.0 |
| Moxostoma anisurum | Silver Redhorse | 0.1 | 0.0 | 0.0 | 0.0 | 0.0 |
| Moxostoma erythrurum | Golden Redhorse | 0.5 | 6.2 | 3.6 | 2.3 | 2.9 |
| **Ictaluridae** | | | | | | |
| Ameiurus natalis | Yellow Bullhead | 0.8 | 0.5 | 0.8 | 0.5 | 0.8 |
| Ameiurus nebulosus | Brown Bullhead | 0.1 | 0.0 | 0.1 | 0.0 | 0.1 |
| Ictalurus punctatus | Channel Catfish | 0.2 | 0.0 | 0.7 | 0.3 | 0.8 |
| Pylodictus olivaris | Flathead Catfish | 0.1 | 0.0 | 0.0 | 0.0 | 0.0 |
| **Atherinidae** | | | | | | |
| Labidesthes sicculus | Brook Silverside | 15.5 | 11.8 | 4.8 | 11.3 | 8.6 |
| **Moronidae** | | | | | | |
| Morone chrysops | White Bass | 0.0 | 0.2 | 0.0 | 0.5 | 0.1 |
| **Centrachidae** | | | | | | |
| Ambloplites rupestris | Rock Bass | 3.7 | 3.2 | 5.3 | 3.0 | 3.0 |
| Lepomis cyanellus | Green Sunfish | 2.2 | 1.5 | 7.0 | 4.4 | 17.4 |
| Lepomis gibbosus | Pumpkinseed | 2.3 | 2.4 | 1.1 | 2.2 | 2.0 |
| Lepomis macrochirus | Bluegill | 29.3 | 29.7 | 39.4 | 12.6 | 15.9 |
| Lepomis megalotis | Longear sunfish | 0.1 | 0.1 | 0.0 | 0.0 | 0.0 |
| | Hybrid sunfish | 0.2 | 0.3 | 0.1 | 0.0 | 0.5 |
| Micropterus dolomieu | Smallmouth Bass | 2.7 | 3.3 | 2.2 | 8.6 | 7.5 |
| Micropterus punctulatus | Spotted Bass | 3.7 | 1.2 | 6.2 | 3.8 | 5.3 |
| Micropterus salmoides | Largemouth Bass | 3.0 | 7.6 | 5.1 | 3.0 | 3.1 |
| Pomoxis nigromaculatus | Black Crappie | 0.2 | 0.1 | 0.4 | 0.5 | 0.0 |
| **Percidae** | | | | | | |
| Etheostoma blennioides | Greenside Darter | 0.0 | 0.0 | 0.1 | 0.0 | 0.1 |
| Etheostoma caeruleum | Rainbow Darter | 0.0 | 0.1 | 0.1 | 0.1 | 0.2 |
| Etheostoma flabellare | Fantail Darter | 0.3 | 0.0 | 0.0 | 0.0 | 0.0 |
| Etheostoma nigrum | Johnny Darter | 0.5 | 0.1 | 0.4 | 0.0 | 0.5 |
| Percina caprodes | Logperch | 22.2 | 11.3 | 10.2 | 7.9 | 18.9 |

**Table A1.** continued

| Scientific Name | Common Name | 1997 | 1998 | 2001 | 2005 | 2008 |
|---|---|---|---|---|---|---|
| Perca flavescens | Yellow Perch | 0.8 | 2.5 | 2.3 | 1.3 | 0.9 |
| Sander vitreus | Walleye | 0.0 | 0.0 | 0.9 | 0.5 | 0.1 |
| **Sciaenidae** | | | | | | |
| Aplodinotus grunniens | Freshwater Drum | 0.1 | 0.0 | 0.0 | 0.1 | 0.0 |
| **Unidentified** | | 0.2 | 0.6 | 0.0 | 0.0 | 0.0 |

**Table A2.** Relative abundance of species collected with biomonitoring gill nets at Cheat Lake, 1997 – 2008.

| Scientific Name | Common Name | 1997 | 1998 | 2001 | 2005 | 2008 |
|---|---|---|---|---|---|---|
| **Clupidae** | | | | | | |
| Dorosoma cepedianum | Gizzard Shad | 20.2 | 23.1 | 17.8 | 2.9 | 12.0 |
| **Cyprinidae** | | | | | | |
| Rhinichthys obtusus | Blacknose Dace | 0.6 | 0.0 | 0.0 | 0.0 | 0.0 |
| Cyprinus carpio | Common Carp | 4.2 | 2.5 | 1.3 | 0.5 | 0.0 |
| **Catostomidae** | | | | | | |
| Catostomus commersoni | White Sucker | 0.0 | 1.7 | 3.3 | 2.6 | 2.2 |
| Hypentilium nigricans | Northern Hogsucker | 0.0 | 0.8 | 0.0 | 0.0 | 0.3 |
| Moxostoma anisurum | Silver Redhorse | 8.9 | 0.0 | 0.0 | 0.0 | 0.0 |
| Moxostoma erythrurum | Golden Redhorse | 8.9 | 5.8 | 11.2 | 7.0 | 11.4 |
| **Ictaluridae** | | | | | | |
| Ameiurus natalis | Yellow Bullhead | 1.8 | 1.7 | 3.3 | 4.4 | 0.3 |
| Ameiurus nebulosus | Brown Bullhead | 16.7 | 12.4 | 1.3 | 2.9 | 0.9 |
| Ictalurus punctatus | Channel Catfish | 5.4 | 6.6 | 21.7 | 28.3 | 15.4 |
| **Esocidae** | | | | | | |
| Esox lucius | Northeren Pike | 0.6 | 0.8 | 0.7 | 0.0 | 0.0 |
| **Salmonidae** | | | | | | |
| Oncorhhynchus mykiss | Rainbow Trout | 0.0 | 0.0 | 0.0 | 0.1 | 0.0 |
| **Moronidae** | | | | | | |
| Morone chrysops | White Bass | 4.2 | 3.3 | 5.3 | 5.7 | 20.7 |
| M. chrysops x M. saxatilis | Hybrid Striped Bass | 0.0 | 0.0 | 0.7 | 0.0 | 0.0 |
| **Centrachidae** | | | | | | |
| Ambloplites rupestris | Rock Bass | 1.8 | 8.3 | 7.9 | 6.6 | 10.2 |
| Lepomis cyanellus | Green Sunfish | 0.0 | . | . | 0.4 | 1.2 |
| Lepomis gibbosus | Pumpkinseed | 4.8 | 5.0 | 1.3 | 2.2 | 0.9 |
| Lepomis macrochirus | Bluegill | 0.6 | 0.8 | 0.7 | 0.4 | 0.0 |
| Micropterus dolomieu | Smallmouth Bass | 0.6 | 0.0 | 1.3 | 7.7 | 5.9 |
| Micropterus punctulatus | Spotted Bass | 0.6 | 0.8 | 0.7 | 2.7 | 1.2 |
| Micropterus salmoides | Largemouth Bass | 6.5 | 5.0 | 2.0 | 1.9 | 1.5 |
| Pomoxis annularis | White Crappie | 0.6 | 2.5 | 5.9 | 0.0 | 0.0 |
| Pomoxis nigromaculatus | Black Crappie | 3.0 | 0.0 | 2.6 | 3.8 | 2.5 |
| **Percidae** | | | | | | |
| Perca flavescens | Yellow Perch | 8.9 | 19.0 | 4.6 | 14.8 | 6.5 |
| Sander vitreus | Walleye | 0.6 | 0.0 | 6.6 | 5.2 | 6.5 |
| **Sciaenidae** | | | | | | |
| Aplodinotus grunniens | Freshwater Drum | 0.6 | 0.0 | 0.0 | 0.0 | 0.0 |

**Table A3.** Lengths and weights for fishes collected by boat electrofishing at Cheat Lake, 1997.

| Scientific Name | Common Name | Number of Observations | Mean Length mm | Minimum Length mm | Maximum Length mm | Mean Weight g | Minimum Weight g | Maximum Weight g |
|---|---|---|---|---|---|---|---|---|
| **Cyprinidae** | | | | | | | | |
| Rhinichthys obtusus | Blacknose Dace | 10 | 162 | 75 | 321 | 122 | 4 | 459 |
| Notemigonus crysoleucas | Golden Shiner | 2 | 112 | 108 | 115 | 13 | 12 | 13 |
| Notropis atherinoides | Emerald Shiner | 87 | 91 | 55 | 140 | 5 | 1 | 18 |
| Notropis volucellus | Mimic Shiner | 1 | 42 | 42 | 42 | . | . | . |
| Pimephales notatus | Bluntnose Minnow | 48 | 59 | 32 | 83 | 2 | 0 | 6 |
| **Catostomidae** | | | | | | | | |
| Moxostoma anisurum | Silver Redhorse | 1 | 315 | 315 | 315 | 397 | 397 | 397 |
| Moxostoma erythrurum | Golden Redhorse | 7 | 121 | 60 | 174 | 34 | 6 | 58 |
| **Ictaluridae** | | | | | | | | |
| Ameiurus natalis | Yellow Bullhead | 10 | 143 | 52 | 240 | 99 | 2 | 206 |
| Ameiurus nebulosus | Brown Bullhead | 1 | 295 | 295 | 295 | 336 | 336 | 336 |
| Ictalurus punctatus | Channel Catfish | 2 | 75 | 73 | 77 | 2 | 2 | 2 |
| Pylodictus olivaris | Flathead Catfish | 1 | 315 | 315 | 315 | 426 | 426 | 426 |
| **Atherinidae** | | | | | | | | |
| Labidesthes sicculus | Brook Silverside | 198 | 69 | 38 | 189 | 2 | 0 | 12 |
| **Centrachidae** | | | | | | | | |
| Ambloplites rupestris | Rock Bass | 47 | 96 | 42 | 201 | 24 | 1 | 179 |
| Lepomis cyanellus | Green Sunfish | 28 | 113 | 74 | 185 | 34 | 6 | 118 |
| Lepomis gibbosus | Pumpkinseed | 29 | 117 | 57 | 188 | 40 | 2 | 156 |
| Lepomis macrochirus | Bluegill | 375 | 83 | 25 | 202 | 15 | 0 | 172 |
| Lepomis megalotis | Longear Sunfish | 1 | 190 | 190 | 190 | 138 | 138 | 138 |
| | Hybrid Sunfish | 2 | 134 | 132 | 135 | 43 | 42 | 45 |
| Micropterus dolomieu | Smallmouth Bass | 34 | 106 | 51 | 188 | 30 | 2 | 100 |
| Micropterus punctulatus | Spotted Bass | 47 | 78 | 50 | 142 | 6 | 1 | 32 |
| Micropterus salmoides | Largemouth Bass | 38 | 241 | 54 | 417 | 275 | 2 | 926 |
| Pomoxis nigromaculatus | Black Crappie | 2 | 115 | 78 | 152 | 24 | 5 | 43 |
| **Percidae** | | | | | | | | |
| Etheostoma flabellare | Fantail Darter | 4 | 41 | 38 | 49 | 0 | 0 | 1 |
| Etheostoma nigrum | Johnny Darter | 6 | 50 | 40 | 62 | 1 | 1 | 1 |

**Table A3.** continued

| Scientific Name | Common Name | Number of Observations | Mean Length mm | Minimum Length mm | Maximum Length mm | Mean Weight g | Minimum Weight g | Maximum Weight g |
|---|---|---|---|---|---|---|---|---|
| Percina caprodes | Logperch | 284 | 84 | 38 | 148 | 5 | 0 | 22 |
| Perca flavescens | Yellow Perch | 10 | 124 | 61 | 238 | 32 | 2 | 166 |
| **Sciaenidae** | | | | | | | | |
| Aplodinotus grunniens | Freshwater Drum | 1 | 60 | 60 | 60 | 2 | 2 | 2 |
| **Unidentified** | | 2 | 89 | 88 | 90 | 6 | 6 | 6 |

**Table A4.** Lengths and weights for fishes collected with biomonitoring gill nets at Cheat Lake, 1997.

| Scientific Name | Common Name | Number of Observations | Mean Length mm | Minimum Length mm | Maximum Length mm | Mean Weight g | Minimum Weight g | Maximum Weight g |
|---|---|---|---|---|---|---|---|---|
| **Clupidae** | | | | | | | | |
| Dorosoma cepedianum | Gizzard Shad | 34 | 334 | 271 | 497 | 460 | 184 | 1464 |
| **Cyprinidae** | | | | | | | | |
| Rhinichthys obtusus | Blacknose Dace | 1 | 411 | 411 | 411 | 740 | 740 | 740 |
| Cyprinus carpio | Common Carp | 7 | 457 | 213 | 699 | 1182 | 154 | 2196 |
| **Catostomidae** | | | | | | | | |
| Catostomus commersoni | White Sucker | | | | | | | |
| Moxostoma anisurum | Silver Redhorse | 15 | 347 | 242 | 400 | 549 | 390 | 734 |
| Moxostoma erythrurum | Golden Redhorse | 15 | 334 | 158 | 504 | 644 | 46 | 1660 |
| **Ictaluridae** | | | | | | | | |
| Ameiurus natalis | Yellow Bullhead | 3 | 240 | 188 | 281 | 214 | 82 | 316 |
| Ameiurus nebulosus | Brown Bullhead | 28 | 305 | 258 | 351 | 511 | 232 | 938 |
| Ictalurus punctatus | Channel Catfish | 9 | 394 | 283 | 491 | 732 | 188 | 1382 |
| **Esocidae** | | | | | | | | |
| Esox lucius | Northern Pike | 1 | 535 | 535 | 535 | 804 | 804 | 804 |
| **Salmonidae** | | | | | | | | |
| Oncorhhynchus mykiss | Rainbow Trout | | | | | | | |
| **Moronidae** | | | | | | | | |
| Morone chrysops | White Bass | 7 | 258 | 144 | 346 | 301 | 36 | 636 |
| M. chrysops x M. saxatilis | Hybrid Striped Bass | | | | | | | |
| **Centrachidae** | | | | | | | | |
| Ambloplites rupestris | Rock Bass | 3 | 194 | 180 | 204 | 169 | 160 | 178 |
| Lepomis cyanellus | Green Sunfish | | | | | | | |
| Lepomis gibbosus | Pumpkinseed | 8 | 162 | 110 | 175 | 116 | 102 | 174 |
| Lepomis macrochirus | Bluegill | 1 | 101 | 101 | 101 | 14 | 14 | 14 |
| Micropterus dolomieu | Smallmouth Bass | 1 | 188 | 188 | 188 | 90 | 90 | 90 |
| Micropterus punctulatus | Spotted Bass | 1 | 143 | 143 | 143 | 38 | 38 | 38 |
| Micropterus salmoides | Largemouth Bass | 11 | 315 | 222 | 437 | 504 | 140 | 1504 |

**Table A4.** continued

| Scientific Name | Common Name | Number of Observations | Mean Length mm | Minimum Length mm | Maximum Length mm | Mean Weight g | Minimum Weight g | Maximum Weight g |
|---|---|---|---|---|---|---|---|---|
| Pomoxis annularis | White Crappie | 1 | 241 | 241 | 241 | 184 | 184 | 184 |
| Pomoxis nigromaculatus | Black Crappie | 5 | 242 | 191 | 277 | 224 | 108 | 314 |
| **Percidae** | | | | | | | | |
| Perca flavescens | Yellow Perch | 15 | 217 | 140 | 300 | 130 | 28 | 318 |
| Sander vitreus | Walleye | 1 | 443 | 443 | 443 | 917 | 917 | 917 |
| **Sciaenidae** | | | | | | | | |
| Aplodinotus grunniens | Freshwater Drum | 1 | 369 | 369 | 369 | 556 | 556 | 556 |

**Table A5.** Lengths and weights for fishes collected by boat electrofishing at Cheat Lake, 1998.

| Scientific Name | Common Name | Number of Observations | Mean Length mm | Minimum Length mm | Maximum Length mm | Mean Weight g | Minimum Weight g | Maximum Weight g |
|---|---|---|---|---|---|---|---|---|
| **Clupidae** | | | | | | | | |
| Dorosoma cepedianum | Gizzard Shad | 17 | 323 | 37 | 445 | 449 | 1 | 857 |
| **Cyprinidae** | | | | | | | | |
| Cyprinella spiloptera | Spotfin Shiner | 6 | 66 | 35 | 80 | 3 | 0 | 5 |
| Cyprinus carpio | Common Carp | 3 | 532 | 513 | 568 | 2131 | 1914 | 2451 |
| Rhinichthys obtusus | Blacknose Dace | 1 | 198 | 198 | 198 | 97 | 97 | 97 |
| Notropis atherinoides | Emerald Shiner | 123 | 92 | 40 | 141 | 6 | 0 | 20 |
| Pimephales notatus | Bluntnose Minnow | 19 | 59 | 32 | 75 | 2 | 0 | 4 |
| Semotilus atromaculatus | Creek Chub | 2 | 83 | 83 | 83 | 5 | 5 | 5 |
| **Catostomidae** | | | | | | | | |
| Hypentilium nigricans | Northern Hogsucker | 7 | 279 | 173 | 391 | 326 | 61 | 805 |
| Moxostoma erythrurum | Golden Redhorse | 63 | 237 | 130 | 522 | 212 | 26 | 1639 |
| **Ictaluridae** | | | | | | | | |
| Ameiurus natalis | Yellow Bullhead | 5 | 241 | 197 | 290 | 198 | 111 | 327 |
| **Atherinidae** | | | | | | | | |
| Labidesthes sicculus | Brook Silverside | 120 | 70 | 35 | 97 | 3 | 0 | 61 |
| **Moronidae** | | | | | | | | |
| Morone chrysops | White Bass | 2 | 175 | 155 | 195 | 61 | 37 | 84 |
| **Centrachidae** | | | | | | | | |
| Ambloplites rupestris | Rock Bass | 33 | 108 | 46 | 177 | 30 | 2 | 134 |
| Lepomis cyanellus | Green Sunfish | 15 | 103 | 40 | 166 | 26 | 1 | 78 |
| Lepomis gibbosus | Pumpkinseed | 24 | 135 | 57 | 206 | 74 | 3 | 185 |
| Lepomis macrochirus | Bluegill | 302 | 89 | 24 | 214 | 22 | 0 | 225 |
| Lepomis megalotis | Longear Sunfish | 1 | 203 | 203 | 203 | 211 | 211 | 211 |
| | Hybrid Sunfish | 3 | 151 | 127 | 165 | 73 | 44 | 97 |
| Micropterus dolomieu | Smallmouth Bass | 34 | 153 | 68 | 288 | 57 | 3 | 313 |
| Micropterus punctulatus | Spotted Bass | 12 | 133 | 62 | 209 | 37 | 3 | 105 |
| Micropterus salmoides | Largemouth Bass | 77 | 204 | 36 | 456 | 237 | 0 | 1336 |

**Table A5.** continued

| Scientific Name | Common Name | Number of Observations | Mean Length mm | Minimum Length mm | Maximum Length mm | Mean Weight g | Minimum Weight g | Maximum Weight g |
|---|---|---|---|---|---|---|---|---|
| Pomoxis nigromaculatus | Black Crappie | 1 | 83 | 83 | 83 | 6 | 6 | 6 |
| **Percidae** | | | | | | | | |
| Etheostoma caeruleum | Rainbow Darter | 1 | 54 | 54 | 54 | 2 | 2 | 2 |
| Etheostoma nigrum | Johnny Darter | 1 | 44 | 44 | 44 | 1 | 1 | 1 |
| Percina caprodes | Logperch | 115 | 99 | 50 | 135 | 7 | 1 | 18 |
| Perca flavescens | Yellow Perch | 25 | 165 | 90 | 270 | 63 | 6 | 222 |
| **Unidentified** | | 6 | 76 | 76 | 76 | 6 | 6 | 6 |

**Table A6.** Lengths and weights for fishes collected with biomonitoring gill nets at Cheat Lake, 1998.

| Scientific Name | Common Name | Number of Observations | Mean Length mm | Minimum Length mm | Maximum Length mm | Mean Weight g | Minimum Weight g | Maximum Weight g |
|---|---|---|---|---|---|---|---|---|
| **Clupidae** | | | | | | | | |
| Dorosoma cepedianum | Gizzard Shad | 28 | 375 | 194 | 502 | 608 | 74 | 1116 |
| **Cyprinidae** | | | | | | | | |
| Cyprinus carpio | Common Carp | 3 | 288 | 214 | 430 | 471 | 165 | 1081 |
| **Catostomidae** | | | | | | | | |
| Catostomus commersoni | White Sucker | 2 | 287 | 231 | 343 | 464 | 434 | 494 |
| Hypentilium nigricans | Northern Hogsucker | 1 | 236 | 236 | 236 | 133 | 133 | 133 |
| Moxostoma erythrurum | Golden Redhorse | 7 | 315 | 308 | 324 | 372 | 343 | 423 |
| **Ictaluridae** | | | | | | | | |
| Ameiurus natalis | Yellow Bullhead | 2 | 272 | 271 | 273 | 307 | 287 | 327 |
| Ameiurus nebulosus | Brown Bullhead | 15 | 290 | 247 | 340 | 429 | 264 | 754 |
| Ictalurus punctatus | Channel Catfish | 8 | 315 | 215 | 507 | 385 | 92 | 1285 |
| **Esocidae** | | | | | | | | |
| Esox lucius | Northern Pike | 1 | 735 | 735 | 735 | 2390 | 2390 | 2390 |
| **Moronidae** | | | | | | | | |
| Morone chrysops | White Bass | 4 | 255 | 250 | 259 | 219 | 208 | 229 |
| **Centrachidae** | | | | | | | | |
| Ambloplites rupestris | Rock Bass | 10 | 168 | 111 | 218 | 117 | 30 | 213 |
| Lepomis gibbosus | Pumpkinseed | 6 | 166 | 124 | 192 | 99 | 37 | 141 |
| Lepomis macrochirus | Bluegill | 1 | 109 | 109 | 109 | 20 | 20 | 20 |
| Micropterus punctulatus | Spotted Bass | 1 | 148 | 148 | 148 | 37 | 37 | 37 |
| Micropterus salmoides | Largemouth Bass | 6 | 269 | 148 | 334 | 305 | 36 | 481 |
| Pomoxis annularis | White Crappie | 3 | 243 | 220 | 261 | 212 | 163 | 253 |
| **Percidae** | | | | | | | | |
| Perca flavescens | Yellow Perch | 23 | 216 | 157 | 291 | 116 | 36 | 283 |

**Table A7.** Lengths and weights for fishes collected by boat electrofishing at Cheat Lake, 2001.

| Scientific Name | Common Name | Number of Observations | Mean Length mm | Minimum Length mm | Maximum Length mm | Mean Weight g | Minimum Weight g | Maximum Weight g |
|---|---|---|---|---|---|---|---|---|
| **Clupidae** | | | | | | | | |
| Dorosma cepedianum | Gizzard Shad | 21 | 312 | 65 | 435 | 282 | 5 | 612 |
| **Cyprinidae** | | | | | | | | |
| Cyprinella spiloptera | Spotfin Shiner | 20 | 74 | 50 | 109 | 5 | 1 | 12 |
| Cyprinus carpio | Common Carp | 4 | 707 | 569 | 875 | 5714 | 2678 | 10896 |
| Nocomis micropogon | River Chub | 1 | 53 | 53 | 53 | 2 | 2 | 2 |
| Notemigonus crysoleucas | Golden Shiner | 1 | 60 | 60 | 60 | 2 | 2 | 2 |
| Notropis atherinoides | Emerald Shiner | 6 | 59 | 26 | 76 | 3 | 0 | 6 |
| Notropis photogenis | Silver Shiner | 14 | 90 | 65 | 108 | 8 | 2 | 31 |
| Notropis volucellus | Mimic Shiner | 15 | 56 | 45 | 65 | 4 | 1 | 20 |
| Pimephales notatus | Bluntnose Minnow | 41 | 62 | 35 | 87 | 4 | 1 | 8 |
| **Catostomidae** | | | | | | | | |
| Hypentilium nigricans | Northern Hogsucker | 3 | 261 | 113 | 389 | 398 | 13 | 920 |
| Moxostoma erythrurum | Golden Redhorse | 49 | 405 | 141 | 543 | 779 | 34 | 1926 |
| **Ictaluridae** | | | | | | | | |
| Ameiurus natalis | Yellow Bullhead | 11 | 214 | 58 | 303 | 189 | 2 | 392 |
| Ameiurus nebulosus | Brown Bullhead | 1 | 340 | 340 | 340 | 608 | 608 | 608 |
| Ictalurus punctatus | Channel Catfish | 9 | 210 | 45 | 542 | 318 | 1 | 1492 |
| **Atherinidae** | | | | | | | | |
| Labidesthes sicculus | Brook Silverside | 65 | 63 | 21 | 95 | 4 | 0 | 42 |
| **Centrachidae** | | | | | | | | |
| Ambloplites rupestris | Rock Bass | 72 | 110 | 33 | 197 | 36 | 1 | 156 |
| Lepomis cyanellus | Green Sunfish | 96 | 113 | 25 | 205 | 37 | 0 | 194 |
| Lepomis gibbosus | Pumpkinseed | 15 | 143 | 80 | 207 | 69 | 9 | 164 |
| Lepomis macrochirus | Bluegill | 538 | 98 | 15 | 226 | 26 | 0 | 448 |
| | Hybrid sunfish | 2 | 22 | 19 | 25 | 0 | 0 | 1 |
| Micropterus dolomieu | Smallmouth Bass | 30 | 123 | 34 | 301 | 44 | 1 | 300 |
| Micropterus punctulatus | Spotted Bass | 84 | 127 | 48 | 276 | 42 | 1 | 244 |

**Table A7.** continued

| **Scientific Name** | **Common Name** | **Number of Observations** | **Mean Length mm** | **Minimum Length mm** | **Maximum Length mm** | **Mean Weight g** | **Minimum Weight g** | **Maximum Weight g** |
|---|---|---|---|---|---|---|---|---|
| Micropterus salmoides | Largemouth Bass | 70 | 215 | 36 | 535 | 301 | 1 | 2062 |
| Pomoxis nigromaculatus | Black Crappie | 6 | 99 | 60 | 204 | 23 | 2 | 106 |
| **Percidae** | | | | | | | | |
| Etheostoma blennioides | Greenside Darter | 1 | 76 | 76 | 76 | 4 | 4 | 4 |
| Etheostoma caeruluem | Rainbow Darter | 1 | 36 | 36 | 36 | 1 | 1 | 1 |
| Etheostoma nigrum | Johnny Darter | 6 | 45 | 35 | 49 | 1 | 0 | 1 |
| Percina caprodes | Logperch | 139 | 96 | 54 | 136 | 10 | 1 | 99 |
| Perca flavescens | Yellow Perch | 31 | 142 | 56 | 202 | 32 | 2 | 90 |
| Sander vitreus | Walleye | 12 | 163 | 113 | 210 | 38 | 12 | 64 |

**Table A8.** Lengths and weights for fishes collected with biomonitoring gill nets at Cheat Lake, 2001.

| Scientific Name | Common Name | Number of Observations | Mean Length mm | Minimum Length mm | Maximum Length mm | Mean Weight g | Minimum Weight g | Maximum Weight g |
|---|---|---|---|---|---|---|---|---|
| **Clupidae** | | | | | | | | |
| Dorosoma cepedianum | Gizzard Shad | 27 | 331 | 176 | 444 | 321 | 60 | 892 |
| **Cyprinidae** | | | | | | | | |
| Cyprinus carpio | Common Carp | 2 | 545 | 475 | 615 | 2245 | 1462 | 3028 |
| **Catostomidae** | | | | | | | | |
| Catostomus commersoni | White Sucker | 5 | 392 | 309 | 455 | 845 | 372 | 1526 |
| Moxostoma erythrurum | Golden Redhorse | 17 | 400 | 327 | 451 | 736 | 378 | 1054 |
| **Ictaluridae** | | | | | | | | |
| Ameiurus natalis | Yellow Bullhead | 5 | 293 | 251 | 364 | 423 | 260 | 790 |
| Ameiurus nebulosus | Brown Bullhead | 2 | 323 | 310 | 335 | 426 | 346 | 506 |
| Ictalurus punctatus | Channel Catfish | 33 | 366 | 158 | 520 | 425 | 28 | 826 |
| **Esocidae** | | | | | | | | |
| Esox lucius | Nothern Pike | 1 | 755 | 755 | 755 | 2168 | 2168 | 2168 |
| **Moronidae** | | | | | | | | |
| Morone chrysops | White Bass | 8 | 273 | 152 | 327 | 279 | 38 | 474 |
| M. chrysops x M. saxatilis | Hybrid Striped Bass | 1 | 269 | 269 | 269 | 244 | 244 | 244 |
| **Centrachidae** | | | | | | | | |
| Ambloplites rupestris | Rock Bass | 12 | 142 | 105 | 169 | 54 | 24 | 88 |
| Lepomis gibbosus | Pumpkinseed | 2 | 145 | 110 | 180 | 72 | 22 | 122 |
| Lepomis macrochirus | Bluegill | 1 | 176 | 176 | 176 | 118 | 118 | 118 |
| Micropterus dolomieu | Smallmouth Bass | 2 | 333 | 279 | 387 | 521 | 272 | 770 |
| Micropterus punctulatus | Spotted Bass | 1 | 282 | 282 | 282 | 274 | 274 | 274 |
| Micropterus salmoides | Largemouth Bass | 3 | 222 | 158 | 322 | 187 | 41 | 438 |
| Pomoxis annularis | White Crappie | 9 | 129 | 105 | 150 | 66 | 18 | 264 |
| Pomoxis nigromaculatus | Black Crappie | 4 | 153 | 121 | 227 | 54 | 16 | 144 |
| **Percidae** | | | | | | | | |
| Perca flavescens | Yellow Perch | 7 | 193 | 161 | 242 | 75 | 34 | 152 |
| Sander vitreus | Walleye | 10 | 427 | 290 | 557 | 824 | 356 | 1634 |

**Table A9.** Lengths and weights for fishes collected by boat electrofishing at Cheat Lake, 2005.

| Scientific Name | Common Name | Number of Observations | Mean Length mm | Minimum Length mm | Maximum Length mm | Mean Weight g | Minimum Weight g | Maximum Weight g |
|---|---|---|---|---|---|---|---|---|
| **Clupidae** | | | | | | | | |
| Dorosoma cepedianum | Gizzard Shad | 5 | 367 | 339 | 397 | 459 | 324 | 652 |
| **Cyprinidae** | | | | | | | | |
| Cyprinella spiloptera | Spotfin Shiner | 21 | 88 | 56 | 117 | 8 | 2 | 18 |
| Cyprinus carpio | Common Carp | 1 | 660 | 660 | 660 | 3973 | 3973 | 3973 |
| Nocomis micropogon | River Chub | 3 | 81 | 76 | 89 | 5 | 4 | 8 |
| Notropis ariommus | Popeye Shiner | 1 | 60 | 60 | 60 | 2 | 2 | 2 |
| Notropis atherinoides | Emerald Shiner | 3 | 60 | 60 | 60 | 6 | 6 | 6 |
| Notropis photogenis | Silver Shiner | 19 | 92 | 79 | 113 | 9 | 4 | 20 |
| Notropis volucellus | Mimic Shiner | 498 | 47 | 30 | 69 | 22 | 2 | 88 |
| Pimephales notatus | Bluntnose Minnow | 37 | 63 | 29 | 83 | 7 | 1 | 28 |
| **Catostomidae** | | | | | | | | |
| Hypentilium nigricans | Northern Hogsucker | 4 | 209 | 125 | 261 | 122 | 18 | 196 |
| Moxostoma erythrurum | Golden Redhorse | 37 | 323 | 62 | 551 | 680 | 2 | 1550 |
| **Ictaluridae** | | | | | | | | |
| Ameiurus natalis | Yellow Bullhead | 8 | 217 | 44 | 286 | 185 | 2 | 336 |
| Ictalurus punctatus | Channel Catfish | 5 | 443 | 97 | 555 | 1332 | 6 | 1972 |
| **Atherinidae** | | | | | | | | |
| Labidesthes sicculus | Brook Silverside | 180 | 66 | 30 | 83 | 15 | 1 | 168 |
| **Moronidae** | | | | | | | | |
| Morone chrysops | White Bass | 8 | 146 | 128 | 165 | 37 | 28 | 48 |
| **Centrachidae** | | | | | | | | |
| Ambloplites rupestris | Rock Bass | 48 | 118 | 58 | 232 | 43 | 4 | 218 |
| Lepomis cyanellus | Green Sunfish | 71 | 110 | 40 | 199 | 35 | 1 | 154 |
| Lepomis gibbosus | Pumpkinseed | 35 | 134 | 61 | 231 | 88 | 4 | 346 |
| Lepomis macrochirus | Bluegill | 201 | 94 | 20 | 218 | 30 | 1 | 288 |
| Micropterus dolomieu | Smallmouth Bass | 138 | 128 | 50 | 300 | 44 | 2 | 318 |
| Micropterus punctulatus | Spotted Bass | 61 | 136 | 58 | 350 | 54 | 2 | 472 |

**Table A9.** continued

| Scientific Name | Common Name | Number of Observations | Mean Length mm | Minimum Length mm | Maximum Length mm | Mean Weight g | Minimum Weight g | Maximum Weight g |
|---|---|---|---|---|---|---|---|---|
| Micropterus salmoides | Largemouth Bass | 48 | 251 | 102 | 537 | 324 | 12 | 2254 |
| Pomoxis nigromaculatus | Black Crappie | 8 | 170 | 75 | 256 | 110 | 4 | 222 |
| **Percidae** | | | | | | | | |
| Etheostoma caeruleum | Rainbow Darter | 1 | 39 | 39 | 39 | 1 | 1 | 1 |
| Percina caprodes | Logperch | 126 | 86 | 50 | 130 | 14 | 2 | 48 |
| Perca flavescens | Yellow Perch | 20 | 165 | 102 | 270 | 78 | 12 | 260 |
| Sander vitreus | Walleye | 8 | 235 | 217 | 253 | 100 | 76 | 134 |
| **Sciaenidae** | | | | | | | | |
| Aplodinotus grunniens | Freshwater Drum | 1 | 500 | 500 | 500 | 1658 | 1658 | 1658 |

**Table A10.** Lengths and weights for fishes collected with biomonitoring gill nets at Cheat Lake, 2005.

| Scientific Name | Common Name | Number of Observations | Mean Length mm | Minimum Length mm | Maximum Length mm | Mean Weight g | Minimum Weight g | Maximum Weight g |
|---|---|---|---|---|---|---|---|---|
| **Clupidae** | | | | | | | | |
| Dorosoma cepedianum | Gizzard Shad | 21 | 378 | 275 | 428 | 565 | 208 | 768 |
| **Cyprinidae** | | | | | | | | |
| Cyprinus carpio | Common Carp | 4 | 505 | 211 | 799 | 4583 | 628 | 8626 |
| **Catostomidae** | | | | | | | | |
| Catostomus commersoni | White Sucker | 19 | 387 | 239 | 464 | 791 | 152 | 1158 |
| Moxostoma erythrurum | Golden Redhorse | 51 | 424 | 240 | 521 | 941 | 158 | 1528 |
| **Ictaluridae** | | | | | | | | |
| Ameiurus natalis | Yellow Bullhead | 32 | 271 | 211 | 339 | 321 | 138 | 586 |
| Ameiurus nebulosus | Brown Bullhead | 21 | 339 | 241 | 405 | 712 | 168 | 1340 |
| Ictalurus punctatus | Channel Catfish | 207 | 433 | 197 | 664 | 881 | 58 | 2638 |
| **Salmonidae** | | | | | | | | |
| Oncorhhynchus mykiss | Rainbow Trout | 1 | 371 | 371 | 371 | 446 | 446 | 446 |
| **Moronidae** | | | | | | | | |
| Morone chrysops | White Bass | 42 | 273 | 138 | 409 | 306 | 26 | 825 |
| M. chrysops x M. saxatilis | Hybrid Striped Bass | | | | | | | |
| **Centrachidae** | | | | | | | | |
| Ambloplites rupestris | Rock Bass | 48 | 146 | 100 | 236 | 40 | 18 | 176 |
| Lepomis cyanellus | Green Sunfish | 3 | 173 | 117 | 202 | 115 | 32 | 198 |
| Lepomis gibbosus | Pumpkinseed | 16 | 192 | 120 | 238 | 134 | 34 | 236 |
| Lepomis macrochirus | Bluegill | 3 | 198 | 194 | 205 | 170 | 170 | 170 |
| Micropterus dolomieu | Smallmouth Bass | 56 | 289 | 138 | 438 | 328 | 36 | 1005 |
| Micropterus punctulatus | Spotted Bass | 20 | 234 | 191 | 306 | 170 | 88 | 360 |
| Micropterus salmoides | Largemouth Bass | 14 | 337 | 245 | 399 | 544 | 178 | 1045 |
| Pomoxis nigromaculatus | Black Crappie | 28 | 226 | 144 | 315 | 160 | 34 | 504 |
| **Percidae** | | | | | | | | |
| Perca flavescens | Yellow Perch | 108 | 272 | 106 | 334 | 270 | 20 | 486 |
| Sander vitreus | Walleye | 38 | 386 | 215 | 546 | 674 | 76 | 1638 |

**Table A11.** Lengths and weights for fishes collected by boat electrofishing at Cheat Lake, 2008.

| Scientific Name | Common Name | Number of Observations | Mean Length mm | Minimum Length mm | Maximum Length mm | Mean Weight g | Minimum Weight g | Maximum Weight g |
|---|---|---|---|---|---|---|---|---|
| **Clupidae** | | | | | | | | |
| Dorosoma cepedianum | Gizzard Shad | 5 | 367 | 339 | 397 | 459 | 324 | 652 |
| **Cyprinidae** | | | | | | | | |
| Cyprinella spiloptera | Spotfin Shiner | 21 | 88 | 56 | 117 | 8 | 2 | 18 |
| Cyprinus carpio | Common Carp | 1 | 660 | 660 | 660 | 3973 | 3973 | 3973 |
| Nocomis micropogon | River Chub | 3 | 81 | 76 | 89 | 5 | 4 | 8 |
| Notropis ariommus | Popeye Shiner | 1 | 60 | 60 | 60 | 2 | 2 | 2 |
| Notropis atherinoides | Emerald Shiner | 3 | 60 | 60 | 60 | 6 | 6 | 6 |
| Notropis photogenis | Silver Shiner | 19 | 92 | 79 | 113 | 9 | 4 | 20 |
| Notropis volucellus | Mimic Shiner | 498 | 47 | 30 | 69 | 22 | 2 | 88 |
| Pimephales notatus | Bluntnose Minnow | 37 | 63 | 29 | 83 | 7 | 1 | 28 |
| **Catostomidae** | | | | | | | | |
| Hypentilium nigricans | Northern Hogsucker | 4 | 209 | 125 | 261 | 122 | 18 | 196 |
| Moxostoma erythrurum | Golden Redhorse | 37 | 323 | 62 | 551 | 680 | 2 | 1550 |
| **Ictaluridae** | | | | | | | | |
| Ameiurus natalis | Yellow Bullhead | 8 | 217 | 44 | 286 | 185 | 2 | 336 |
| Ictalurus punctatus | Channel Catfish | 5 | 443 | 97 | 555 | 1332 | 6 | 1972 |
| **Atherinidae** | | | | | | | | |
| Labidesthes sicculus | Brook Silverside | 180 | 66 | 30 | 83 | 15 | 1 | 168 |
| **Mononidae** | | | | | | | | |
| Morone chrysops | White Bass | 8 | 146 | 128 | 165 | 37 | 28 | 48 |
| **Centrachidae** | | | | | | | | |
| Ambloplites rupestris | Rock Bass | 48 | 118 | 58 | 232 | 43 | 4 | 218 |
| Lepomis cyanellus | Green Sunfish | 71 | 110 | 40 | 199 | 35 | 1 | 154 |
| Lepomis gibbosus | Pumpkinseed | 35 | 134 | 61 | 231 | 88 | 4 | 346 |
| Lepomis macrochirus | Bluegill | 201 | 94 | 20 | 218 | 30 | 1 | 288 |
| Micropterus dolomieu | Smallmouth Bass | 138 | 128 | 50 | 300 | 44 | 2 | 318 |
| Micropterus punctulatus | Spotted Bass | 61 | 136 | 58 | 350 | 54 | 2 | 472 |

**Table A11.** continued

| Scientific Name | Common Name | Number of Observations | Mean Length mm | Minimum Length mm | Maximum Length mm | Mean Weight g | Minimum Weight g | Maximum Weight g |
|---|---|---|---|---|---|---|---|---|
| Micropterus salmoides | Largemouth Bass | 48 | 251 | 102 | 537 | 324 | 12 | 2254 |
| Pomoxis nigromaculatus | Black Crappie | 8 | 170 | 75 | 256 | 110 | 4 | 222 |
| **Percidae** | | | | | | | | |
| Etheostoma caeruleum | Rainbow Darter | 1 | 39 | 39 | 39 | 1 | 1 | 1 |
| Percina caprodes | Logperch | 126 | 86 | 50 | 130 | 14 | 2 | 48 |
| Perca flavescens | Yellow Perch | 20 | 165 | 102 | 270 | 78 | 12 | 260 |
| Sander vitreus | Walleye | 8 | 235 | 217 | 253 | 100 | 76 | 134 |
| **Sciaenidae** | | | | | | | | |
| Aplodinotus grunniens | Freshwater Drum | 1 | 500 | 500 | 500 | 1658 | 1658 | 1658 |

**Table A12.** Lengths and weights for fishes collected with biomonitoring gill nets at Cheat Lake, 2008.

| Scientific Name | Common Name | Number of Observations | Mean Length mm | Minimum Length mm | Maximum Length mm | Mean Weight g | Minimum Weight g | Maximum Weight g |
|---|---|---|---|---|---|---|---|---|
| **Clupidae** | | | | | | | | |
| Dorosoma cepedianum | Gizzard Shad | 21 | 378 | 275 | 428 | 565 | 208 | 768 |
| **Cyprinidae** | | | | | | | | |
| Cyprinus carpio | Common Carp | 4 | 505 | 211 | 799 | 4583 | 628 | 8626 |
| **Catostomidae** | | | | | | | | |
| Catostomus commersoni | White Sucker | 19 | 387 | 239 | 464 | 791 | 152 | 1158 |
| Moxostoma erythrurum | Golden Redhorse | 51 | 424 | 240 | 521 | 941 | 158 | 1528 |
| **Ictaluridae** | | | | | | | | |
| Ameiurus natalis | Yellow Bullhead | 32 | 271 | 211 | 339 | 321 | 138 | 586 |
| Ameiurus nebulosus | Brown Bullhead | 21 | 339 | 241 | 405 | 712 | 168 | 1340 |
| Ictalurus punctatus | Channel Catfish | 207 | 433 | 197 | 664 | 881 | 58 | 2638 |
| **Salmonidae** | | | | | | | | |
| Oncorhhynchus mykiss | Rainbow Trout | 1 | 371 | 371 | 371 | 446 | 446 | 446 |
| **Mononidae** | | | | | | | | |
| Morone chrysops | White Bass | 42 | 273 | 138 | 409 | 306 | 26 | 825 |
| M. chrysops x M. saxatilis | Hybrid Striped Bass | | | | | | | |
| **Centrachidae** | | | | | | | | |
| Ambloplites rupestris | Rock Bass | 48 | 146 | 100 | 236 | 40 | 18 | 176 |
| Lepomis cyanellus | Green Sunfish | 3 | 173 | 117 | 202 | 115 | 32 | 198 |
| Lepomis gibbosus | Pumpkinseed | 16 | 192 | 120 | 238 | 134 | 34 | 236 |
| Lepomis macrochirus | Bluegill | 3 | 198 | 194 | 205 | 170 | 170 | 170 |
| Micropterus dolomieu | Smallmouth Bass | 56 | 289 | 138 | 438 | 328 | 36 | 1005 |
| Micropterus punctulatus | Spotted Bass | 20 | 234 | 191 | 306 | 170 | 88 | 360 |
| Micropterus salmoides | Largemouth Bass | 14 | 337 | 245 | 399 | 544 | 178 | 1045 |
| Pomoxis nigromaculatus | Black Crappie | 28 | 226 | 144 | 315 | 160 | 34 | 504 |
| **Percidae** | | | | | | | | |
| Perca flavescens | Yellow Perch | 108 | 272 | 106 | 334 | 270 | 20 | 486 |
| Sander vitreus | Walleye | 38 | 386 | 215 | 546 | 674 | 76 | 1638 |

(g) Welsh, S. and K. Matt. 2020. An Evaluation of Artificial Habitat Structures in Cheat Lake with Emphasis on Yellow Perch Spawning and Water Level Fluctuations. West Virginia Cooperative Fish and Wildlife Research Unit; and

# An Evaluation of Artificial Habitat Structures in Cheat Lake with Emphasis on Yellow Perch Spawning and Water Level Fluctuations.

**Project Report (DRAFT)**

**31 July 2020**

**Submitted by:**

**Stuart A. Welsh and Kyle J. Matt**

**West Virginia Cooperative Fish and Wildlife Research Unit**

**Room 322, Percival Hall, West Virginia University**

**Morgantown, WV 26506**

**Submitted to:**

**Jody J. Smet, AICP, Vice President Regulatory Affairs**

**David H. Fox, Director, Environmental and Dam Safety Programs**

**Eagle Creek Renewable Energy**

**Two Bethesda Metro Center, Suite 1330, Bethesda, MD 20814**

## Introduction

Cheat Lake, a 700 hectare (1730 acre) hydropower reservoir on Cheat River in northern West Virginia, experiences water level fluctuations resulting in part from the storage and release of water for power production. Lake water elevation at full pool is 265.2 m (870 ft). Three regulation periods are in place to limit the amount of lake drawdown. From May through October, lake elevation is relatively constant with a minimum drawdown level of 264.6 m (868 ft). Lake elevation is permitted to be lowered to the minimum level of 261.2 m (857 ft) from November through March. During April, lake elevation can be drawn down to a level of 263 m (863 ft). Water level fluctuations influence reservoir fish populations, including reduced spawning success for some fish species (Hirsch et al. 2017). From a community level, reduced spawning success of one or more fish species leads to lower numbers of fish larvae and young-of-year fish, resulting in a reduced forage base for predatory gamefishes. Water level fluctuations during spring months may result in egg-dewatering and spawning failure for individuals of some species, such as Yellow Perch. Cheat Lake supports one of the most productive Yellow Perch fisheries in West Virginia, so it is relevant from a management perspective to understand the potential of population impacts owing to water level fluctuations (Taylor 2013, Hilling et al. 2018).

Evaluations of the timing and duration of Yellow Perch spawning relative to water level fluctuations are needed to inform fishery management decisions of Cheat Lake. Based on studies from other lakes, Yellow Perch typically spawn in nearshore littoral zones, where egg masses are draped across vegetation or woody debris (Echo 1955; Muncy 1962; Scott and Crossman 1973; Nelson and Walburg 1977; Becker 1983).

Egg masses are long, transparent, gelatinous, ribbon-like and accordion-shaped. A gravid female may have from 2,000 to 157,600 eggs depending on body size and age (Brazo et al. 1975, Hardy 1978), but average estimates of the number of eggs within an egg mass are 23,316 and 25,512 (Hanchin et al. 2003), and 23,000 (Scott and Crossman 1973, Hardy 1978). Yellow Perch eggs hatch about 10–20 days after spawning.

Currently, we have little information on Yellow Perch spawning in Cheat Lake, so information on when Yellow Perch spawn, as well as data on spawning water depths and distances from the shoreline are needed to understand the potential for egg dewatering during periods of lake level drawdown. The primary objectives of this study were to document the timing of Yellow Perch spawning, as well as examine spawning habitat characteristics, i.e., water depth, distance from shore, and water turbidity. Further, we examined water level fluctuation as a variable of influence on the timing of spawning, as well as its role in the potential for egg dewatering.

**Methods**

During spring 2019 and 2020, 40 artificial spawning structures were placed (submerged) at two sites on Cheat Lake; 20 structures at Crammys Run and 20 at Canyon Bend (Figure 1). Lake bottom contours of near-shore areas of Crammys Run were mostly of gradual slope, whereas those of Canyon Bend were mostly steep slopes. Each spawning structure was comprised of a 2.4-m (8-ft) piece of 51-mm (2.0-in) diameter PVC pipe (Schedule 40), 10 sections of 1.8-m (6-ft) strands of artificial aquatic plants (reelweeds by LaDredge Outdoors; https://www.reelweeds.com/), and two 2.4-m (8-ft) pieces of 13-mm (0.5-in) diameter rebar. These parts were assembled into a 1.8-m (6-ft) tall by 2.4-m (8-ft) long structure, as depicted in Figure 2. The ends of the PVC pipe were sealed with caps, so that the pipe served as a float. Zip ties were used to attach the tops of the artificial plant strands to the PVC float and bottoms of the strands to the rebar. When deployed, the rebar end of the spawning structures rested on the lake bottom, and the structure maintained a vertical position in the water column (owing to the floatation of the PVC pipe). If the water was less than 1.8-m (6-ft) deep at the deployment site, then the 2.4-m (8-ft) piece of PVC pipe floated on the water's surface (Figure 3). When deployed at locations with steep bottom contours, the spawning habitat unit was oriented parallel to the shoreline to reduce water depth variation along the unit's 2.4-m (8-ft) length. A harness of 550 paracord, attached at each end of the PVC pipe, was connected to a longer strand of 550 paracord terminating in an attached location buoy (Figure 2). Each buoy was labeled with a unique number for identification. When the spawning structure was deployed, the tethered buoy floated on the water's surface, providing a way to find and retrieve the structure.

The 40 spawning structures were checked daily for the presence of egg masses during the expected spring spawning period. Initially, we considered using underwater cameras to check the spawning structures for the presence of egg masses, but this presented two concerns. First, given an expected range of water turbidity levels, days with poor water clarity would inhibit the efficiency of cameras. Second, we realized that it would be important to remove egg masses from the structures on a daily basis, so to prevent the double counting of egg masses on consecutive sampling days. Consequently, we checked for egg mass presence by removing the structures from the water. We recorded presence/absence of egg masses, and also counted the number of egg masses on each spawning structure. Egg masses were removed from the structures, placed in a bucket of lake water, and relocated to nearby areas. Egg masses were relocated to areas with submerged tree habitat and deep water (i.e. areas with a low chance for egg mass dewatering). Ten egg masses was preserved in 50% ethanol for estimation of the average number of eggs per egg mass (see methods in Appendix A). The estimate of the average number of eggs per egg mass was compared with those from the literature and used to calculate total egg numbers by site and year.

Habitat covariates were recorded daily, primarily at the time when spawning structures were checked. The depth of water at each spawning structure was recorded at deployment and retrieval using a handheld sonar unit. Water temperatures were measured at the lake surface in a near-shore area, and at the lake bottom at or near the deepest habitat unit with either a Marcum LX-9 unit or a Hobo tidbit logger. The mean value of the two water temperatures was used as a water temperature covariate. We measured the distance of the structure to the nearest shoreline's high water mark (i.e. full pool elevation level) using a laser range finder. We also recorded the distance of the structure to the nearest shoreline's current water level. A secchi disk depth (cm) was also recorded at each site, which provided an index of water turbidity. A covariate for water level fluctuation was calculated by subtracting the lake elevation at the time of the structure retrieval from the lake elevation at the time of deployment on the previous day. The water level fluctuation covariate was either negative or positive depending on the direction of change of water level during the time period between daily sampling events. A caveat with this approach is that the actual time of the spawning event is unknown. It is possible that a change in water level elevation could occur after a spawning event. For example, consider a habitat unit that was deployed at 11:00 am and then retrieved with the presence of an egg mass at 11:00 am on the following day. We could document that a water level increase occurred from 4:00 am to 10:00 am on the day of retrieval, but we would not know if the spawning event occurred before or after 4:00 am.

A main focus of this research was on the relationship between fluctuations in water levels of Cheat Lake and the potential for dewatering of egg masses. Water level elevation changes of the lake were plotted from data downloaded from the USGS river gage site (https://waterdata.usgs.gov/usa/nwis/uv?site_no=03071590). For analysis, we estimated the proportion of egg masses located in potential dewatering areas based on two scenarios. In the first scenario, we assumed that egg masses were deposited on the lake bottom. In the second scenario, the assumption was that egg masses were deposited onto a structure at a position of 0.914 m (3 ft) above the bottom. The range of 0.0–0.914 m was based on our observations of egg mass positions on artificial spawning structures and on natural structures in near-shore habitats. We attempted to position the 20 habitat units at each site so that 10 were in the potential dewatering zone and 10 were in deeper areas that were outside of this zone.

*Data Analysis*

Generalized Estimation Equations (GEE) for binary response (presence/absence of egg masses) with a logit link were used to analyze data of Yellow Perch egg masses on artificial habitat units and associated covariates. This GEE analysis is equivalent to a Logistic Regression analysis, but allows for the use of a correlation matrix structure to properly address spatial clustering of data. In our study, 20 habitat units were clustered together on each sampling day. To select an appropriate working correlation structure, we fit models with autoregressive AR(1), compound symmetry, and independent working correlation matrices to our global model and used the correlation information criterion (CIC) to select a working correlation structure (Hin and Wang 2009).

Before analysis, habitat variables were examined with Pearson correlation coefficients, which supported near collinearity ($r = 0.98$) between two distance measures; distances of habitat units to (1) the full pool level on the shoreline and to (2) the current water level at the time of sampling. The distance to the full pool level was retained for analysis, and hereafter referred to as "Distance to the shore". Near collinearity was not observed between other variables, resulting in the use of six covariates; Secchi disk depth, Distance to the shore, Water temperature, Water depth, Lunar illumination, and Lake level fluctuation.

A set of 35 candidate models were fit to the data using GEE analyses with a binomial distribution, a logit link function, and an AR(1) correlation structure (Statistical Analysis System, SAS 9.4; PROC GENMOD). Twelve of the candidate models included six single covariate models with a year effect and six single covariate models with a site effect. An additional 20 candidate models of two-variable or three-variable additive effects of covariates included 10 with a year effect and 10 with a site effect. For these models, the year effect or site effect was added to the following 10 model structures; Water depth + Distance to shore, Water depth + Lake level fluctuation, Water depth + Lunar illumination, Water depth + Secchi disk depth, Water depth + Water temperature, Distance to shore + Lake level fluctuation, Lunar illumination + Secchi disk depth, Water depth + Distance to shore + Lake level fluctuation, Water depth + Lunar illumination + Secchi disk depth, and Water depth + Lunar illumination + Water temperature. Three models included all six covariates; one with a year effect, one with a site effect, and a global model with both a year effect and a site effect.

We used an information-theoretic approach for model selection and inference. The best model (or suite of competing models) was selected with the Quasi-likelihood Information Criterion ($QIC_u$) of Pan (2001). We also estimated QIC distances among models ($\Delta QIC_u$) and $QIC_u$ model weights ($w_i$) following methods of Burnham and Anderson (2002). Models, which represented alternative hypotheses, were considered to be supported by the data if $\Delta QIC_u$ values were less than 2.0 (Burnham and Anderson 2002). Predicted probability plots (i.e., effect plots) of covariates provided a visual aid for interpretation of model selection results. Further, descriptive statistics of covariates (means and standard errors), histogram plots, and time-series plots aided interpretation of modeling results.

**Results**

Artificial spawning structures were deployed at the Crammys Run and Canyon Bend study sites for 51 days in 2019 (11 March to 30 April) and 40 days in 2020 (11 March to 19 April). The time periods of egg mass presence on spawning structures in 2019 and 2020, which we refer to as spawning periods, were documented during a 27-day period (21 March to 16 April) in 2019 and a 22-day period (21 March to 11 April) in 2020 (Figure 4). Presences of egg masses were documented 46 and 35 times in 2019, and 13 and 26 times in 2020 on spawning structures at Crammys Run and Canyon Bend, respectively. Typically, a single egg mass was present on a spawning structure, but multiple egg masses were found occasionally on a single spawning structure. In 2019, for 46 instances of egg mass presence on structures at Crammys Run, 36 were single egg masses, 7 represented 2 egg masses, and 3 were for 3 egg masses. Thus, a total of 59 egg masses were found on structures at Crammys Run. For 35 instances of egg mass presence on structures at Canyon Bend, 28 were single egg masses, 5 represented 2 egg masses, and single occurrences were found for 3 and 4 egg masses (45 egg masses in total). In 2020, only 13 single egg masses were found on structures at Crammys Run. For 26 instances of egg mass presence on structures at Canyon Bend, 22 were single egg masses, and 4 represented 2 egg masses (i.e., 30 egg masses in total). Egg masses were generally attached to the spawning structures in two ways: spiraled around a single artificial vegetation strand, or draped over one or more strands (Figure 5).

A total of 10 egg masses were collected in 2020 for estimation of the average number of eggs per egg mass. Two of the 10 egg masses preserved poorly in ethanol, so eight egg masses were examined, resulting in a range of values from 10,538 to 84,570 eggs per egg mass (Appendix A, Table A1). The average value was 38,237 eggs with a 95% confidence interval of 20,372 to 56,102 eggs. The ethanol-preserved eight egg masses ranged in length from 580 to 2990 mm. The ethanol preservation altered the gelatinous structure of the egg skeins, allowing the egg masses to stretch to a longer length than that of an unpreserved egg mass. This alteration to the egg skein, however, did not affect the count of eggs. The lengths of egg masses noted during field collection did not extend beyond 2.0 m (6.6 ft), but the ethanol-preserved eggs were not measured at the time of collection. Based on our average estimate of 38,237 eggs per egg mass, the 59 and 49 egg masses at Crammys Run and Canyon Bend in 2019 contained a total of 2,255,983 and 1,720,665 eggs, respectively. The egg masses at Crammys Run (13) and Canyon Bend (30) in 2020 contained a total of 497,081 and 1,147,110 eggs, respectively.

Summarizing the results of egg presence on spawning structures between March and April is useful, given that the minimum lake elevation level changes from 261.2 m (857 ft) in March to 263 m (863 ft) in April. In 2019, a total of 19 egg masses were found on 9 structures during 21–31 March, whereas 85 egg masses were found on 72 structures during 1–16 April. In 2020, a total of 32 egg masses were found on 29 structures during 21–31 March, and a total of 11 egg masses were found on 11 structures during 1–11 April. Based on an average estimate of 38,237 eggs per egg mass, the calculated numbers of eggs per time period were 726,503 (March 2019), 3,250,145 (April 2019), 1,223,584 (March 2020), and 420,607 (April 2020). Thus, the number of eggs during April exceeded that of March in 2019, but this relationship was reversed in 2020.

For the GEE analysis, a three-variable additive effects model with a year effect was the only model supported by the data (Table 1). The $QIC_u$-selected model was Year + Water depth + Lunar illumination + Water temperature. The GEE parameter estimates for this model (with confidence intervals and p-values) were Year (0.60, 0.15 – 1.05, p=0.0087), Water depth (-0.08, -0.15 – -0.0044, p=0.0378), Lunar illumination (-1.2, -1.9002 – -0.4836, p=0.0010), and Water temperature (0.14, 0.0259 – 0.2475, p=0.0156).

Plots of predicted probability for presence = 1 from the GEE analysis (Figure 6), and data summary statistics (Table 2) aid the interpretation of the $QIC_u$-selected model and its GEE parameter estimates. The negative parameter estimates for water depth and lunar illumination variables indicate a negative association between the presence of egg masses and both water depth and lunar illumination. Model results for water depth and lunar illumination are supported by histogram and time series plots (Figures 4, 7). The mean values of water depths for habitat units with the presence of egg masses in 2019

(2.7 m or 8.9 ft) and 2020 (2.6 m or 8.5 ft) were less than those of all habitat units in 2019 (3.5 m or 11.5 ft) and 2020 (3.6 m or 11.8 ft; Table 2). The mean values of percent lunar illumination for habitat units with the presence of egg masses in 2019 (0.24) and 2020 (0.35) were less than those of all habitat units in 2019 (0.38) and 2020 (0.41; Table 2). The positive parameter estimate for water temperature supports a positive relationship between egg mass presence and water temperature. This relationship is depicted by effect plots (Figure 6), and by an overlay plot of the water temperature time series and the daily egg mass count, particularly for data from April 2019 and March 2020 (Figure 4).

Several data patterns are worth noting relative to the three covariates not supported by the $QIC_u$-selected model (Distance to shore, Lake level fluctuation, and Secchi disk depth). Egg masses were generally not present in distances exceeding 45 m to the shoreline (Figure 8), and on average were closer to the shoreline in 2019 (23.1 m or 75.8 ft) and 2020 (18.3 m or 60.0 ft) than that of the average distances of all habitat units in 2019 (24.9 m or 81.7 ft) and 2020 (25.2 m or 82.7 ft; Table 2). The numbers of egg masses associated with increasing lake levels (n = 68) exceeded those of decreasing lake levels (n = 46; Figure 9). Secchi disk depths were positively associated with egg mass presence in 2019, suggesting that Yellow Perch may avoid spawning during turbid water conditions, but the opposite pattern occurred in 2020 (Figure 6). The mean values of Secchi disk depths at Crammys Run and Canyon Bend in 2020 (171 and 156 cm) were lower than those of 2019 (208 and 228).

The 2019 and 2020 fluctuations in water levels during spawning periods were similar, but differed from those of some years prior to our study. During the spawning period of 21 March – 16 April 2019, water level elevations of Cheat Lake fluctuated within a range of 263.4–265.1 m (864.2–869.8 ft), a difference of 1.7 m (5.6 ft; Figure 10). During the spawning period of 21 March – 11 April 2020, water level elevations fluctuated within a range of 263.5–265.1 m (864.5–869.8 ft), a difference of 1.6 m (5.3 ft; Figure 10). The ranges of lake elevation fluctuations for 2019 and 2020 spawning periods were minimal relative to the same period of time (21 March – 16 April) for two of the previous three years (2016, 261.8–265.0, 3.2 m; 2017, 263.4–265.2, 1.8 m; 2018, 261.4–265.2, 3.8 m; Figure 11).

Fluctuations in water levels of Cheat Lake were examined in relation to the placement of artificial spawning habitat units and the potential for dewatering of egg masses. As defined previously, the potential for dewatering is based on the elevation of lake water, where drawdown of lake elevations could potentially reach 261.2 m (857 ft) in March and 263 m (863 ft) in April. Based on our observations, Yellow Perch deposit egg masses within a zone ranging from the lake bottom to up to 0.914 m (3 ft) above the lake bottom if spawning structures are present. We attempted to place half (0.5) of the artificial spawning structures in areas with the potential for dewatering and half (0.5) in areas outside of the potential for dewatering. However, the proportion of habitat units placed in areas of potential dewatering of the lake bottom and 0.914 m (3 ft) above the lake bottom ranged from 0.17 to 0.29, and 0.37 to 0.44, respectively (Table 3).

Based on the maximum range of water level fluctuations during the spawning periods of 2019 and 2020, we estimated the proportion of egg masses located in potential dewatering areas (Table 3, Figure 12). For 2019, if all egg masses were deposited onto the lake bottom, then 36% of egg masses (21 of 59) were in potential dewatering areas at Crammys Run, whereas 9% of egg masses (4 of 45) were in potential dewatering areas at

Canyon Bend. With the two sites combined, 24% of egg masses (25 of 104) were in potential dewatering areas. If egg masses were deposited onto structures at 0.914 m (3 ft) above the lake bottom, then estimates of egg placement in potential dewatering areas were 64% (38 of 59), 36% (16 of 45), and 52% (54 of 104) for Crammys Run, Canyon Bend, and the two sites combined, respectively. For 2020, if all egg masses were on the lake bottom, then 85% (11 of 13) at Crammys Run, 43% (13 of 30) at Canyon Bend, and 56% (24 of 43) at both sites combined were in the dewatering zone. If egg masses were deposited onto structures at 0.914 m (3 ft) above the lake bottom, then estimates of egg masses in potential dewatering areas were 85% (11 of 13), 63% (19 of 30), and 70% (30 of 43) at Crammys Run, Canyon Bend, and the two sites combined, respectively (Figure 12).

**Discussion**

A main objective of this research was to document the timing of Yellow Perch spawning in Cheat Lake in relation to regulations on periods of hydropower-drawdown of lake levels. Of particular interest was the duration and effort of spawning between March and April, because a 4 m (13 ft) lake level drawdown is permitted during March, and a 2.1 m (7 ft) drawdown is permitted during April. Thus, the dewatering of Yellow Perch egg masses would likely be less if the majority of the spawning period and spawning effort occurred during April than in March. During our two-year study, the spawning periods were similar in timing and duration, where spawning occurred from 21 March to 16 April in 2019 and from 21 March to 11 April in 2020. The effort of spawning, however, differed between years, where the majority of egg masses in 2019 was found on spawning structures in April, and most egg masses in 2020 were documented during

March. Under current lake level regulations, egg losses from dewatering will likely be increased during years when Yellow Perch spawning efforts during March exceed those of April. From a fishery management perspective, single or consecutive years when most of the spawning effort occurs in March could result in reduced year class strengths of the Yellow Perch population.

Our study documented several characteristics useful for understanding where Yellow Perch spawn within Cheat Lake, particularly with regard to water depth and distance to the shore. Water depth and distance to the shore are often correlated, especially when lake bottom gradients have moderate to steep slopes, but shallow mud flats do not generally follow this pattern. In our study, Crammys Run had mostly shallow mud flats with some areas of steep bottom slopes, and Canyon Bend had mostly steep slopes with one shallow mud flat. We realize that our placement of habitat units may have influenced the results. Shallow mud flats (distant from the shore) and deeper habitats generally did not contain many spawning structures. Fish spawned in these areas likely because of the presence of our artificial spawning habitat units, and in the absence of units, may have otherwise spawned in near-shore areas. From a fishery management perspective relative to lake level drawdowns, our finding that Yellow Perch will spawn in deep water supports an option for placement of spawning structures in deeper water just outside of the potential dewatering zone.

The importance of photoperiod and water temperature as cues for the onset of fish spawning periods is well established. In our study, spawning began on March 21 in both years, and likely reflects a photoperiod influence. Water temperatures on those days were 6.1 °C (43.0 °F) in 2019 and 10.6 °C (51.1 °F) in 2020, and varied throughout the spawning periods ranging from 6.0–14.8 °C (42.8–58.6 °F) in 2019, and 8.9–13.4 °C (48.0–56.1 °F) in 2020. Our modeling efforts focused on the variation of water temperature within the spawning periods and its association with egg mass presence. Our data supported a positive relationship between water temperature and egg mass presence. Temporal variation in water temperature may influence the spawning efforts between March and April (Starzynski and Lauer 2015), particularly in years where water temperatures are below or exceed spawning threshold temperatures during a portion of the expected spawning period. Water temperature variation may also influence the spawning effort distribution between deeper and shallower water, as water temperature of shallower water general exceeds that of deeper water.

The relationship between egg mass presence and lunar illumination may be a spurious effect, because the duration of the spawning period is less than one lunar cycle. But in both years of the study, a larger number of egg masses were present during periods of the lunar cycle closer to the new moon. If this is a valid relationship, then it suggests that Yellow Perch prefer to spawn on darker nights near the new moon. The relationship of egg mass presence with lunar illumination and darker nights could be better understood with a longer time series from additional years of study, or by modeling covariates of cloud cover or sky brightness.

Our 2019 data supported secchi disk depth, a proxy for water turbidity, as a variable with influence on the presence of Yellow Perch egg masses on artificial habitat. Spawning was rarely documented during high water turbidity in 2019. This pattern, however, was reversed in 2020, where spawning occurred across a wider range of water turbidity values. We expected that Yellow Perch may delay spawning during periods of turbid conditions, as individuals may experience difficulty in locating spawning structures or locating mating partners. Alternatively, it is possible that Yellow Perch spawned during turbid conditions in 2019, but individuals may not have been able to locate the artificial habitat structures during that time. In some reservoirs, turbid conditions often exist in near-shore areas owing to wakes from motor boat traffic, an occurrence that could influence Yellow Perch spawning behavior. In our two-year study, we rarely experienced near-shore turbidity, as motor boat traffic was minimal during late March and early April.

Although not supported by modeling results, egg mass presence was more commonly associated with an increase in lake level than with lake level drawdown. It seems biologically reasonable that water level fluctuations could influence the timing of spawning. It is also possible that there is a lag effect associated with lake level fluctuation, where changes in lake levels in days previous may influence the timing of spawning, but we did not address this in our models. The direction of lake level fluctuation at or near the time of spawning, however, may not be the main concern. A larger issue is that eggs are present for approximately 10 to 20 days before hatching, so whether or not lake level drawdowns impact the timing of spawning, post-spawn drawdowns can impact eggs during this 10- to 20-day incubation period.

We are uncertain as to why the number of egg masses on our artificial spawning structures in 2020 were less than that of 2019. For example, we counted 59 egg masses on habitat units at Crammys Run in 2019, and 45 egg masses at Canyon Bend in 2019. In 2020, we counted 13 egg masses at Crammys Run and 30 egg masses at Canyon Bend. The between-year difference may be explained in part by a longer spawning season in

2019 relative to that of 2020. Also, an extended period of lake level drawdown for the dredging of a boat launch area at a local marina occurred during the first half of March 2020, which may have led to Yellow Perch leaving the shallow Crammys Run area to spawn elsewhere. Also, it is possible that the higher levels of turbidity during 2020 reduced Yellow Perch spawning efforts. Another possible contributing factor was our concurrent study in 2020 on the use of benthic artificial habitat structures (see Appendix B). Yellow Perch that spawned on these benthic habitat structures may have otherwise spawned on the other artificial spawning structures.

A main objective of this study was on understanding the potential for dewatering of Yellow Perch egg masses during periods of lake level drawdown. Also, year-to-year variation in egg dewatering potential was addressed in our two-year study. During a 27-day spawning period in 2019, we calculated that about half (52%, or 54 of 104) of Yellow Perch egg masses had the potential to be dewatered for both sites (if the lake level was lowered to the minimum elevation of 261.2 m (857 ft) in March, or 263 m (863 ft) in April). For the 22-day spawning period in 2020, the estimate of Yellow Perch egg masses with the potential to be dewatered for both sites was as high as 70%; 30 of 43). Thus, the potential for dewatering of eggs is high, but the actual percent of eggs dewatered will be lower, as lake level drawdown generally does not reach the minimum lake elevations as permitted for March or April.

Although we focused on the potential for dewatering of egg masses, actual dewatering of egg masses does occur on Cheat Lake, and we observed many egg masses on near-shore natural structures, including submerged and dewatered eggs (Figure 13). Considering that egg masses were present on natural structures at our study sites, as well as expected along near-shore habitats outside of our study sites, then it is reasonable to assume that the number of eggs with dewatering potential is much larger than the 5.6 million eggs documented in this two-year study. In Cheat Lake, location likely determines the dewatering of eggs and the potential for eggs to be dewatered. This was demonstrated by our data, as the proportion of egg masses that were susceptible to dewatering was lower at Canyon Bend than that at Crammys Run. We believe that this difference reflects a difference in availability of shallow versus deep habitat between the two sites. Nearshore areas at Crammys Run will likely be shallower than those at Canyon Bend, resulting in a higher dewatering potential of egg masses at Crammys Run. Future studies using bathymetry data, such as those provided by Smith and Welsh (2015), could provide insights into the potential for dewatering of eggs at a lake level scale.

Several caveats may have impacted study results on egg dewatering potential. The difference in egg dewatering potential between sites, as well as the overall estimates of egg dewatering potential may be biased by the depths of placement location of our artificial structures. Structures placed in deeper water (which in some areas correspond with farther distances from the shore), may have influenced spawning locations. It is possible that nearshore and shallower areas would have been used in the absence of these deep water artificial spawning structures. A higher proportion of spawning events in shallower water would have resulted in a higher estimate of egg dewatering potential.

Another study concern was that egg masses could become unattached from the artificial structure during structure retrieval. This was particularly a concern for water deeper than 3 m (> 10 ft). Egg masses detached from artificial structures on a few occasions for shallow sets (<3 m). Because of the near-neutral buoyancy of the egg masses, however, there was a tendency for the unattached egg masses to float upward with the lifting of the structure, thus unattached egg masses were observed and counted. For deeper water (> 3 m), unattached egg masses may have gone unnoticed and uncounted.

Our study demonstrated that Yellow Perch in Cheat Lake spawn in shallow near-shore areas, as well as in a wide range of depths and distances from the shore. Spawning in deeper water reduces the potential for dewatering of eggs during lake level drawdowns, but may be inhibited by a lack of spawning structures. The potential for dewatering of Yellow Perch eggs exceeded 50% when considering data from both sites and both years of the study. Thus, hydropower drawdown has the potential to reduce egg production of the Cheat Lake Yellow Perch population by more than half. Under the current lake level drawdown regulations, the largest egg losses will likely occur when Yellow Perch focus their spawning efforts in March as opposed to April. Intuitively, the dewatering of Yellow Perch eggs will result in fewer larvae and fewer young-of-year individuals. Less clear is the community effect, but we do know that larvae and young-of-year Yellow Perch can provide a substantial forage base for predatory fishes. For example, Smith (2018) found that Yellow Perch represented an important forage fish for Walleye in Cheat Lake. Thus, dewatering and associated egg losses may not only impact the Yellow Perch population, but may also have a bottom up effect on other fish populations of Cheat Lake.

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Table 1. Model selection statistics for 35 candidate models (i.e., alternative hypotheses) fit to egg mass presence/absence data from Cheat Lake, West Virginia. Models included a year effect (2019 and 2020) or site effect (Crammys Run and Canyon Bend). Covariates were water depth (Depth), distance to shoreline (Distance), lake level fluctuation (LLF), lunar illumination (Lunar), water temperature (Temp), and Secchi disk depth (Secchi).

| Model | AICc | Delta | Model L | Wt |
|---|---|---|---|---|
| Year + Depth + Lunar + Temp | 842.4 | 0.0 | 1.0 | 1.0 |
| Year + Depth + Distance + LLF + Lunar + Temp + Secchi | 850.0 | 7.6 | 0.0 | 0.0 |
| Site + Depth + Lunar + Temp | 853.0 | 10.6 | 0.0 | 0.0 |
| Global | 853.1 | 10.6 | 0.0 | 0.0 |
| Site + Depth + Distance + LLF + Lunar + Temp + Secchi | 854.0 | 11.5 | 0.0 | 0.0 |
| Year + Depth + Lunar | 855.8 | 13.3 | 0.0 | 0.0 |
| Year + Depth + Lunar + Secchi | 857.7 | 15.3 | 0.0 | 0.0 |
| Year + Depth + Temp | 860.4 | 18.0 | 0.0 | 0.0 |
| Site + Depth + Lunar + Secchi | 864.6 | 22.2 | 0.0 | 0.0 |
| Site + Depth + Lunar | 866.0 | 23.6 | 0.0 | 0.0 |
| Year + Lunar | 869.9 | 27.5 | 0.0 | 0.0 |
| Year + Temp | 870.8 | 28.4 | 0.0 | 0.0 |
| Year + Depth + LLF | 870.9 | 28.5 | 0.0 | 0.0 |
| Year + Lunar + Secchi | 871.8 | 29.4 | 0.0 | 0.0 |
| Year + Depth | 872.8 | 30.3 | 0.0 | 0.0 |
| Year + Depth + Distance + LLF | 874.3 | 31.9 | 0.0 | 0.0 |
| Year + Depth + Secchi | 874.5 | 32.1 | 0.0 | 0.0 |
| Year + Depth + Distance | 875.2 | 32.8 | 0.0 | 0.0 |
| Site + Depth + Temp | 877.2 | 34.8 | 0.0 | 0.0 |
| Site + Lunar + Secchi | 878.9 | 36.5 | 0.0 | 0.0 |
| Site + Lunar | 880.1 | 37.6 | 0.0 | 0.0 |
| Year + Distance + LLF | 880.3 | 37.9 | 0.0 | 0.0 |
| Year + Distance | 880.4 | 38.0 | 0.0 | 0.0 |
| Site + Depth + Secchi | 882.2 | 39.8 | 0.0 | 0.0 |
| Site + Depth + LLF | 883.4 | 40.9 | 0.0 | 0.0 |
| Year + LLF | 884.9 | 42.5 | 0.0 | 0.0 |
| Site + Depth | 885.4 | 43.0 | 0.0 | 0.0 |
| Site + Depth + Distance + LLF | 886.5 | 44.1 | 0.0 | 0.0 |
| Site + Temp | 887.0 | 44.6 | 0.0 | 0.0 |
| Year + Secchi | 887.5 | 45.0 | 0.0 | 0.0 |
| Site + Depth + Distance | 887.6 | 45.2 | 0.0 | 0.0 |
| Site + Distance + LLF | 890.9 | 48.5 | 0.0 | 0.0 |
| Site + Distance | 891.1 | 48.7 | 0.0 | 0.0 |
| Site + Secchi | 894.4 | 52.0 | 0.0 | 0.0 |
| Site + LLF | 896.3 | 53.8 | 0.0 | 0.0 |

Table 2. Summary statistics of habitat variables for all spawning habitat units and for those units with presence of Yellow Perch egg masses (N = sample size, SE = standard error, min = minimum value, and max = maximum value).

| | Crammys Run | | | | | Canyon Bend | | | | | Sites combined | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Variable | N | Mean | SE | min | max | N | Mean | SE | min | max | N | Mean | SE | min | max |
| All habitat units in 2019 | | | | | | | | | | | | | | | |
| Secchi depth (cm) | 24 | 208 | 11.8 | 44 | 285 | 24 | 228 | 11.1 | 40 | 290 | 48 | 218 | 8.1 | 40 | 290 |
| Water Depth (m) | 465 | 3.2 | 0.12 | 0.31 | 6.1 | 470 | 3.8 | 0.08 | 0.46 | 7.6 | 935 | 3.5 | 0.05 | 0.3 | 7.6 |
| Distance from shore (m) | 465 | 27.2 | 0.79 | 5.0 | 86 | 470 | 22.5 | 0.45 | 7.0 | 47 | 935 | 24.9 | 0.46 | 5.0 | 86 |
| Water temperature (°C) | 24 | 10 | 0.55 | 6.0 | 14.8 | 24 | 10.2 | 0.51 | 7.1 | 14.4 | 48 | 10.7 | 0.37 | 6.0 | 14.8 |
| Lunar illumination | 24 | 0.38 | 0.07 | 0.0 | 1.0 | 24 | 0.39 | 0.07 | 0.0 | 1.0 | 48 | 0.38 | 0.05 | 0.0 | 1.0 |
| All habitat units in 2020 | | | | | | | | | | | | | | | |
| Secchi depth (cm) | 20 | 171 | 8.7 | 105 | 225 | 20 | 156 | 8.0 | 72 | 225 | 40 | 163 | 6.0 | 72 | 225 |
| Water Depth (m) | 400 | 3.4 | 0.08 | 0.0 | 6.0 | 400 | 3.8 | 0.1 | 0.0 | 8.2 | 800 | 3.6 | 0.06 | 0.0 | 8.2 |
| Distance from shore (m) | 400 | 27.1 | 0.79 | 6.0 | 86 | 400 | 23.3 | 0.56 | 6.0 | 56 | 800 | 25.2 | 0.49 | 6.0 | 86 |
| Water temperature (°C) | 20 | 10.8 | 0.26 | 8.9 | 12.5 | 20 | 11.7 | 0.29 | 10 | 13.4 | 40 | 12.2 | 0.28 | 8.9 | 13.4 |
| Lunar illumination | 20 | 0.41 | 0.08 | 0.0 | 1.0 | 20 | 0.41 | 0.08 | 0.0 | 1.0 | 40 | 0.41 | 0.06 | 0.0 | 1.0 |
| Habitat units with egg presence 2019 | | | | | | | | | | | | | | | |
| Secchi depth (cm) | 46 | 212 | 8.3 | 44 | 285 | 35 | 249 | 7.4 | 40 | 290 | 81 | 228 | 6.0 | 40 | 290 |
| Water Depth (m) | 46 | 2.4 | 0.16 | 0.91 | 5.4 | 35 | 3.1 | 0.24 | 1.1 | 6.2 | 81 | 2.7 | 0.14 | 0.91 | 6.2 |
| Distance from shore (m) | 46 | 25.3 | 1.7 | 8.5 | 61 | 35 | 20.2 | 1.5 | 9.0 | 47 | 81 | 23.1 | 1.2 | 8.5 | 61 |
| Water temperature (°C) | 46 | 10.9 | 0.37 | 6.0 | 14.8 | 35 | 11.1 | 0.36 | 7.1 | 14.3 | 81 | 11.0 | 0.26 | 6.0 | 14.8 |
| Lunar illumination | 46 | 0.27 | 0.04 | 0.0 | 0.99 | 35 | 0.2 | 0.04 | 0.0 | 0.76 | 81 | 0.24 | 0.03 | 0.0 | 0.99 |
| Habitat units with egg presence 2020 | | | | | | | | | | | | | | | |
| Secchi depth (cm) | 13 | 162 | 10.2 | 105 | 225 | 26 | 145 | 5.4 | 72 | 195 | 39 | 151 | 5.0 | 72 | 225 |
| Water Depth (m) | 13 | 1.7 | 0.15 | 0.58 | 2.8 | 26 | 3.0 | 0.25 | 0.9 | 5.3 | 39 | 2.6 | 0.2 | 0.58 | 5.3 |
| Distance from shore (m) | 13 | 14.9 | 1.3 | 7.0 | 26 | 26 | 20 | 2.0 | 9.0 | 42 | 39 | 18.3 | 1.4 | 7.0 | 42 |
| Water temperature (°C) | 13 | 10.7 | 0.34 | 8.9 | 12.2 | 26 | 12.3 | 0.19 | 10.1 | 13.4 | 39 | 11.8 | 0.21 | 8.9 | 13.4 |
| Lunar illumination | 13 | 0.27 | 0.1 | 0.0 | 1.0 | 26 | 0.39 | 0.05 | 0.01 | 0.98 | 39 | 0.35 | 0.05 | 0.0 | 1.0 |

Table 3. Proportion of artificial spawning habitat units with and without egg masses located in areas of potential dewatering zones, as defined by minimum lake drawdown regulations. An elevated egg mass is located on structures at 0.914 m (3 ft) above the lake bottom, and a bottom egg mass is located on the lake bottom. Proportions (Estimate) are provided with lower (LCI) and upper (UCI) 95% profile likelihood confidence intervals.

| | Egg mass | Dewatering zone | | | | | |
|---|---|---|---|---|---|---|---|
| Site | Location | outside | inside | Total | Estimate | LCI | UCI |
| All habitat units 2019 | | | | | | | |
| Crammys | Elevated | 268 | 197 | 465 | 0.42 | 0.38 | 0.47 |
| Crammys | Bottom | 353 | 112 | 465 | 0.24 | 0.20 | 0.28 |
| Canyon | Elevated | 298 | 172 | 470 | 0.37 | 0.32 | 0.41 |
| Canyon | Bottom | 390 | 80 | 470 | 0.17 | 0.14 | 0.21 |
| All habitat units 2020 | | | | | | | |
| Crammys | Elevated | 228 | 172 | 400 | 0.43 | 0.38 | 0.48 |
| Crammys | Bottom | 287 | 113 | 400 | 0.28 | 0.24 | 0.33 |
| Canyon | Elevated | 223 | 177 | 400 | 0.44 | 0.39 | 0.49 |
| Canyon | Bottom | 285 | 115 | 400 | 0.29 | 0.24 | 0.33 |
| Habitat units with egg presence 2019 | | | | | | | |
| Crammys | Elevated | 21 | 38 | 59 | 0.64 | 0.52 | 0.76 |
| Crammys | Bottom | 38 | 21 | 59 | 0.36 | 0.24 | 0.48 |
| Canyon | Elevated | 29 | 16 | 45 | 0.36 | 0.23 | 0.50 |
| Canyon | Bottom | 41 | 4 | 45 | 0.09 | 0.03 | 0.19 |
| Combined | Elevated | 50 | 54 | 104 | 0.52 | 0.42 | 0.61 |
| Combined | Bottom | 79 | 25 | 104 | 0.24 | 0.17 | 0.33 |
| Habitat units with egg presence 2020 | | | | | | | |
| Crammys | Elevated | 2 | 11 | 13 | 0.85 | 0.60 | 0.97 |
| Crammys | Bottom | 2 | 11 | 13 | 0.85 | 0.60 | 0.97 |
| Canyon | Elevated | 11 | 19 | 30 | 0.63 | 0.46 | 0.79 |
| Canyon | Bottom | 17 | 13 | 30 | 0.43 | 0.27 | 0.61 |
| Combined | Elevated | 13 | 30 | 43 | 0.70 | 0.55 | 0.82 |
| Combined | Bottom | 19 | 24 | 43 | 0.56 | 0.41 | 0.70 |

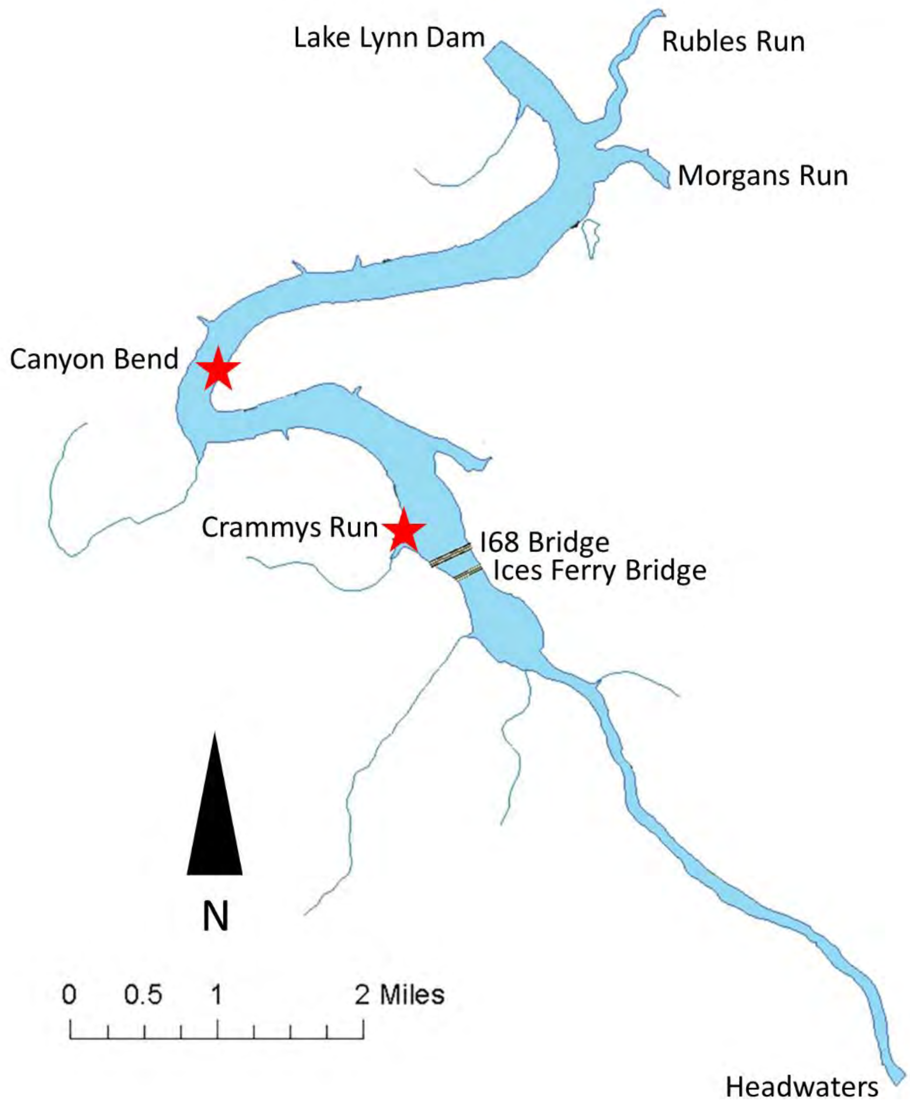


Figure 1. Cheat Lake, located in northern West Virginia, including locations of two study sites (red stars). One site was located near the mouth of Crammys Run, and the other site was on the inside shoreline of Canyon Bend.

Figure 2. Artificial spawning habitat structures used in a study of Yellow Perch on Cheat Lake, West Virginia (displayed by West Virginia University graduate student, Kyle Matt).

Figure 3. Study sites at Crammys Run (top) and Canyon Bend (bottom). White buoys mark the locations of the spawning habitat units. When the water depth was less than or equal to 1.83 m (6 ft), then the white PVC floats of the spawning habitat units were on top of the water (see bottom right). An organization contact and phone number was printed on each white buoy. One large buoy at each site (see bottom left) was used to alert boaters, and also provided information about the research project.

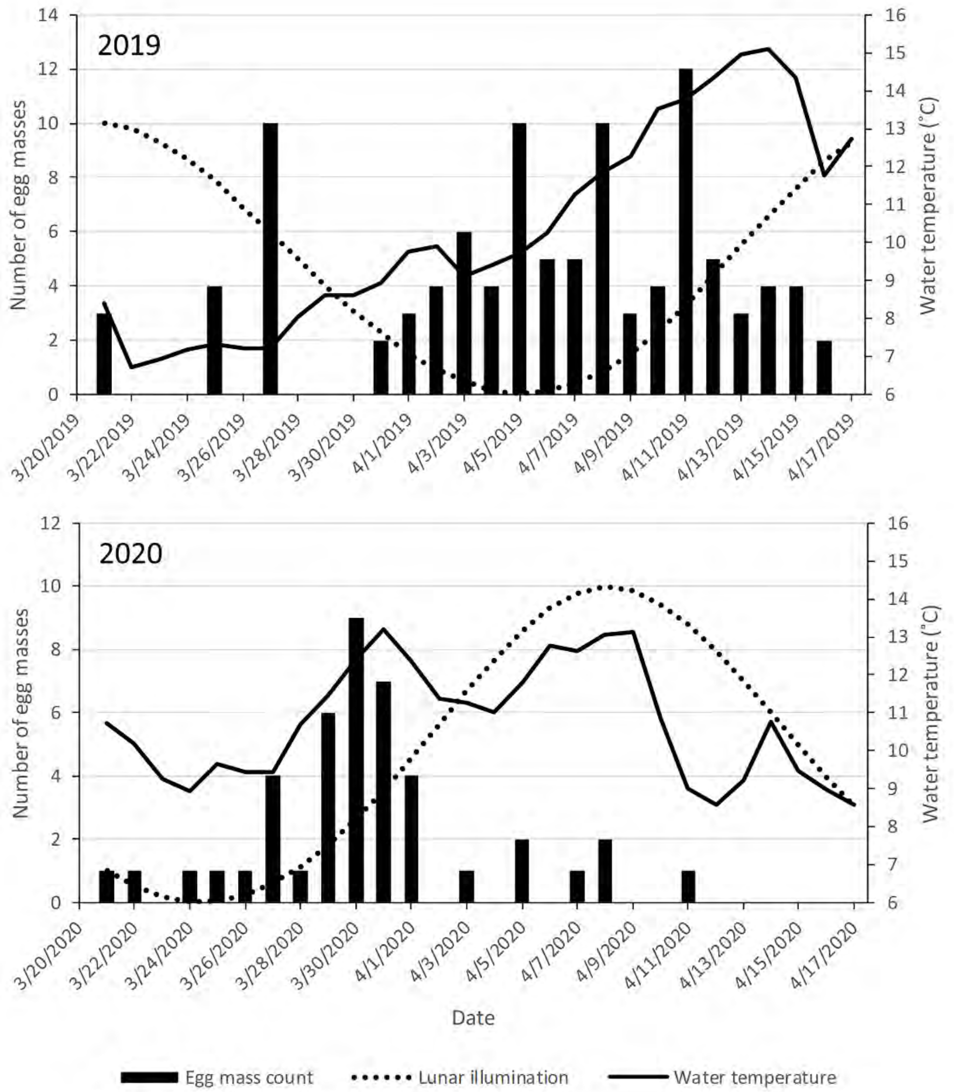


Figure 4. Time series of daily counts of Yellow Perch egg masses on 40 artificial habitat units. Water temperature and lunar illumination are plotted for the spawning periods, which ranged from 21 March–16 April in 2019 and 21 March–11 April in 2020.

Figure 5. Yellow perch egg masses spiraled (left) or draped (right) around artificial spawning habitat structures.

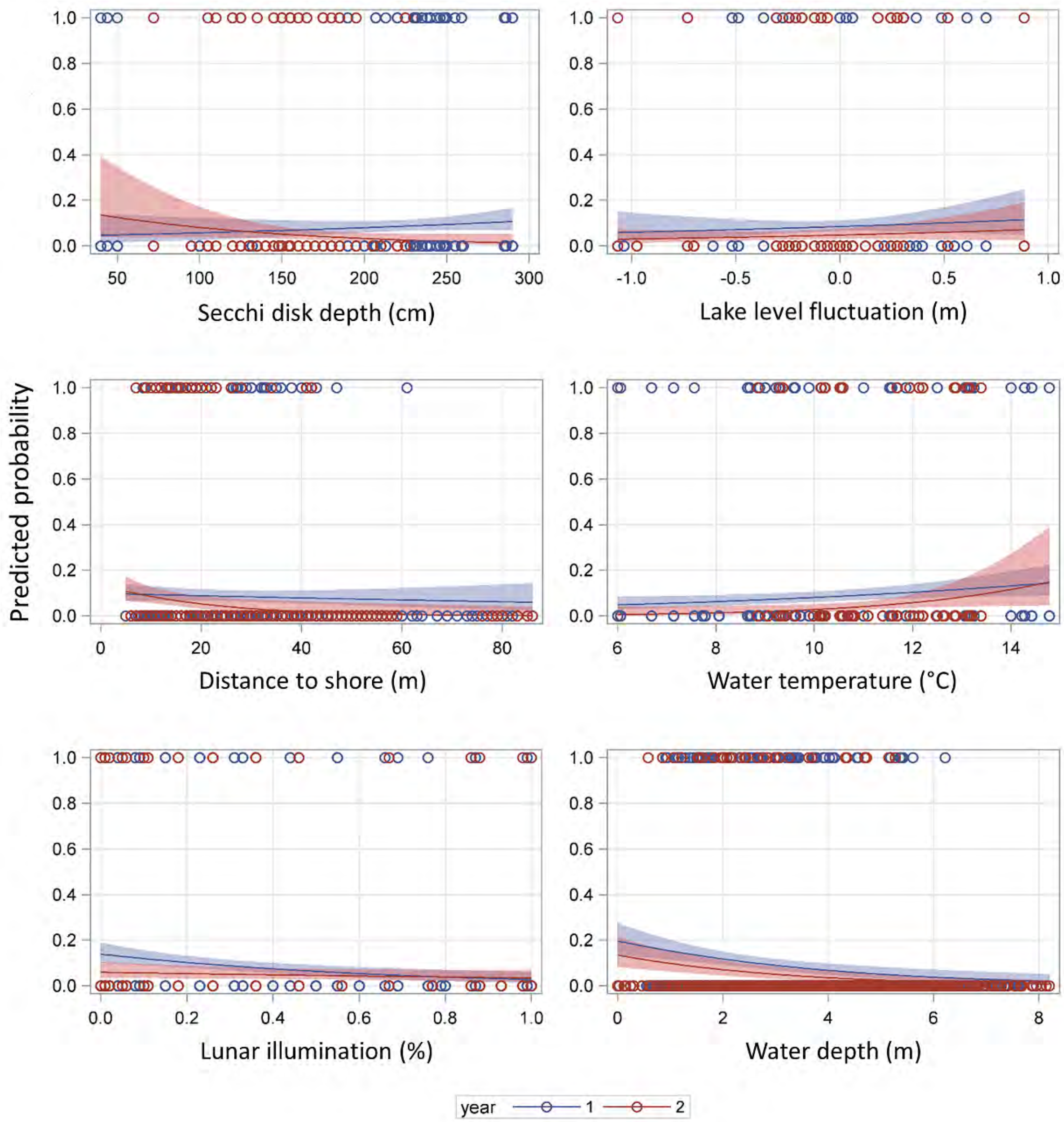


Figure 6. Predicted probability of egg mass presence on artificial spawning habitat based on analyses using Generalized Estimating Equations (GEE). Plots depict relationships from 2019 and 2020 of single model covariates; secchi disk depth, lake level fluctuation, distance to shore, water temperature, lunar illumination, and water depth.

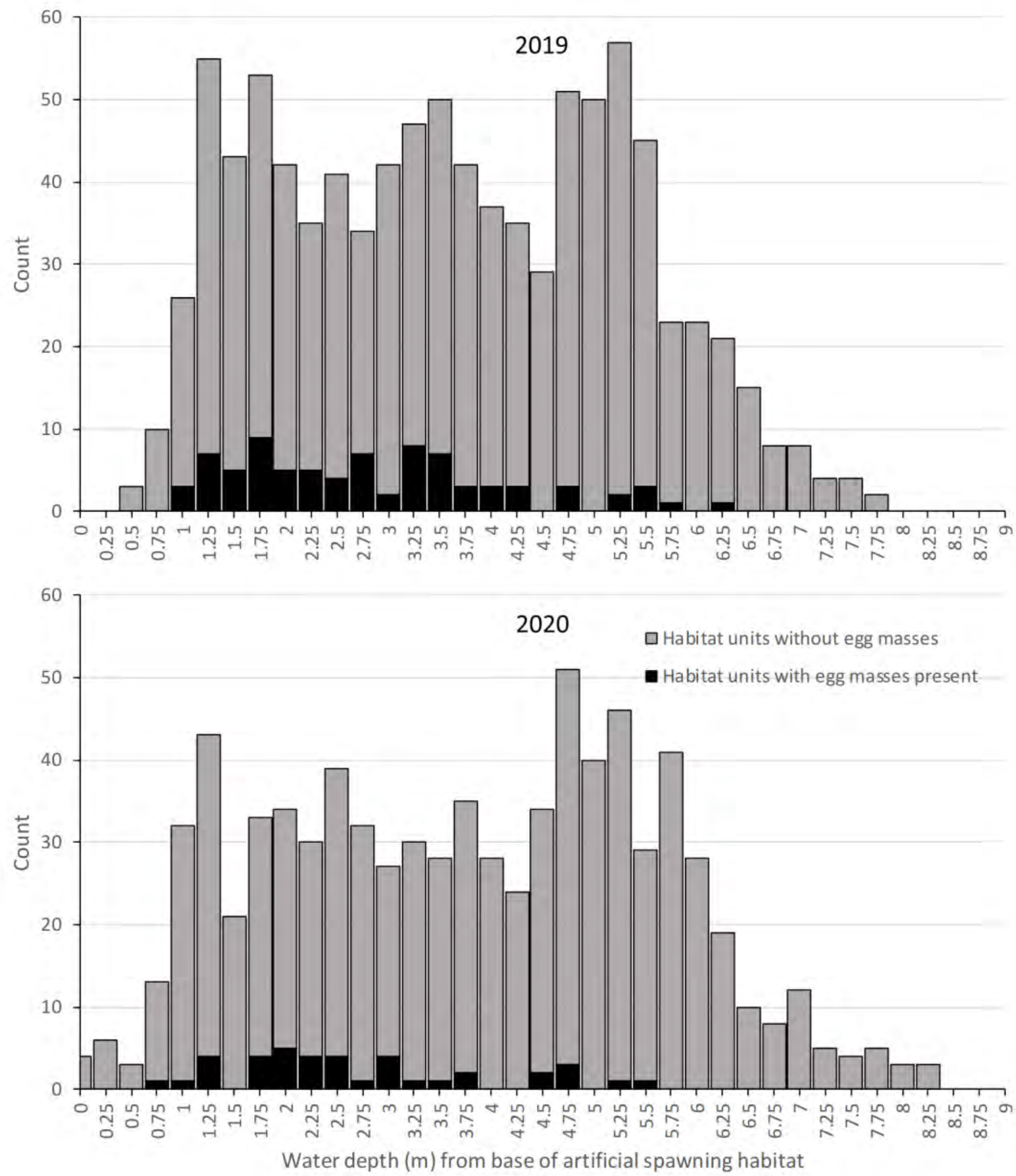


Figure 7. Water depths of artificial spawning habitat units in 2019 and 2020 with and without the presence of egg masses.

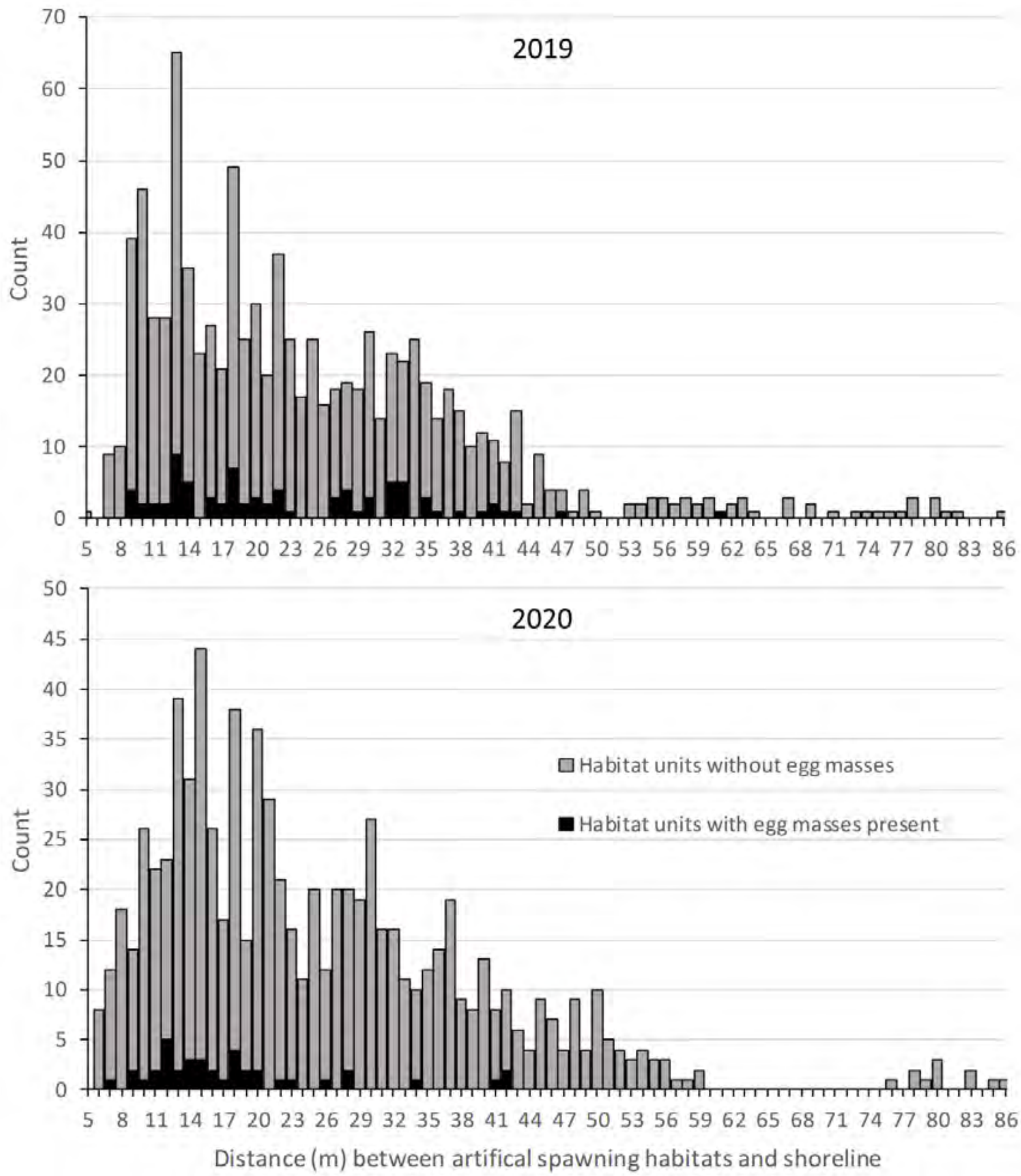


Figure 8. Distances from shoreline of artificial spawning habitat units with and without the presence of egg masses for 2019 and 2020. The y-axis is a count of habitat units. Distances were measured from the water surface (directly above submerged habitat units) to the full pool water mark on the nearest shoreline.

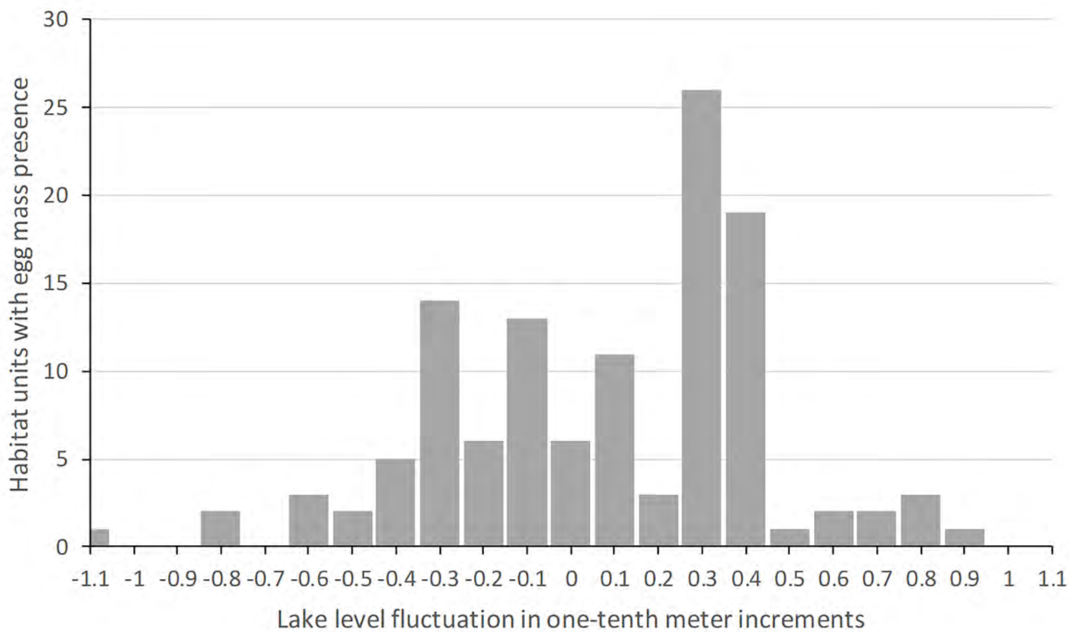


Figure 9. Artificial spawning habitat structures with the presence of Yellow Perch egg masses relative to lake level fluctuations in one-tenth meter increments.

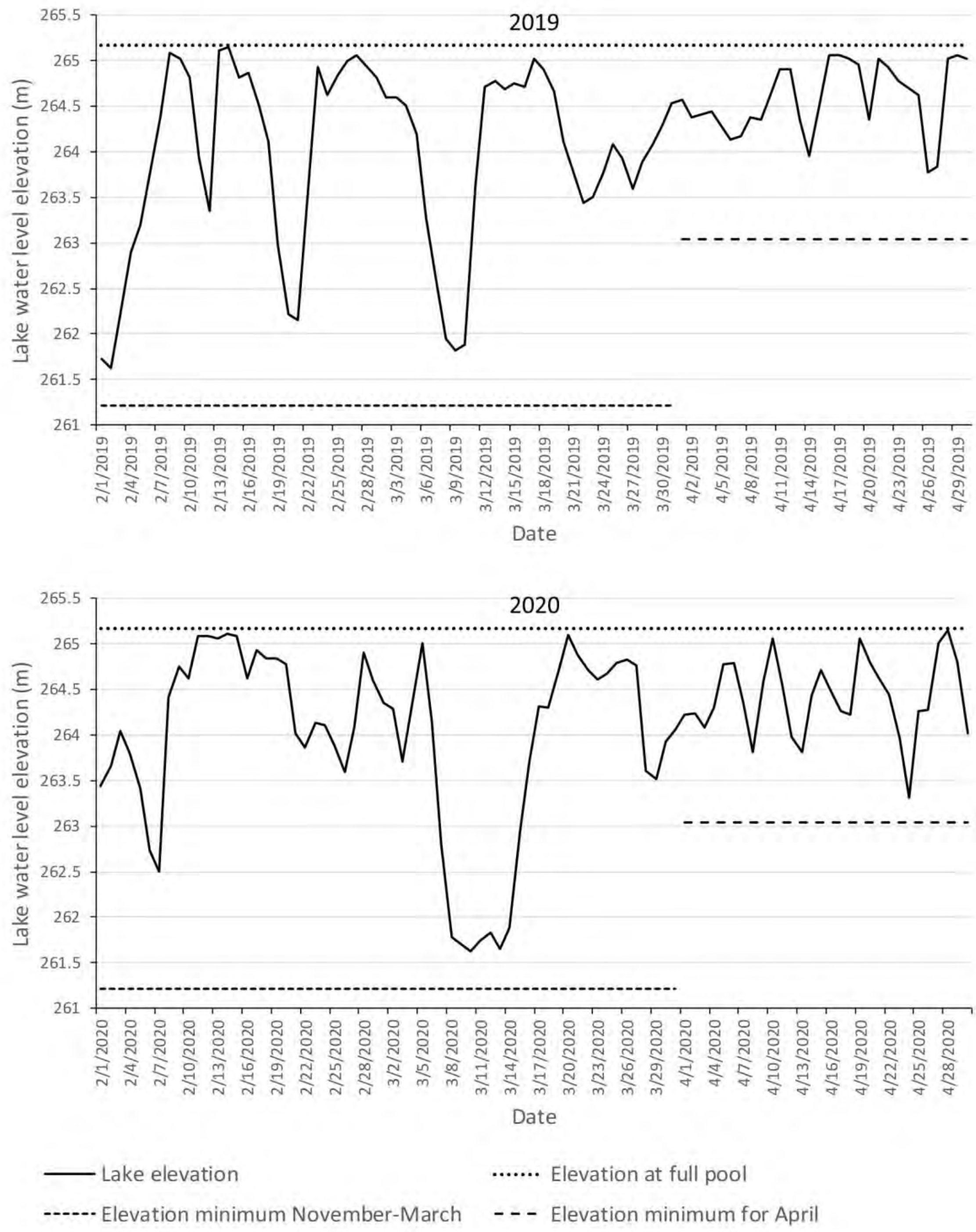


Figure 10. Fluctuations in surface elevation of Cheat Lake during February–April of 2019 and 2020. Elevation at full pool is 265.2 m (870 ft). The minimum permitted drawdown elevation is shown for February–March (261.2 m; 857 ft) and April (263 m; 863 ft).

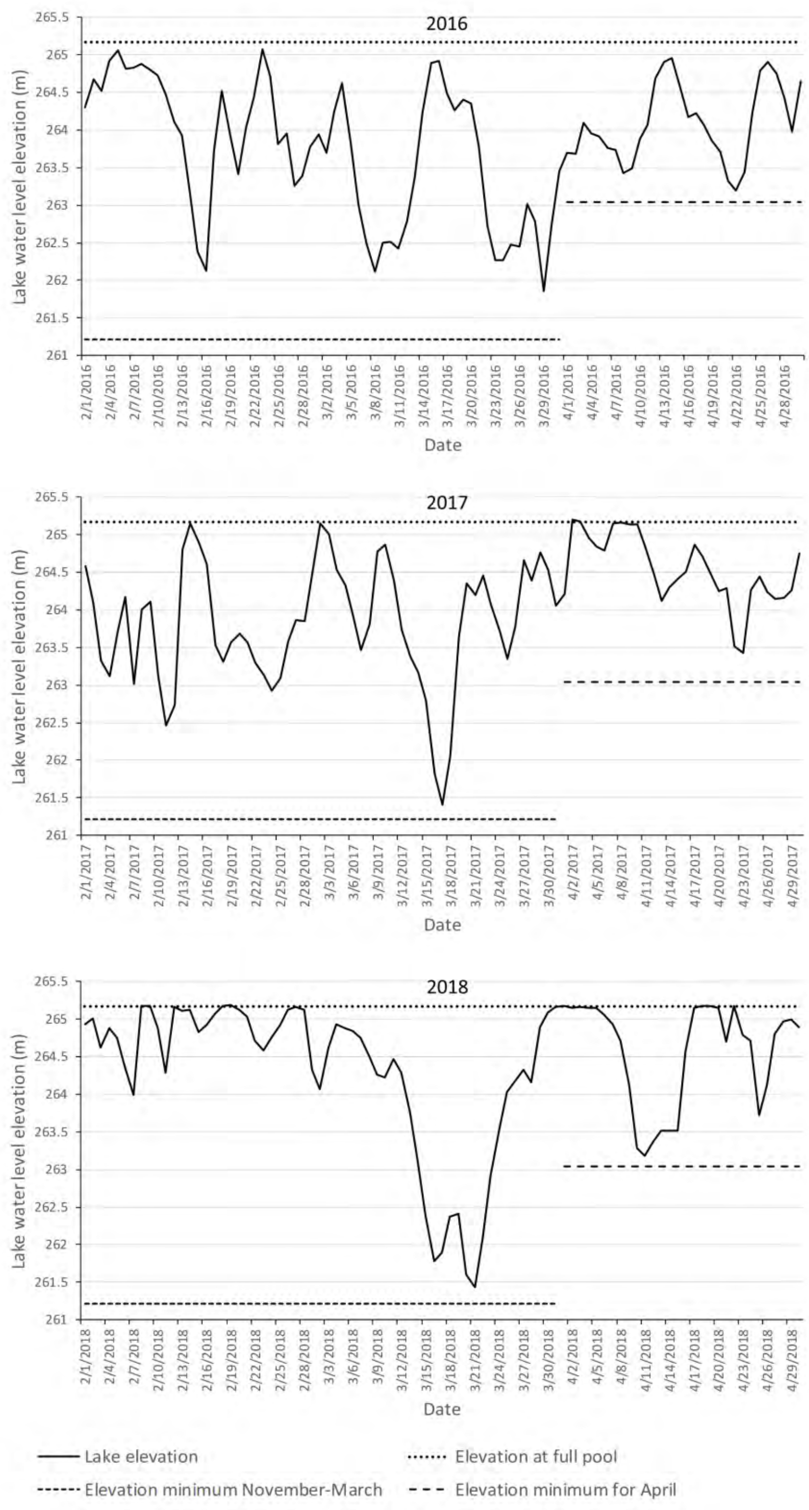


Figure 11. Fluctuations in surface elevation of Cheat Lake during February–April of 2016–2018. Elevation at full pool is 265.2 m (870 ft). The minimum permitted drawdown elevation is shown for February–March (261.2 m; 857 ft) and April (263 m; 863 ft).

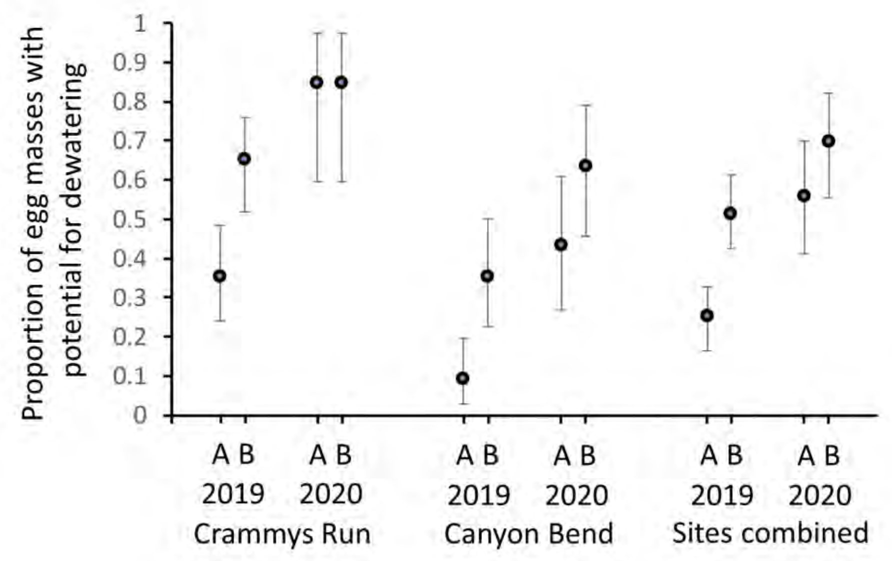


Figure 12. Proportion of egg masses in 2019 and 2020 with potential for dewatering at Crammys Run and Canyon Bend, Cheat Lake, West Virginia. Estimates are based on two scenarios, where egg masses are deposited directly onto the lake bottom (A), or egg masses are deposited onto structures at 0.914 m (3 ft) above the lake bottom (B). Error bars are 95% profile likelihood confidence intervals.

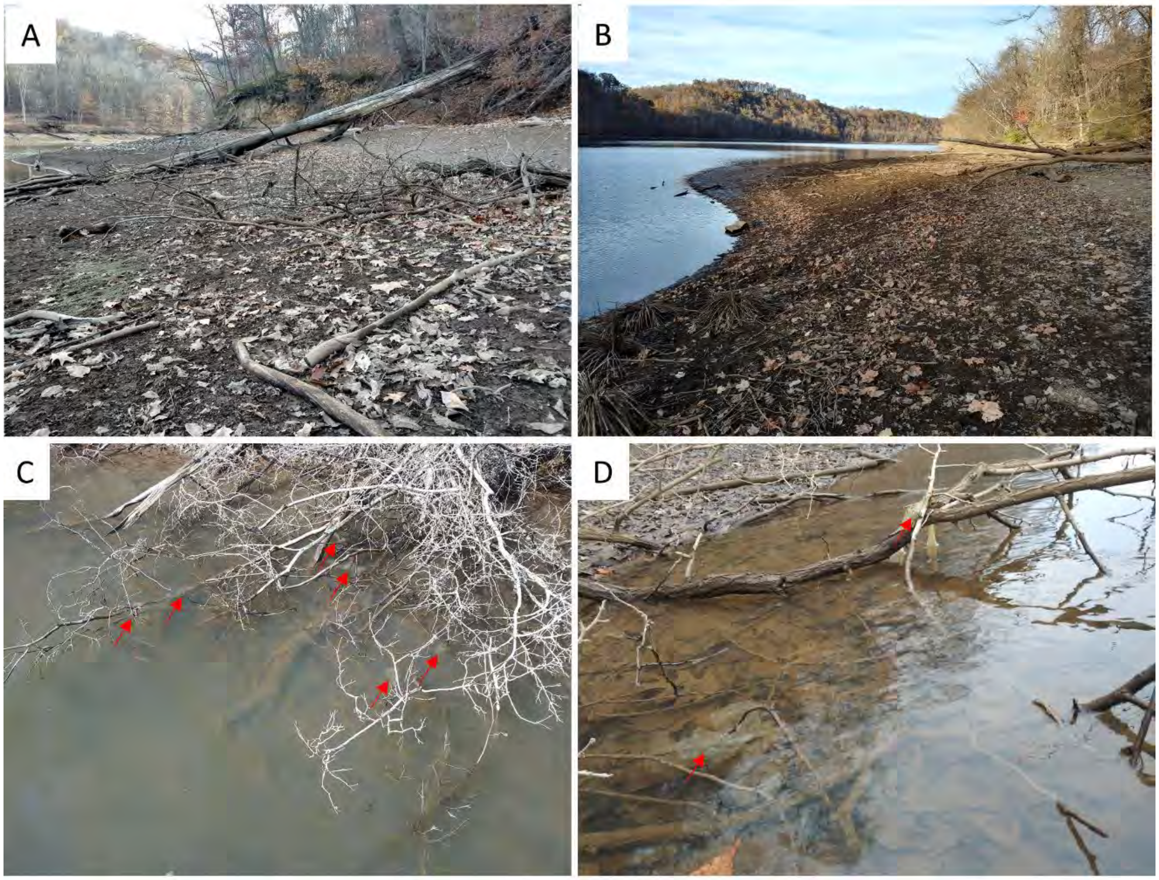


Figure 13. Examples of lake level drawdown of Cheat Lake, West Virginia (A, B), egg masses associated with near-shore natural structure (C, D), and a dewatered egg mass on a natural structure (D).

## Appendix A. Methods for estimating the number of eggs in a Yellow Perch egg mass

In the field, 10 egg masses were removed from the artificial spawning habitat units and preserved in 50% ethanol. Egg masses were removed from the ethanol, strained, and measured for length. Two egg masses were poorly preserved, so we used eight egg masses for our analysis. A gravimetric method was used to determine fecundity (Ganias et al. 2014). Each egg mass was weighed on an Ohaus digital scale. A subsample was removed from the middle of each egg mass and weighed. Each subsample contained greater than 600 eggs. Partitions of the subsample, consisting of 10 to 30 eggs, were placed onto a gridded dish and the eggs were counted under a microscope (Figure A1). Fecundity was estimated with the formula $N = Wn/W^1$, where N = the number of eggs in the egg mass, W = the weight of the egg mass, n = the number of eggs counted in the subsample, and $W^1$ = the weight of the subsample (Ganias et al. 2014). An average value was calculated from eight fecundity estimates (Table A1).

### References

Ganias K., Murua H, Claramunt G., Dominguez-Petit R., Gonçalves P., Juanes F., Keneddy J., Klibansky N., Korta M., Kurita Y., Lowerre-Barbieri S., Macchi G., Matsuyama M., Medina A., Nunes C., Plaza G., Rideout R., Somarakis S., Thorsen A., Uriarte A., Yoneda M. 2014. Chapter 4: Egg production, 109 pp. In Handbook of applied fisheries reproductive biology for stock assessment and management, ed. R. Domínguez-Petit, H. Murua, F. Saborido-Rey and E. Trippel. Vigo, Spain. Digital CSIC. http://hdl.handle.net/10261/87768.

Table A1. Data on length, width, and weight of eight Yellow Perch egg masses from Cheat Lake, West Virginia. Weights of each egg mass, weights of a subsample of each egg mass, and the egg count of each subsample were used to calculate the average number of eggs per egg mass (i.e. fecundity).

| Length (mm) | Width (mm) | Weight (g) | Subsample weight (g) | Subsample egg count | Fecundity |
|---|---|---|---|---|---|
| 580 | 42 | 50 | 4 | 843 | 10538 |
| 1380 | 57 | 200 | 4 | 646 | 32300 |
| 2070 | 92 | 578 | 11 | 857 | 45031 |
| 1660 | 85 | 459 | 8 | 709 | 40679 |
| 2990 | 93 | 712 | 9 | 1069 | 84570 |
| 1040 | 52 | 194 | 7 | 972 | 26938 |
| 1540 | 58 | 364 | 7 | 678 | 35256 |
| 1560 | 65 | 444 | 9 | 620 | 30587 |
| | | | | Average = | 38237 |

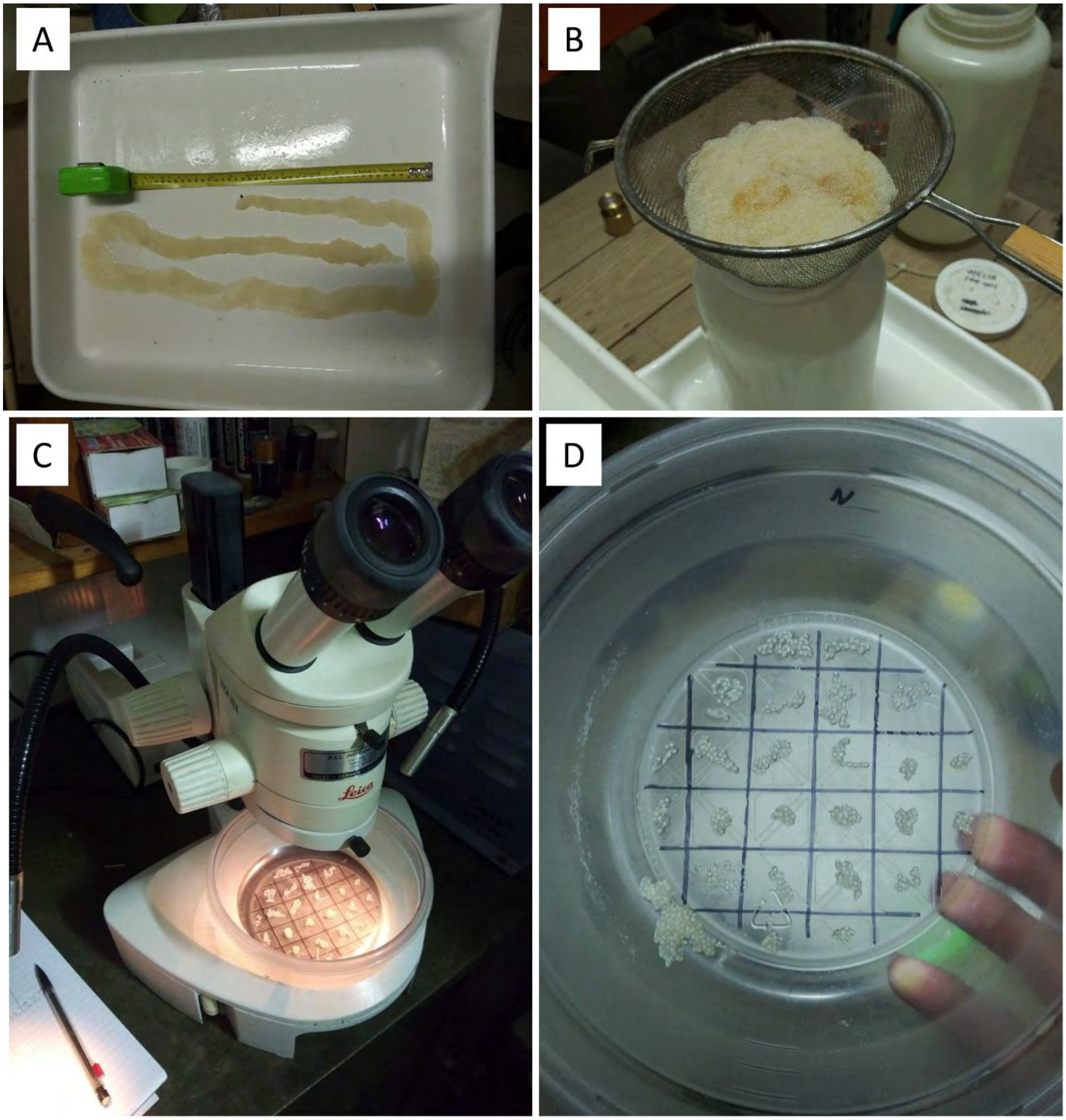


Figure A1. Photographs of the egg counting process, including an ethanol-preserved Yellow Perch egg mass (A), ethanol strained from a preserved egg mass (B), and partitioned subsamples of eggs (C, D).

**Appendix B. Fish use and Yellow Perch spawning on benthic artificial habitat reefs**

In addition to our study involving artificial spawning habitat structures, we also conducted two separate studies using benthic artificial habitat reefs (Cradle artificial shallow fry habitat; https://www.fishiding.com/shallow-water-habitat/). One study during 2019 was on the use of artificial benthic reef habitats by fishes, including young-of-year Yellow Perch. A second study in spring 2020 was on the use of these benthic habitats as spawning structures for Yellow Perch.

We know very little about the near-shore habitats that young-of-year Yellow Perch use in Cheat Lake following their larval stage. After hatching, larval Yellow Perch are expected to leave the littoral zone and live in the water column of the limnetic zone for about 30–40 days (Whiteside et al. 1985). In the limnetic zone, the larvae forage on zooplankton (Fulford et al. 2006). Individuals grow to about one inch in length, before returning to near-shore littoral habitats (Whiteside et al. 1985). We wanted to know if young-of-year Yellow Perch would use near-shore artificial benthic habitat structures. Specifically, this information would be beneficial in determining if placing structures during the post-spawn period could benefit growth and survival of young Yellow Perch.

Benthic artificial habitat units (Figure B1) were arranged in eight clusters (reefs) on the lake bottom at two separate sites; four reefs at Crammys Run and four at Canyon Bend (Table B1). Each reef area included 11 habitat units positioned within a 3 m (10 ft) x 7 m (23 ft) area on the lake bottom. Each reef area was placed in a different depth zone, so that a range of depths were represented from 0.61–4.3 m (2–14 ft). An additional eight control areas were marked in similar depth ranges as the reefs, but no artificial structures were placed in these areas. Sampling took place twice a week with an underwater camera

(Marcum LX-9), where each reef or control area was observed for five minutes. The following covariates were collected at each reef: Secchi disk depth, water temperature, and pH (the latter two measured near the lake bottom). Reefs were not sampled with the camera during times of high turbidity (i.e. a Secchi disk depth of less than 150 cm). Presence/absence data were recorded for fish species found in association with the artificial structures. In 2020, these reefs were monitored for the presence of Yellow Perch egg masses during the spawning period from 21 March to 11 April. Monitoring for egg masses used similar methods as previously described for underwater camera use.

**Results and Discussion**

Observations of the artificial benthic reefs were made with underwater camera on 18 days between 10 May and 2 August of 2019. Mean values and associated ranges for water quality variables at the time of data collection were calculated for secchi disk depth, water temperature, and pH. Crammys Run mean values (with ranges) for the aforementioned variables were as follows: 152.7 cm (100–195), 20.6 °C (12.8–27.4), and a pH of 7.23 (7.03–7.58). Canyon Bend mean values were 166.6 cm (110–225), 22.8 °C (15.6–28.3), and a pH of 7.36 (7.12–7.73). Only three adult Yellow Perch were observed in association with the structures; no young-of-year Yellow Perch were observed. We did document other fishes in association with the benthic reef structures, including Channel Catfish (*Ictalurus punctatus*), black basses (*Micropterus* sp.), sunfishes (*Lepomis* sp.), and Walleye (*Sander vitreus*). Species identification was not always possible owing to the position or distance of the fish relative to the camera location. For Crammys Run and Canyon Bend, we documented fish presence for 39.5% and 54.9% of our structure surveys and 8.3% and 31.6% for control surveys, respectively. The higher proportions of fish presence at the structures relative to those from control sites (no structures) support that fishes were associating with these structures.

During spring 2020, Yellow Perch egg masses were documented on all reefs, with exception of the deepest reef at Crammys Run. Additionally, dewatered eggs were documented on the shallow reef structures. We were not able to get a time series of data similar to that of the study using artificial spawning habitat structures, because of poor water clarity and the associated difficulty with getting clear video images with the underwater camera. During the 22-day spawning period (21 March to 11 April), the mean secchi disk depth values (and associated standard errors) were 171.2 cm (8.7) at Crammys Run and 153.5 cm (8.2) at Canyon Bend. Clear video images at or near the lake bottom were not possible at surface Secchi disk depths of 150 or less, but distances exceeding 200 cm were optimal. During the 22-day spawning period, secchi disk depths greater than 200 cm occurred on 7 days at Crammys Run and 1 day at Canyon Bend. Video-captured images of egg masses on the benthic structures are presented in Figure B2. Dewatered eggs on shallow reef structures are presented in Figure B3.

We offer several explanations as to why artificial benthic habitats were not used by young-of-year Yellow Perch. First, based on recent electrofishing data, we suspect that most of the habitat units may have been placed too deep and too far from shore. Habitat units were placed at a range of depths from 0.55 to 4.4 m (1.8 to 14.3 feet), and at a range of 9 to 38 meters (29.5 to 125 ft) from the shore. The placement locations of the habitat units were, in part, influenced by our consideration of monitoring the structures for egg masses in spring 2020 as part of our Yellow Perch spawning research. Observations from fall 2019 electrofishing surveys on Cheat Lake support young-of-year Yellow Perch in association with near-shore vegetation and depths of < 1 m. Vegetation is absent from many sections of Cheat Lake, so artificial structures placed closer to the shoreline in shallow water may be more effective as habitat for young-of-year Yellow Perch. Placement of habitat units in shallow, near-shore areas of Cheat Lake, however, may not be a long-term solution, as the units may be damaged by freeze/thaw cycles during water level drawdown periods of winter. Additionally, shallow near-shore placement of benthic structures will likely lead to dewatering of eggs during lake level drawdowns in March and April. If additional benthic habitat reefs are deployed for fish habitat enhancement and Yellow Perch spawning structures, then we suggest that reef placement should be in deeper areas just outside of the potential lake level drawdown zone.

**References**

Fulford, R.S., J.A. Rice, T.J. Miller, F.P. Binkowski, J.M. Dettmers, and B. Belonger. 2006. Foraging selectivity by larval yellow perch (*Perca flavescens*): implications for understanding recruitment in small and large lakes. Canadian Journal of Fisheries and Aquatic Science 63:28–42.

Whiteside, M.C., C.M. Swindoll, and W.L. Doolittle. 1985. Factors affecting the early life history of yellow perch, *Perca flavescens*. Environmental Biology of Fishes 12:47–56.

Table B1. Location of artificial benthic habitat reefs and associated control areas at two study sites on Cheat Lake. Also provided are the distances (Dist.) from the shoreline, and depth ranges of the reef and control areas.

| | Crammys Run | | | Canyon Bend | | |
|---|---|---|---|---|---|---|
| Type | Dist. (m) | Depth (m) | Coordinates | Dist. (m) | Depth (m) | Coordinates |
| Reef | 9 | 0.55-1.43 | N 39.67245 W 079.86978 | 9 | 0.686-1.60 | N 39.68627 W 079.89332 |
| Reef | 20 | 1.62-2.68 | N 39.67221 W 079.86977 | 11 | 1.30-2.97 | N 39.68602 W 079.89362 |
| Reef | 26 | 2.29-3.47 | N 39.67258 W 079.86951 | 38 | 2.36-3.37 | N 39.68647 W 079.89348 |
| Reef | 28 | 3.11-4.36 | N 39.67145 W 079.86997 | 16 | 2.97-4.37 | N 39.68551 W 079.89392 |
| Control | 8 | 0.853-1.46 | N 39.67276 W 079.86951 | 8 | 0.884-1.49 | N 39.68648 W 079.89314 |
| Control | 19 | 1.77-2.38 | N 39.67188 W 079.86997 | 13 | 1.74-2.35 | N 39.68591 W 079.89372 |
| Control | 23 | 2.56-3.17 | N 39.67203 W 079.86986 | 25 | 2.56-3.17 | N 39.68624 W 079.89367 |
| Control | 37 | 3.63-4.24 | N 39.67242 W 079.86953 | 40 | 3.47-4.08 | N 39.68641 W 079.89371 |

Figure B1. Artificial benthic habitat structure used in a study of Yellow Perch on Cheat Lake, West Virginia (displayed by West Virginia University graduate student, Kyle Matt).

Figure B2. A benthic reef of artificial habitat structures (top left), and dewatered eggs on exposed benthic artificial habitat structures.

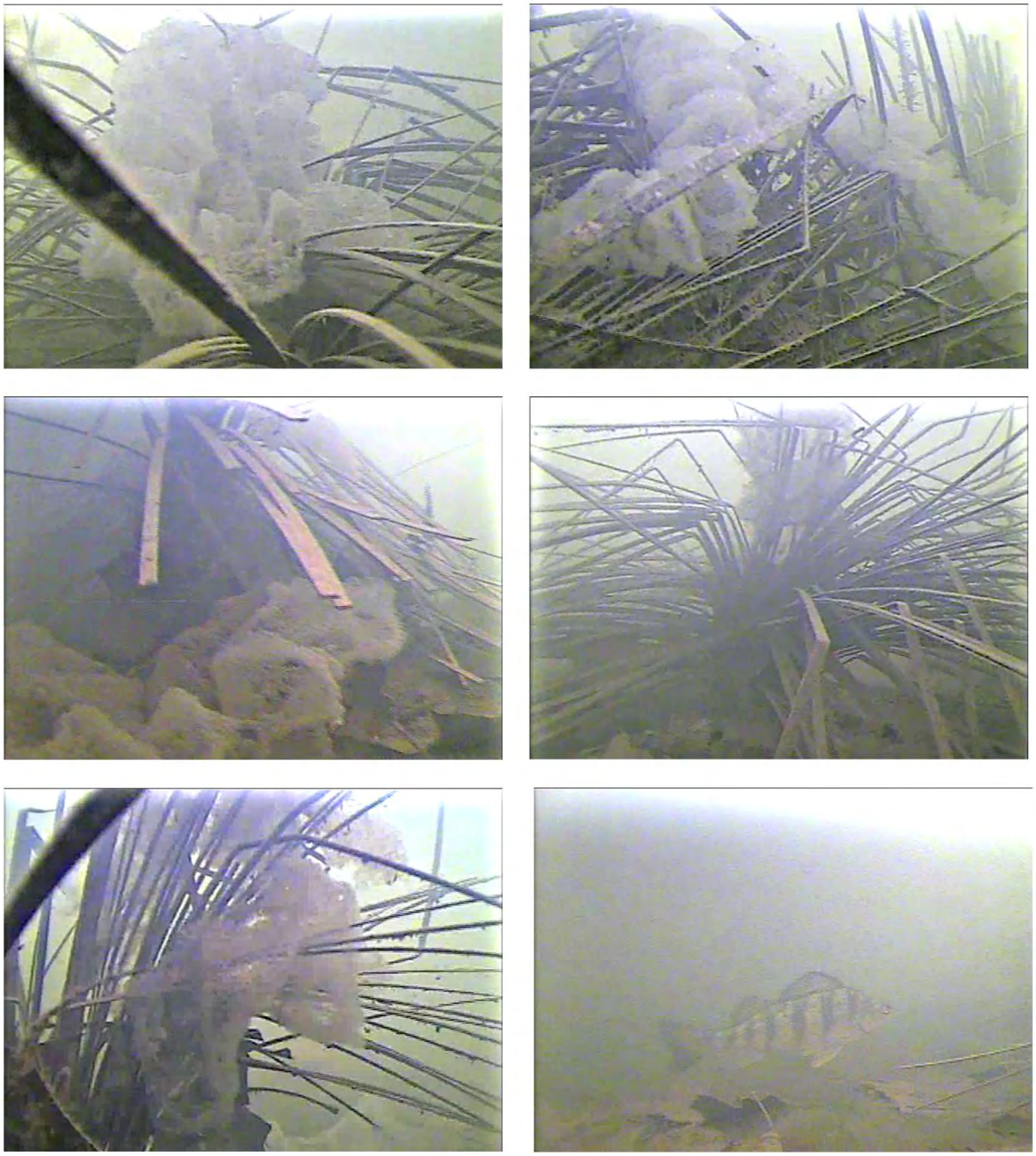

Figure B3. Video images of egg masses on benthic artificial habitat structures and a Yellow Perch.

(h) West Virginia Division of Natural Resources (WVDNR). 2009. Biological Monitoring of Aquatic Communities of Cheat Lake, and Cheat River downstream of the Lake Lynn Hydro-station, 2005 – 2009.

# BIOLOGICAL MONTIORING OF AQUATIC COMMUNITIES OF CHEAT LAKE, AND CHEAT RIVER DOWNSTREAM OF THE LAKE LYNN HYDRO STATION, 2009

FERC PROJECT NUMBER 2459

Prepared by:
David Wellman, Frank Jernejcic, and Jim Hedrick
West Virginia Division of Natural Resources
Wildlife Resources Section

March 2010

# Table of Contents

# List of Tables

# List of Figures

# Chapter 1: Introduction and Study Area

## Introduction

The Federal Energy Regulatory Commission (FERC) issued a renewal license to Allegheny Energy Supply, LLC (AES) for the Lake Lynn Project in December 1994, for a term of 30 years. A biomonitoring study of the aquatic resources of Cheat Lake, Cheat Lake embayments, the Cheat Lake tailwaters, and the Cheat River downstream of the dam to the confluence with the Monongahela River was required by FERC under the new license agreement.

The new license agreement prescribed two article changes to the operation of the Lake Lynn Project. Article 403 specified that target reservoir water level ranges be maintained throughout the year. Lake elevations must be held between 868 and 870 ft from May to October to enhance recreation. Elevations can fluctuate between 857 and 870 ft from November to March to maximize power generation and between 863 and 870 ft during April to enhance early spawning of fishes.

Article 404 implemented a 212 cubic feet per second (cfs) minimum flow release to mitigate poor water quality downstream from the project caused by acidic tributaries. No minimum flow was required prior to 1995.

The biological monitoring plan was established to monitor the status of the aquatic resources. The resource agencies suggested the licensee conduct biomonitoring for two consecutive years starting in 1997 and every three years thereafter. During 2004 the West Virginia Division of Natural Resources (WVDNR) established an agreement with AES to conduct and coordinate the biomonitoring study with the Pennsylvania Fish and Boat Commission (PAFBC). State agencies and AES agreed to modify the plan and evaluate the status and population dynamics of specific game fish species in addition to whole community biomonitoring.

Due to modifications, the biomonitoring study scheduled for 2004 was not conducted until 2005. Species-specific monitoring and/or community wide biomonitoring was conducted annually through 2009. The modification also included detailed water quality analyses. These analyses monitored and evaluated the annual impacts of acid mine drainage on the Cheat River downstream of the Lake Lynn project through 2009.

The modified biomonitoring plan was divided into two sections: Pennsylvania and West Virginia waters. The biomonitoring and species-specific evaluations in West Virginia waters were conducted by the WVDNR. A private environmental consultant conducted evaluations and monitoring downstream from the Lake Lynn project in Pennsylvania waters.

The WVDNR, PAFBC, and AES established the following proposed tasks to continue biomonitoring, investigate species-specific impacts, and address impacts and remediation of water quality issues. Tasks were divided into a Cheat River and Cheat tailwater component (Tasks 1 – 3), and a Cheat Lake and Cheat embayment component (Tasks 4 – 7).

1. Fish biomonitoring downstream of Cheat Lake
2. Benthic macroinvertebrate resource biomonitoring downstream of Cheat Lake
3. Water quality biomonitoring downstream of Cheat Lake
4. Fish biomonitoring of Cheat Lake and Cheat embayments
5. Walleye population monitoring and stock assessment
6. Monitoring of adult walleye movement
7. Physical and chemical water quality characteristics of Cheat Lake

Either the WVDNR or a private consultant conducted research to address each of these tasks. The following five-year timeline for completing specific tasks was originally proposed.

## Five-Year Timeline

| | Years | | | | |
|---|---|---|---|---|---|
| **Tasks** | **2005** | **2006** | **2007** | **2008** | **2009** |
| **Cheat River and Tailwater Components** | | | | | |
| Task 1: Fish Biomonitoring Tailwater and Cheat River | ■ | | | ■ | |
| Task 2: Benthic Biomonitoring Tailwater and Cheat River | ■ | | | ■ | |
| Task 3: Water Quality Biomonitoring Tailwater and Cheat River | ■ | ■ | ■ | ■ | ■ |
| **Cheat Lake and Embayment Components** | | | | | |
| Task 4: Fish Biomonitoring Cheat Lake and Embayments | ■ | | | ■ | |
| Task 5: Walleye Stocking Assessment | ■ | ■ | ■ | ■ | ■ |
| Task 6: Adult Walleye Movement | ■ | ■ | ■ | | ■ |
| Task 7: Physical and Chemical Water Quality Characteristics | ■ | ■ | ■ | ■ | ■ |

The following four tasks were originally proposed for completion or partial completion during 2009:

Task 3 – Water quality monitoring downstream of Cheat Lake;
Task 5 – Walleye population monitoring and stocking assessment;
Task 6 – Adult walleye movement;
Task 7 – Physical and chemical water quality characteristics of Cheat Lake.

## Study Area Description

The Lake Lynn Hydro Project is located on Cheat River in Monongalia County, West Virginia (Figure 1). The hydro station is located on the Pennsylvania and West Virginia border and is 3.7 miles upstream from the confluence of the Cheat River with the

Monongahela River. The concrete gravity-type dam is 1,000-ft long, 125-ft high and impounds 1,730 acres at an elevation of 870 feet. Maximum depth is about 90 feet near the dam. Four turbines, with a maximum output flow of 9,700 cfs, produce power and 26 tainter gates regulate additional discharge.

Cheat Lake was divided into three major study areas: the Cheat embayments (Rubles Run – 56 acres, and Morgan Run – 37 acres); lower Cheat Lake, downstream of I-68 bridge to Lake Lynn hydro station; and upper Cheat Lake upstream of the I-68 bridge to the head of the lake. The 3.7-mile section of Cheat River downstream from the hydro station was defined as the Cheat tailwater area located in the first 1.1 miles, and Cheat River between the Cheat tailwater area and the confluence of Cheat River with the Monongahela River (lower 2.6 miles). Cheat River approximately 0.5 miles upstream of Cheat Lake was also included in the study area.

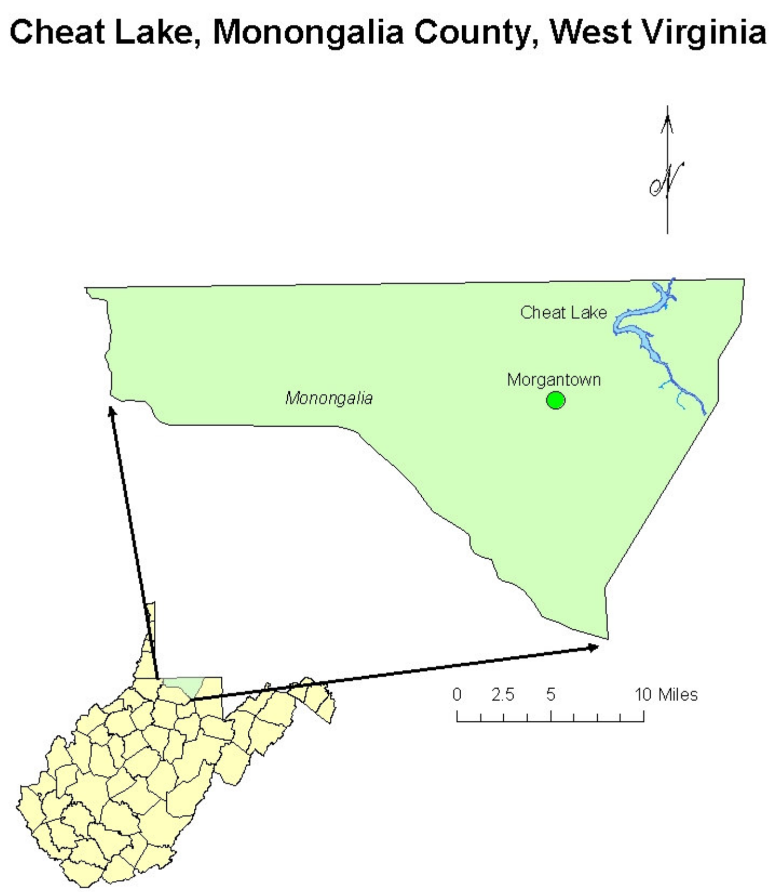


**Figure 1.** The Lake Lynn Hydro Project is located on Cheat Lake in Monongalia County, West Virginia. The hydro station is located on the Pennsylvania and West Virginia border and is 3.7 miles upstream from the confluence of the Cheat River with the Monongahela River.

# Chapter 2: Water Quality Monitoring of Cheat River (Task 3)

## Introduction

Water quality monitoring was established by the WVDNR, PAFBC, and AES to address impacts and remediation of water quality issues downstream of Cheat Lake dam that could impact the fishery to the confluence with Monongahela River. Due to sufficient data being collected in previous years of this study, water quality samples were not collected downstream of Cheat Lake dam from Cheat River or Grassy Run in (Biomonitoring reports, 2005-8).

Continuous monitoring of Cheat River's water quality downstream of Cheat Lake was not conducted because the two continuous water quality monitors that were stolen and/or destroyed in 2007 and 2008 were not replaced. Continuous water quality data was not recorded from Cheat River at Albright as in previous years due to the loss of the water quality monitor to river ice. However, continuous water quality monitoring of Cheat River entering Cheat Lake was conducted to determine the quality of water entering Cheat Lake. This is the only water quality data, either downstream or upstream of Cheat Lake that is reported for 2009.

## Methods

Temperature, conductivity, and pH were monitored from January through October at 30-minute intervals with a YSI Model 600 XLM continuous water quality monitor at a station approximately 0.5-mile upstream of Cheat Lake in Cheat River (Figure 2). On a bi-monthly basis the YSI was cleaned, calibrated and data were downloaded.

## Results

Water quality monitoring data was summarized from January through October 2009 (Table 1). Water temperature in Cheat River upstream of Cheat Lake averaged 57°F and ranged from 32 to 82°F (Figure 3). Specific conductivity averaged 106 µs/cm and ranged from 44 to 226 µs/cm (Figure 4). The pH in Cheat River averaged 6.5 and ranged from 5.8 to 7.3 (Figure 5).

pH in Cheat River fell below 6.0 for extended periods on four separate occasions from January through May (Figure 6). In May, pH was below 6.0 for nearly the entire month. High water events coincided with Cheat River pH depression. Similarly, conductivity was also the lowest during winter and early spring high river flows and lowest during fall when river flows were lowest (Figure 7). Conductivity positively influences pH in Cheat River, but pH is negatively influenced by increased river flow (Figures 8 - 9). However, as river flow increased, conductivity was reduced in Cheat River (Figure 10).

## Conclusions

In previous years of this study, continuous water quality monitoring of Grassy Run and Cheat River downstream of Cheat Lake dam indicated the potential for low pH conditions blocking seasonal upstream fish movement from Monongahela River to the Cheat Lake tailwater. Acid loads calculated from Grassy Run revealed that several tons of acid per year are entering Cheat River. AMD tributaries on the opposite side of Cheat River from Grassy Run could also limit movement of fish upstream into the Cheat tailwater, but to a lesser degree than Grassy Run. This information should be used by state agencies to develop AMD treatment options for improving water quality in Cheat River. Improving water quality, will enhance not only the fisheries in Cheat tailwater, but the entire reach between the dam and its confluence with Monongahela River.

As observed by continuous monitoring, water quality of the river entering Cheat Lake is typically sufficient to support a fishery. However, pH depressions just upstream of Cheat Lake in Cheat River were measured during late winter and spring high flows, illustrating the vulnerability of Cheat Lake to upstream acid sources. One theory may be that during normal to low river flows, acid treatment throughout the Cheat watershed is capable of treating acid sources. During low flows in late summer and fall, pH values were well above 6.0 and conductivities, possibly a surrogate of limestone treatment for acid throughout the watershed, were also at their highest. Conversely, during high flows in winter and spring, pH and conductivity values were at their lowest indicating dilution of treatment. These observations illustrate the low buffering capacity of the Cheat watershed and consequently, the vulnerability of Cheat Lake's fishery to acidic episodes. High flows associated with snow melt events during late winter and/or early spring could negatively impact fish spawning and egg or larval survival. During high river inflows that might be associated with low pH, Cheat Lake's fishery may benefit during power generation that increases discharge. Acidic water would quickly move through the lake, not exposing the fishery to an extended pH depression.

**Table 1.** Yearly mean, maximum, and minimum values for YSI monitor at head of Cheat Lake from January through October, 2009. Measurements taken in 30-minute intervals.

| Parameter | Mean | Maximum | Minimum |
|---|---|---|---|
| | | **Head of Cheat Lake** | |
| **Temperature, F** | 57 | 82 | 32 |
| **pH** | 6.5 | 7.3 | 5.8 |
| **Specific conductivity us/cm** | 106 | 226 | 44 |

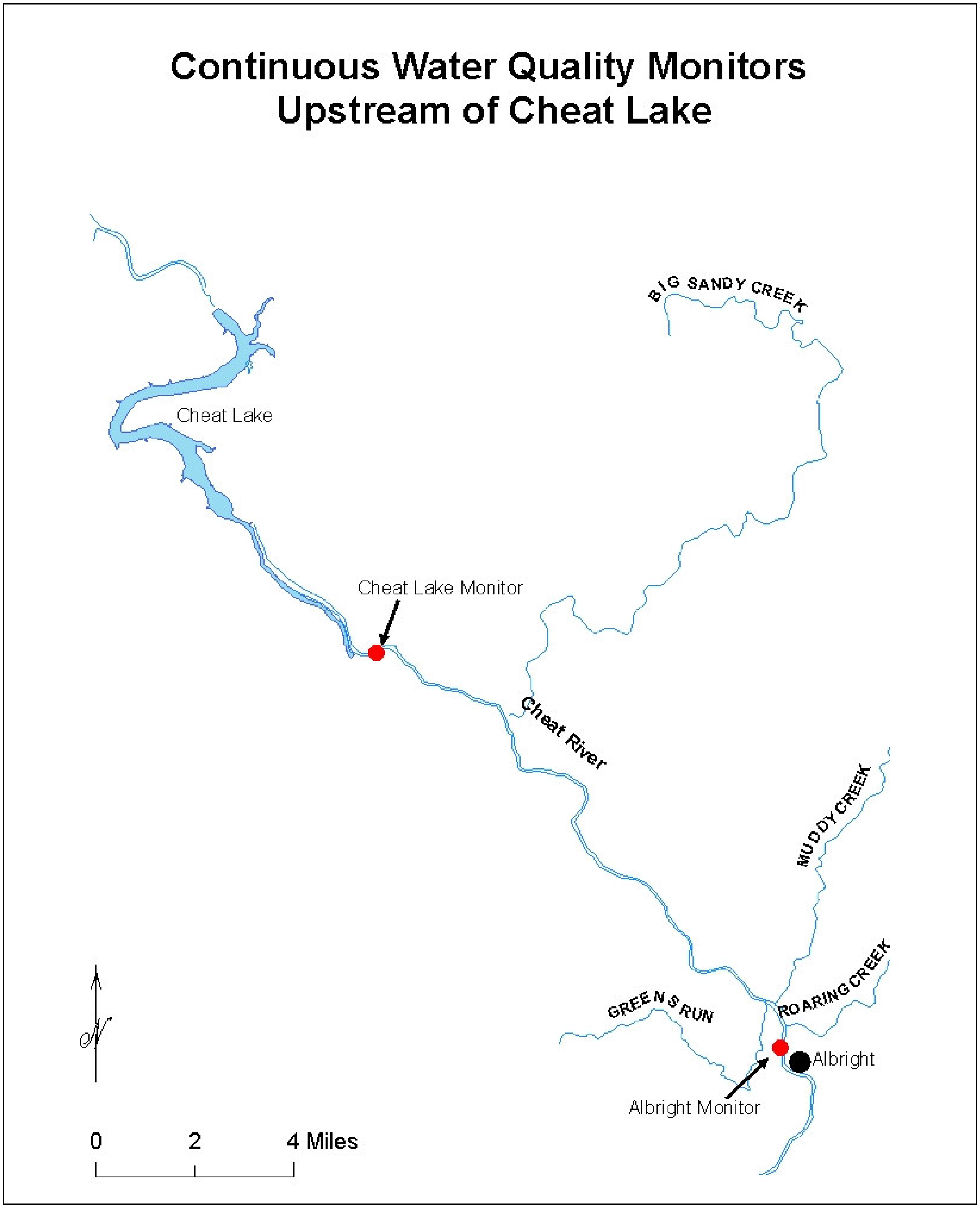


**Figure 2.** Approximate locations of WVDNR continuous water quality monitors upstream of Cheat Lake. The Albright monitor was not in service in 2009.

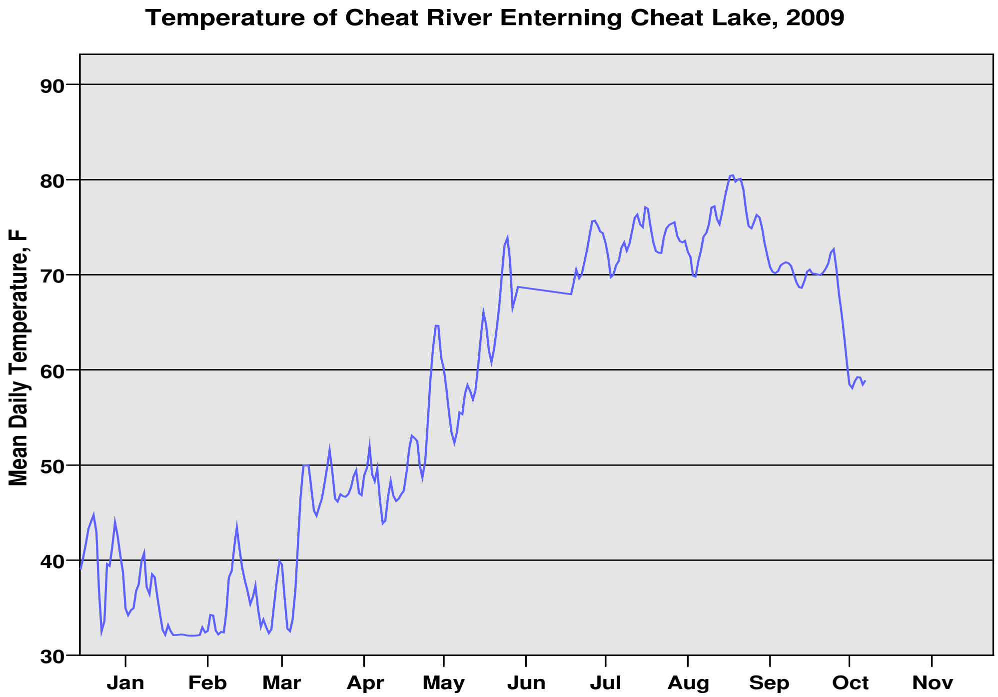


**Figure 3.** Mean daily temperatures of Cheat River entering Cheat Lake, January – October, 2009. The straight line in June indicates no data recording.

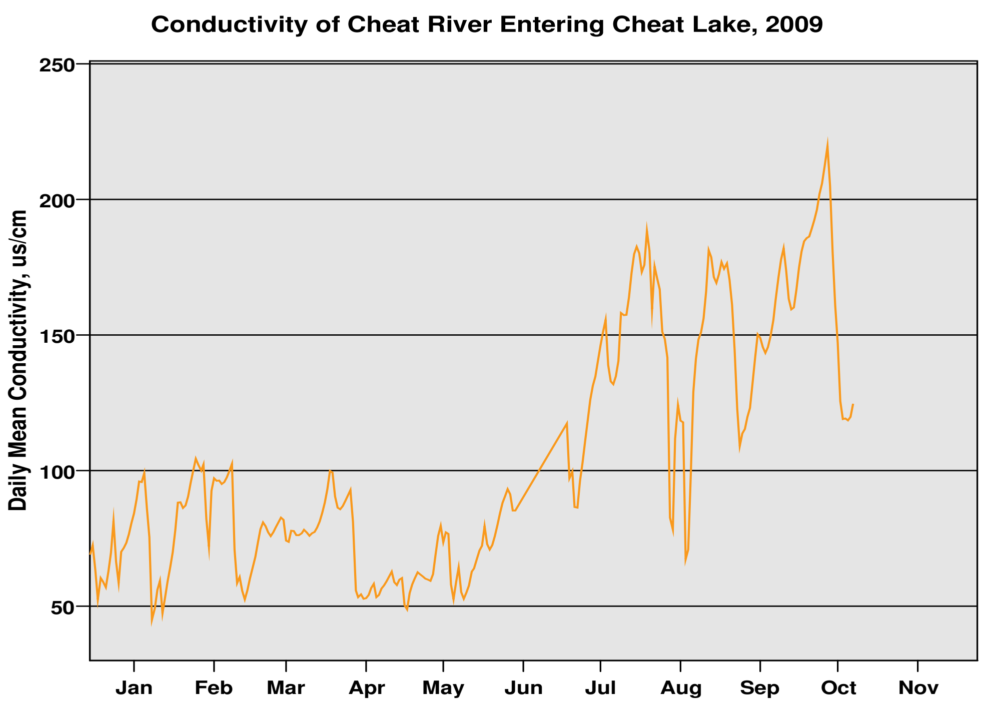


**Figure 4.** Mean daily conductivity of Cheat River entering Cheat Lake, January – October, 2009. The straight line in June indicates no data recording.

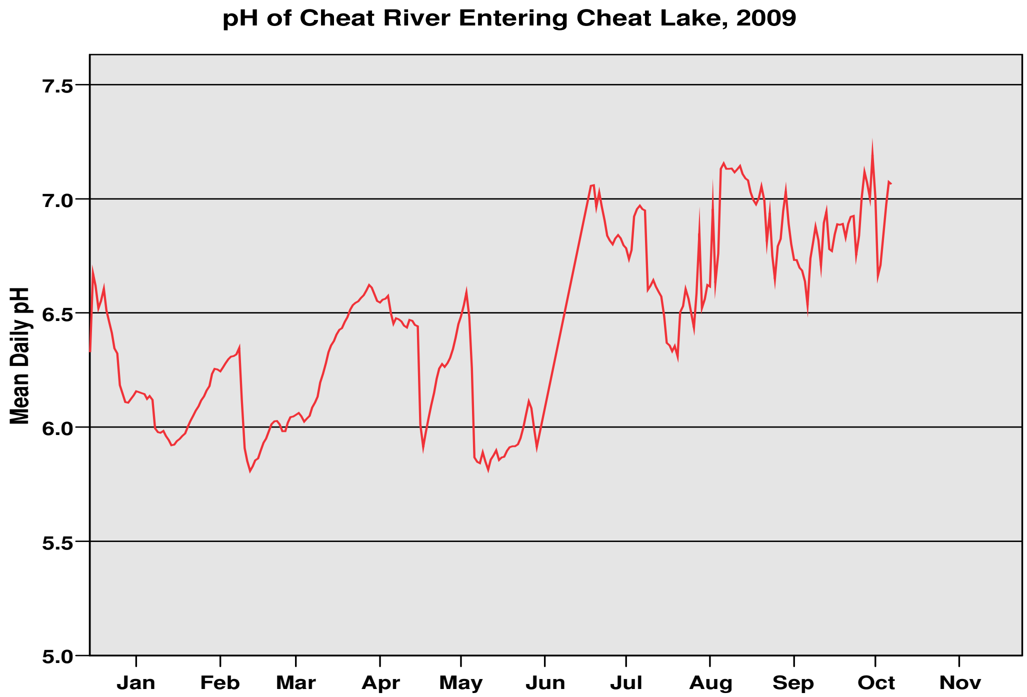


**Figure 5.** Mean daily pH of Cheat River entering Cheat Lake, January – October, 2009. The straight line in June indicates no data recording.

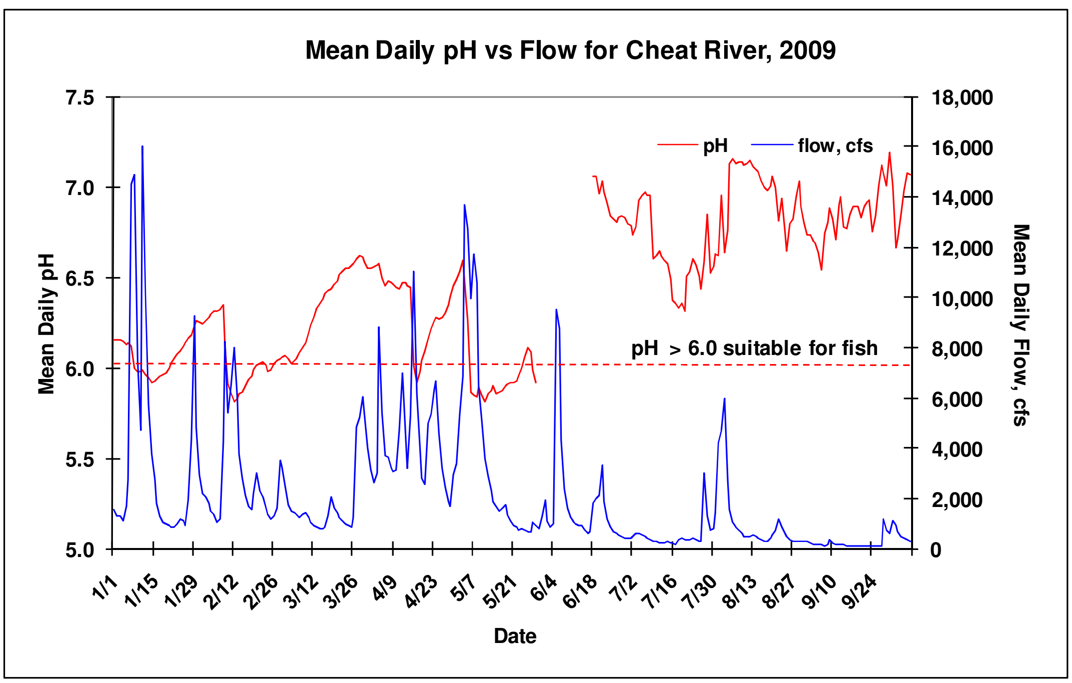


**Figure 6.** Mean daily pH entering Cheat Lake versus mean daily flow at Rowlesburg, January – October, 2009. Provisional mean daily flows are from USGS Rowlesburg gage.

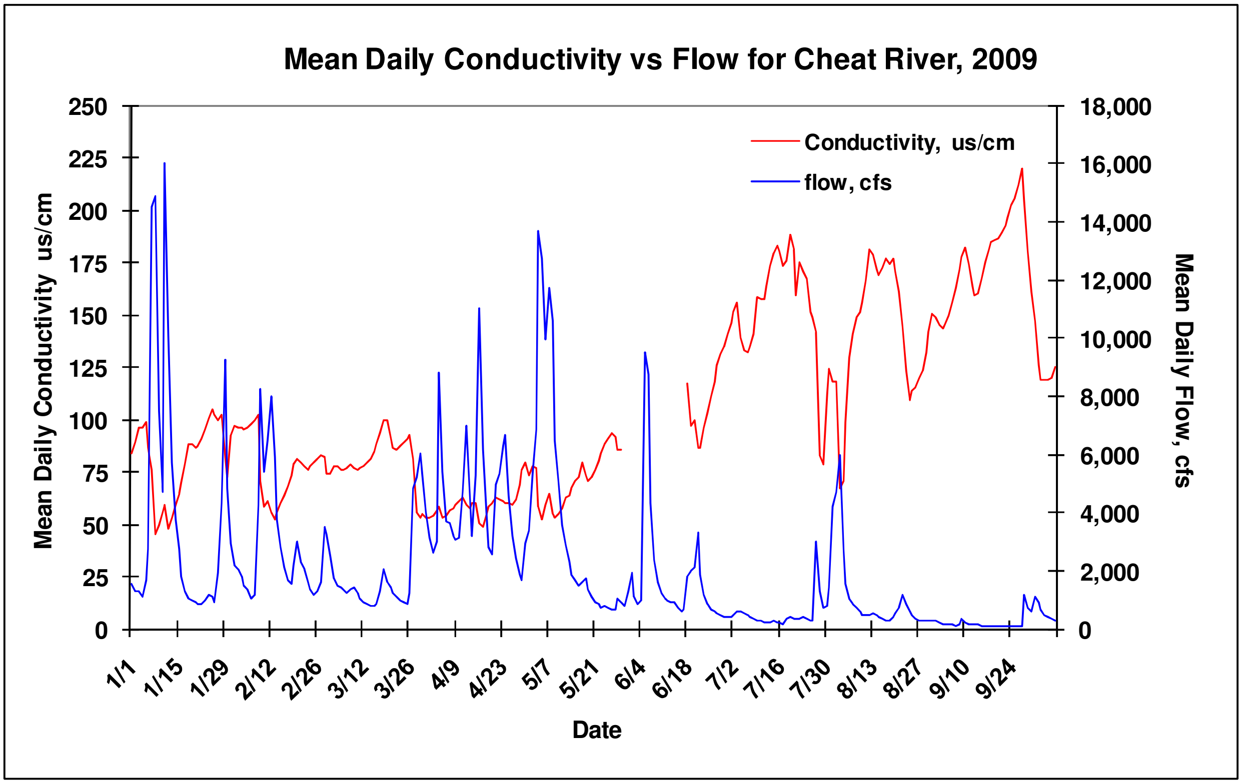


**Figure 7.** Mean daily pH entering Cheat Lake versus mean daily flow at Rowlesburg, January – October, 2009. Provisional mean daily flows are from USGS Rowlesburg gage.

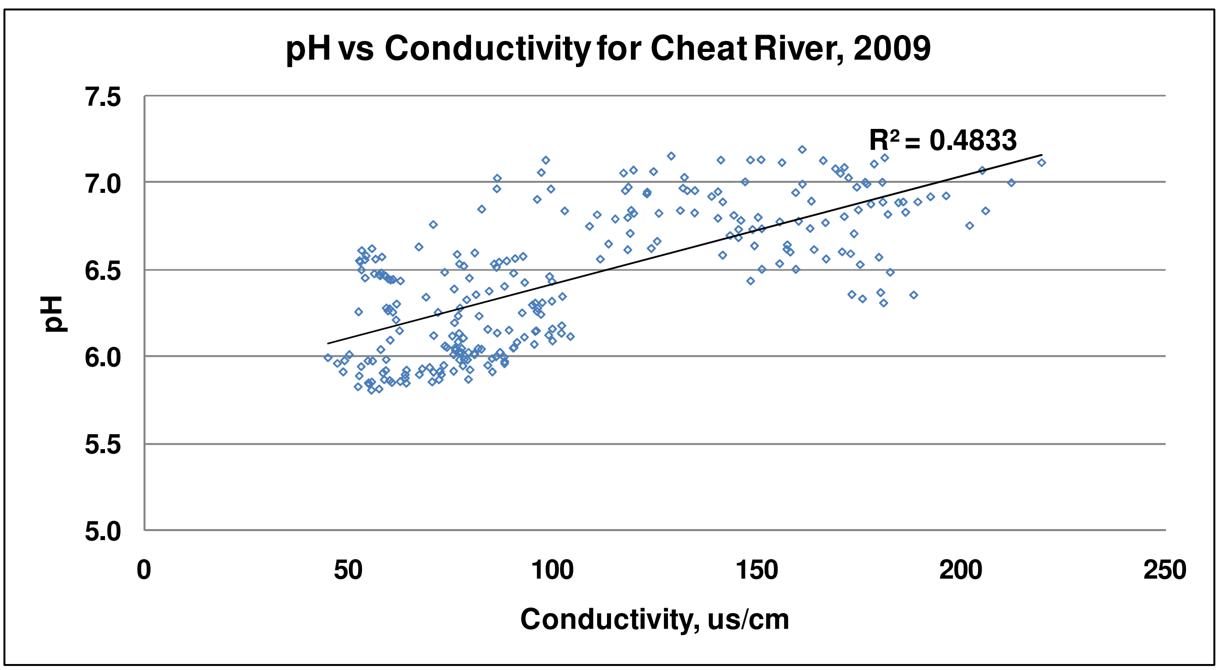


**Figure 8.** Relationship of pH and conductivity for Cheat River entering Cheat Lake from January through October, 2009.

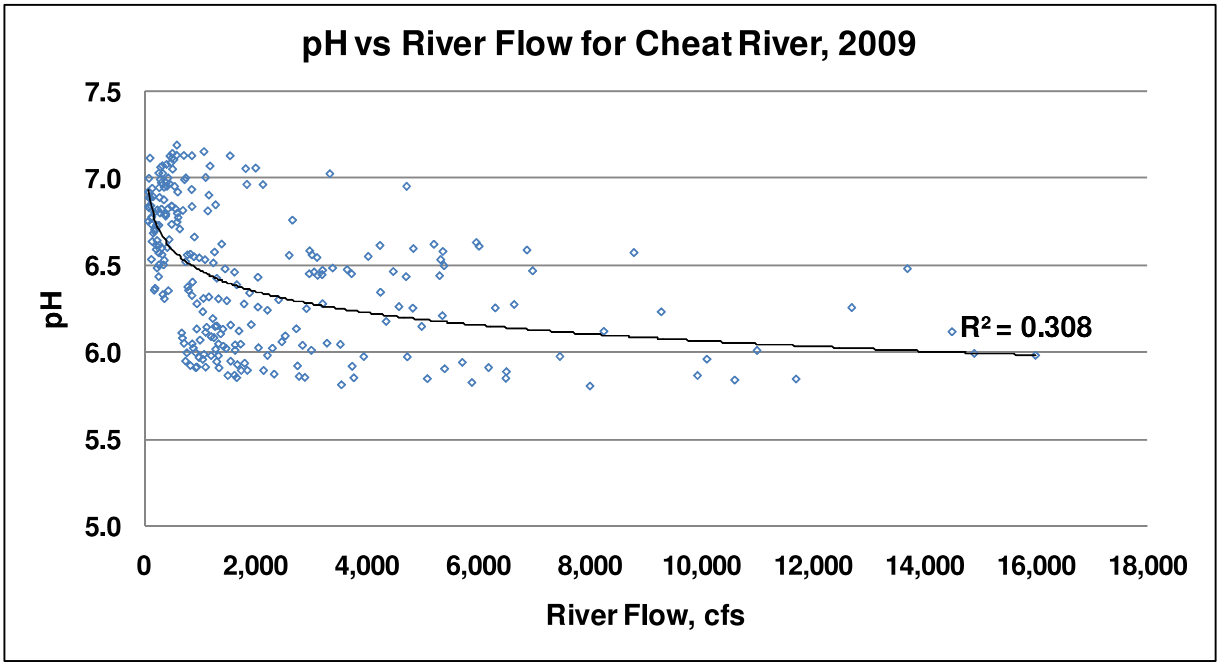


**Figure 9.** Relationship of pH and river flow for Cheat River entering Cheat Lake from January through October, 2009. Provisional flow data provided by USGS Rowlesburg gage.

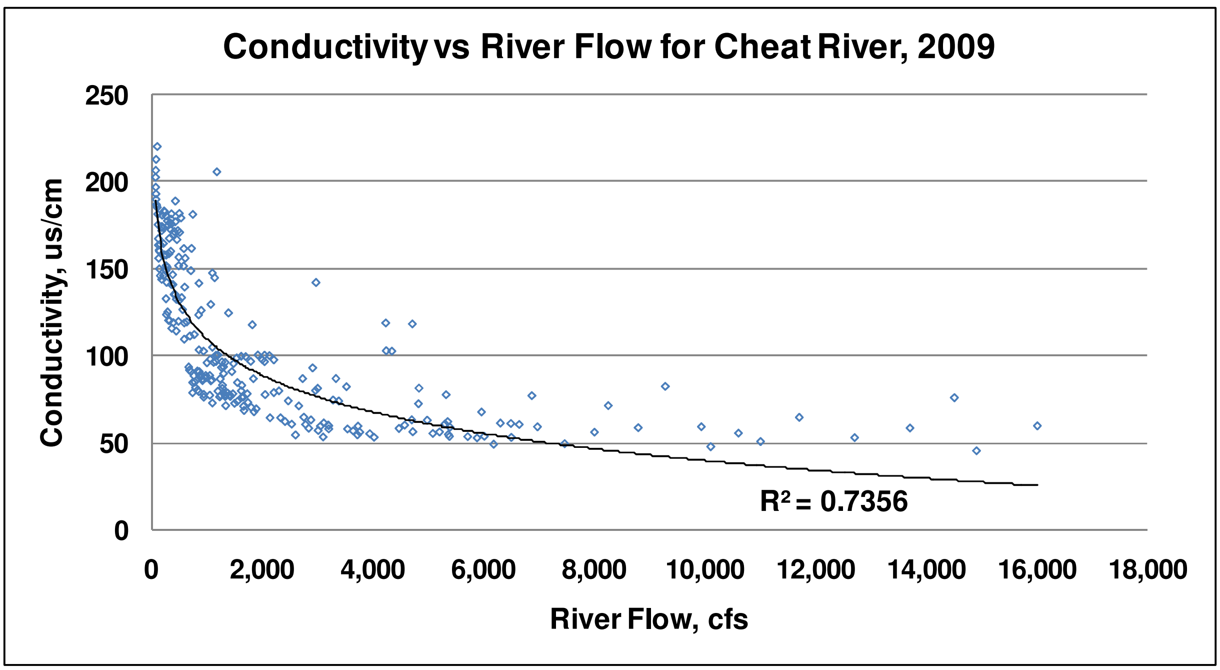


**Figure 10.** Relationship of conductivity and river flow for Cheat River entering Cheat Lake from January through October, 2009. Provisional flow data provided by USGS Rowlesburg gage.

# Chapter 3: Walleye Stocking Assessment (Task 5)

## Introduction

Walleyes are a popular sport fish in West Virginia. However, West Virginia's reservoirs support limited walleye fisheries that were historically dependent upon periodic fry stockings. Construction of a new hatchery in 2003 resulted in an expanded capability of the WVDNR to raise and stock fingerling walleyes. With this new capability, a plan to establish a walleye fishery in Cheat Lake was developed based on existing habitat, lake elevation fluctuations, and improving water quality. Great Lakes walleye fingerlings were first stocked into Cheat Lake in 2004 and each year since except 2008 (Table 2). Additionally, a genetic strain of walleye, known as the upper Ohio River walleye, has been stocked into Cheat River upstream of Rowlesburg since 2005. Spring and fall gill netting has been used to determine the success of these stockings in the lake and boat electrofishing in the river.

## Methods

Since 2005, walleye stocking assessment surveys have been conducted each year using gill nets in March, April, November, and December. In most instances, nets were 150-ft in length, 6-ft deep with 6 25-ft. panels of 1.5, 1.75, 2.0, 1.5, 1.75, 2.0-inch bar length, and were set perpendicular to the shoreline. During fall 2007, gill nets that were 6-ft deep with 5 25-ft panels of 0.75, 1.0, 1.5, 1.75, and 2.0-inch bar mesh employed in the WVDNR statewide reservoir surveys were used in place of the Cheat Lake walleye gill nets. Typically, 24 net-nights were conducted each year. Six gill nets were set during each sampling event and an overnight set was considered one net-night. However, greater effort, 49 net-nights, occurred in 2006 when nets were also set in the summer. In 2009, only 22 net-nights were conducted successfully due to high flow filling some nets with leaves, twisting and pushing them parallel to shore in the upper lake. Station locations were consistent throughout the study (Figure 11). Walleyes were measured to the nearest millimeter and weighed to the nearest 2 grams. To determine age and growth, otoliths were removed from walleyes that could not be released.

Wr, PSD, CPUE, mean length-at-age, and age-class frequency were determined. Wr was determined using the equations of Anderson and Neumann (1996).

## Results

### Catch-Per-Unit-Effort (CPUE)

Since 2005, 118 walleyes have been collected during the spring and fall stocking assessment surveys. Mean CPUE for all surveys combined from 2005 through 2009 was 0.9 fish/net-night, with the highest CPUE in 2008 at 2.0 fish/net-night (Table 3). CPUE during fall surveys (1.4 fish/net-night) was about five times greater than spring surveys

(0.3 fish/net-night). CPUE was less for the upper lake area (0.6 fish/net-night) than either the middle lake (1.1 fish/net-night) or the lower lake (1.1 fish/net-night) areas (Table 4).

## Relative Weight (Wr) and Proportional Stock Density (PSD)

Walleye condition was assessed with Wr. The mean Wr observed for walleyes from 2005 through 2009 was 82, suggesting fair condition (Table 5). However, mean Wr for an entire sample can mask important length-related trends in fish condition (Murphy et al. 1991); therefore mean Wr was calculated for 25mm length groups and plotted against length groups (Figure 12). This analysis revealed a noticeable downward trend as condition decreases with increased walleye lengths. All Wr values represent fish collected in the fall so that spawning condition did not bias the results (Murphy and Willis 1996).

To have sufficient number of walleyes to calculate a PSD, data was pooled from all surveys from 2005 through 2009. PSD was 88 (90 CI: 82 – 93) (Table 6), which indicates that 88% of walleyes collected from 2005 through 2009 were ≥ 380 mm (≥ 15-inches), which is considered quality size for anglers (Figure 13). This is greater than the recommended range (30 – 60) by Anderson (1976) for a balanced population. Nearly 66% of walleyes were in the quality (380 – 509 mm) PSD size class and 19% were in the preferred (510 – 629 mm) size class. Only one memorable size (630 - 759mm) walleye and no trophy (≥760mm) walleyes were collected.

## Length-Frequencies

Length data of walleyes captured during the stocking assessment surveys were pooled to provide an overall picture of the study (Figure 14) and were also separated for yearly comparisons (Figure 15). Pooled data indicated that most walleyes were in the 375 mm to 500 mm length groups. Yearly data looked similar with the exception of 2007. In 2007, only standard experimental gill nets were used, which select for smaller walleyes. Those nets collected walleyes as small as 234 mm, representing naturally reproduced walleyes or survival of stocked fingerlings from the spring.

## Population Age Structure

Otoliths were collected from 29 walleyes for aging purposes from 2005 through 2009 (Table 7). Based on aging data, walleyes greater than 382 mm (15-in) are available to anglers within two years in Cheat Lake. By three years, walleyes may potentially reach angler-preferred size of 509 mm (20-in), but most likely need four years of growth. Mean length-at-age analysis for Cheat Lake is similar to other reservoirs that require supplemental stockings of fingerling walleyes to sustain the fisheries (Figure 16).

## Conclusions

Walleye fry were stocked in Cheat Lake in 1999 and 2000. Fingerlings have been stocked annually since 2004 except for 2008. Consequently, results of the 2005 through 2009 walleye monitoring and assessment surveys, as well as anecdotal angler reports, indicate a walleye sport fishery has developed in Cheat Lake. It appears that limited walleye reproduction is occurring, but supplemental stockings are needed to maintain the fishery and meet angler expectations.

Catch-per-unit-effort was similar across years except in 2008 when it was the highest, following four consecutive years of fingerling stockings. Walleyes were not stocked in 2008, and CPUE drastically decreased in 2009. However, this decrease probably reflects sampling inefficiency. High, turbid water during the fall 2009 survey filled some gill nets with leaves, making them more visible to walleyes and pushing them into shore. Studies have shown that stocking walleyes in consecutive years can result in density-dependent decreases in walleye condition, growth, stocking survival, or abundance of adjacent year-classes (Li et al. 1996a;b). Therefore, WVDNR will stock for one or two consecutive years, depending on fingerling availability, and then skip a year. Cheat Lake's CPUE is similar to other West Virginia reservoir walleye fisheries that also depend on fingerling stockings.

Currently, Cheat Lake's walleye size structure and growth are similar to other West Virginia reservoirs that receive walleye stockings. The majority of walleyes collected in Cheat Lake were in the 380 mm (15-in) to 509 mm (20-in) range, and a few up to 629 mm (25-in). In general, walleye condition is good, but as walleyes increase in size and age, condition decreases. Increased competition among larger walleyes for limited forage within Cheat Lake may be occurring.

Water level fluctuations during the spring and early summer are important because of the effect on habitat, spawning success, egg survival, and availability of food for fry, fingerlings, and adults. Turbid water conditions and lake elevation fluctuations resulting from storm events in March and April might reduce walleye reproductive success in Cheat Lake. In addition, forage may be limited in Cheat Lake, partly due to a lack of habitat for small fish to avoid predation. Consequently, future efforts may be placed on establishing vegetation or habitat structures (i.e. Christmas tree shelters) to increase the forage base and survival of young game fishes, such as walleyes. Future monitoring will continue to focus on walleye abundance and age structure assessment, movement, reproductive success, and habitat based on the current water level regime.

**Table 2.** Cheat Lake and Cheat River walleye stocking records from 1999 through 2009.

| Walleye Genetic Strain | 1999 - Fry | | 2000 - Fry | | 2004 - Fingerling | | 2005 - Fingerling | | 2006 - Fingerling | | 2007 – Fingerling | | 2008 - Fingerling | | 2009 - Fingerling | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Lake | River | Lake | River | Lake | River | Lake | River | Lake | River | Lake | River | Lake | River | Lake | River |
| Ohio River | . | . | . | . | . | . | . | 8,961 | . | 3,259 | . | . | . | 609 | . | 1,218 |
| Great Lakes | 1.7 mil | . | 1.0 mil | | 50,000 | . | 43,812 | . | 46,362 | . | 24,794 | . | . | . | 6,800 | . |

**Table 3.** Comparisons of gill net CPUE for walleyes collected during the Cheat Lake walleye stocking assessments, 2005 - 2009.

| Year | No. Walleye | Effort Net-nights | Mean CPUE walleye/net-night | 90% CL |
|---|---|---|---|---|
| 2005 | 20 | 18 | 0.8 | 1.1 |
| 2006 | 18 | 49 | 0.4 | 0.4 |
| 2007 | 19 | 24 | 0.8 | 0.8 |
| 2008 | 48 | 24 | 2.0 | 1.7 |
| 2009 | 13 | 22 | 0.6 | 0.5 |
| **Total** | **118** | **137** | **0.8** | **1.1** |

2005, 2006, 2008, and 2009: walleye experimental gill nets;
2007: standard experimental gill nets.

**Table 4.** Comparisons of gill net CPUE for walleyes collected in the upper, middle, and lower sections of Cheat Lake, 2005 – 2009.

| Location | No. Walleye | Effort Net-nights | Mean CPUE walleye/net-night | 90% CL |
|---|---|---|---|---|
| Upper | 27 | 43 | 0.6 | 0.3 |
| Middle | 46 | 48 | 1.1 | 0.9 |
| Lower | 45 | 46 | 1.1 | 0.5 |
| **Total** | **118** | **137** | **0.9** | **0.6** |

**Table 5.** Relative weights (Wr) of walleyes collected during the Cheat Lake walleye stocking assessments, 2005 - 2009.

| Species | 2005 | 2006 | 2007 | 2008 | 2009 |
|---|---|---|---|---|---|
| Walleye | 88 | 87 | 96 | 81 | 92 |

**Table 6.** Proportional Stock Density (PSD) of walleyes collected during the Cheat Lake walleye stocking assessments, 2005 – 2009.

| Year | No. Walleye | PSD | 90% Confidence Limit | | Sufficient Sample Size | Recommended PSD Range |
|---|---|---|---|---|---|---|
| | | | Lower | Upper | | |
| 2005 | 20 | 100 | 82 | 100 | Yes (20) | 30 - 60 |
| 2006 | 18 | 100 | 85 | 100 | No (20) | |
| 2007 | 19 | 29 | 12 | 52 | No (30) | |
| 2008 | 48 | 96 | 87 | 99 | Yes (20) | |
| 2009 | 13 | 100 | 81 | 100 | No (20) | |
| **Total** | **118** | **88** | **82** | **93** | **Yes (20)** | |

**Table 7.** Age-key for walleyes from four West Virginia reservoirs.

| | | | Length Range, mm | |
|---|---|---|---|---|
| **Reservoir** | **Age** | **N** | **Minimum** | **Maximum** |
| **Burnsville** | 0 | 32 | 160 | 260 |
| | 1 | 4 | 340 | 362 |
| | 2 | 6 | 366 | 503 |
| | 3 | 5 | 398 | 505 |
| | 4 | 3 | 501 | 582 |
| | 5 | 1 | 495 | 495 |
| | 7 | 1 | 610 | 610 |
| | **Total** | **52** | **160** | **610** |
| **Cheat** | 0 | 0 | . | . |
| | 1 | 3 | 303 | 405 |
| | 2 | 4 | 406 | 488 |
| | 3 | 11 | 386 | 509 |
| | 4 | 5 | 423 | 523 |
| | 5 | 2 | 512 | 552 |
| | 6 | 2 | 482 | 600 |
| | 7 | 1 | 464 | 464 |
| | 8 | 1 | 512 | 512 |
| | **Total** | **29** | **303** | **600** |
| **East Lynn** | 0 | 36 | 151 | 249 |
| | 0 | 0 | . | . |
| | 1 | 10 | 274 | 416 |
| | 2 | 9 | 407 | 478 |
| | 3 | 7 | 439 | 593 |
| | 4 | 1 | 590 | 590 |
| | 5 | 1 | 588 | 588 |
| | 7 | 2 | 554 | 692 |
| | **Total** | **66** | **151** | **692** |
| **Stonecoal** | 0 | 11 | 232 | 262 |
| | 1 | 11 | 366 | 400 |
| | 2 | 7 | 410 | 500 |
| | 3 | 9 | 428 | 522 |
| | 4 | 3 | 454 | 510 |
| | 9 | 1 | 662 | 662 |
| | **Total** | **42** | **232** | **662** |
| **Total Aged** | | **189** | **151** | **692** |

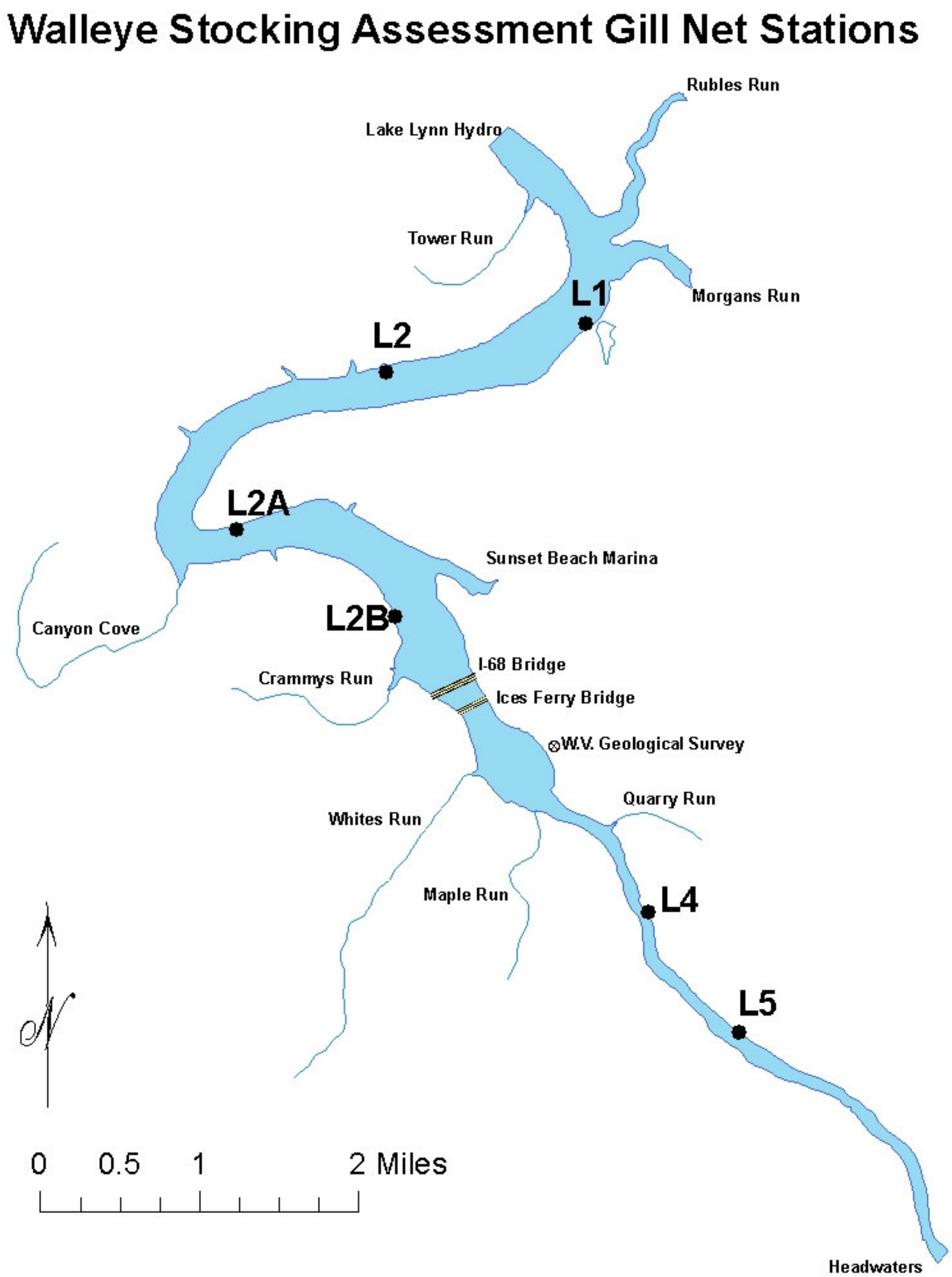


**Figure 11.** Cheat Lake walleye stocking assessment gill net sites, 2009.

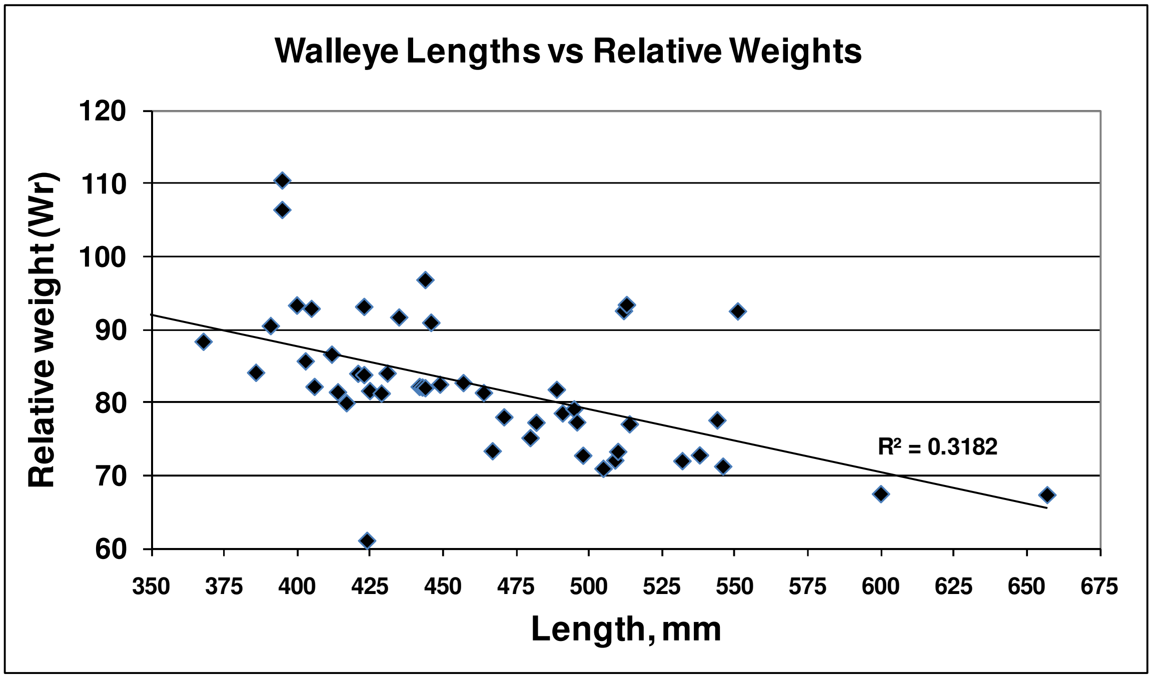


**Figure 12.** Relative weights plotted against 25mm length groups for walleyes collected from 2005 through 2009 in Cheat Lake.

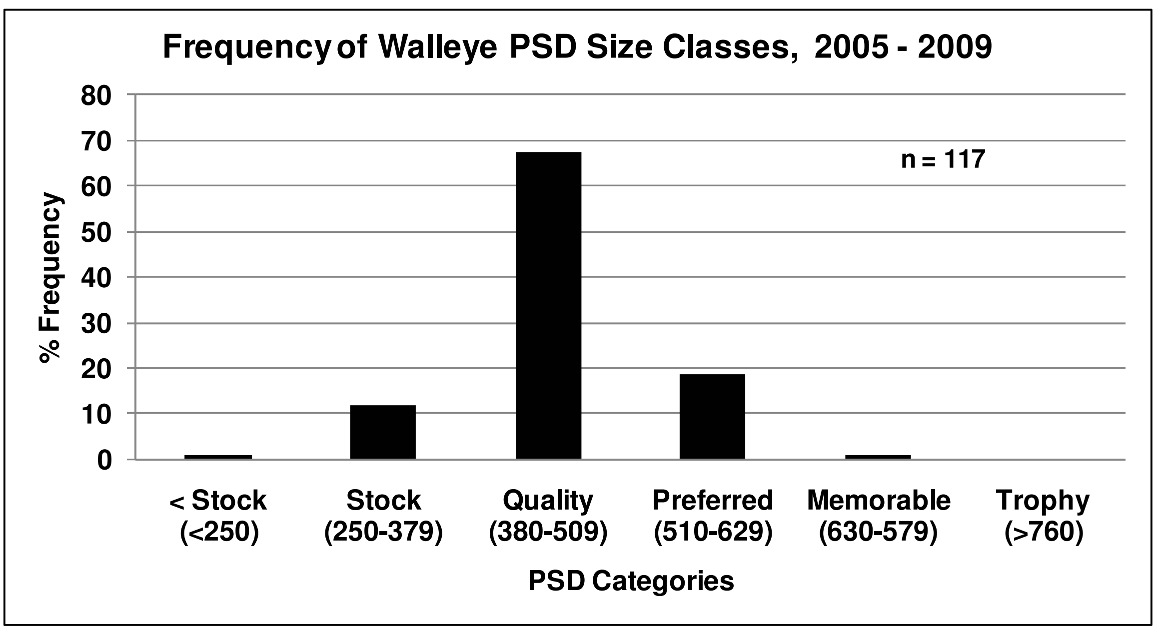


**Figure 13.** PSD size class frequencies for walleyes collected from 2005 through 2009 during Cheat Lake walleye stocking assessment (length classes in mm).

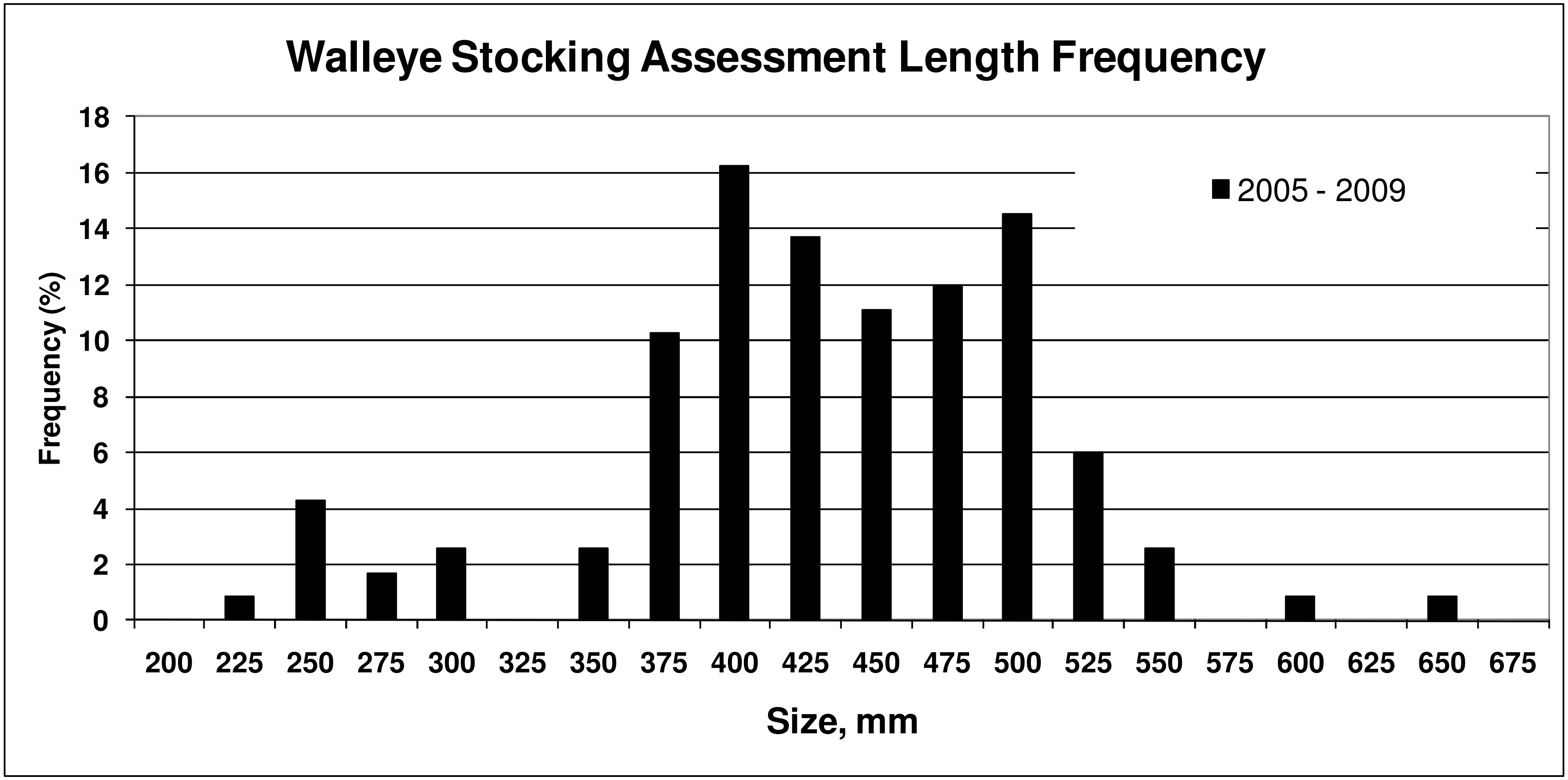


**Figure 14.** Pooled length-frequencies for walleyes captured during walleye stocking assessment surveys from 2005 through 2009.

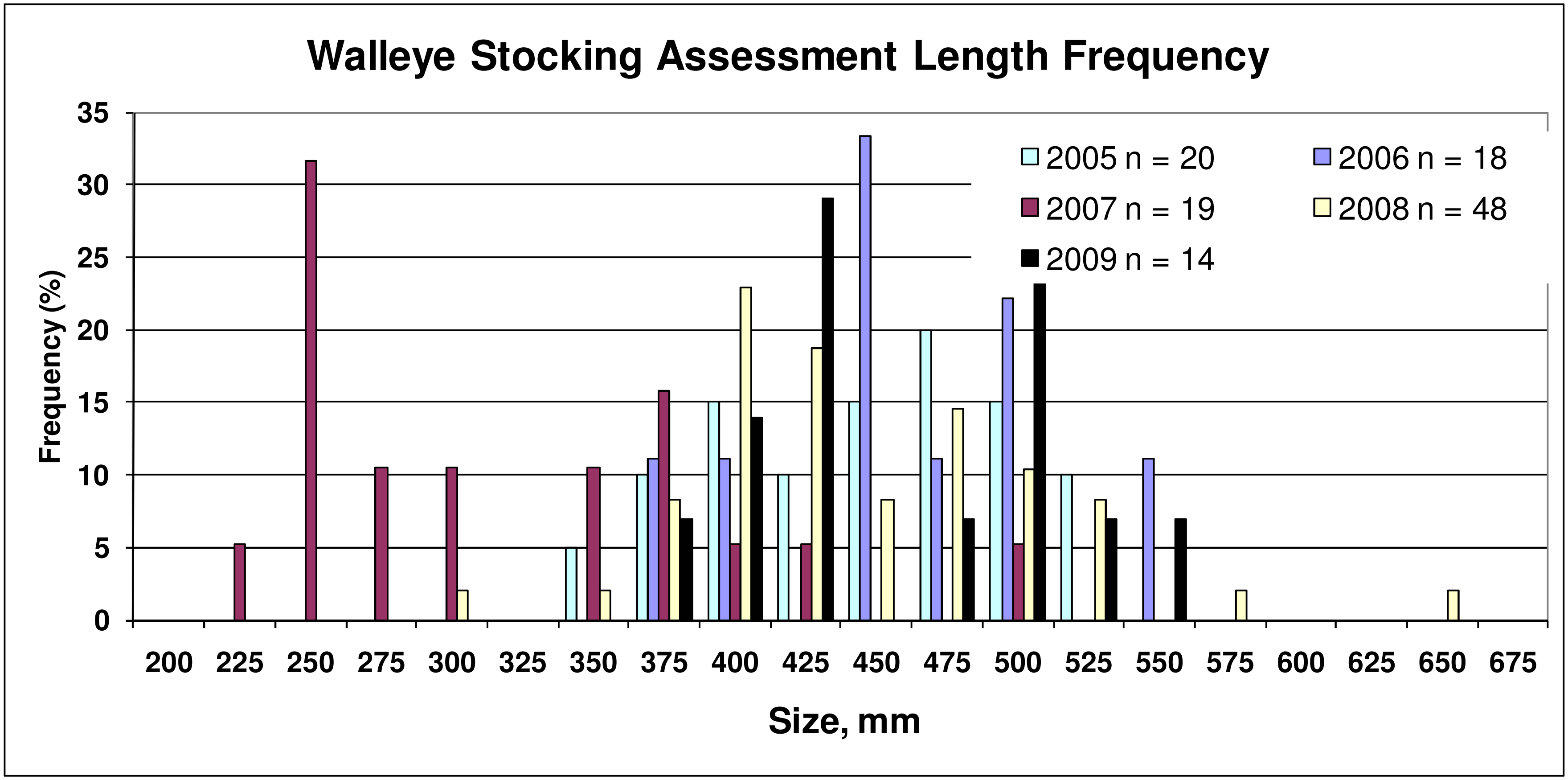


**Figure 15.** Length-frequencies for walleyes captured during walleye stocking assessment surveys from 2005 through 2009. Walleyes were collected with walleye experimental gill nets in 2005, 2006, 2008, and 2009. Standard experimental gill nets were used in 2007 as part of the WVDNR reservoir project.

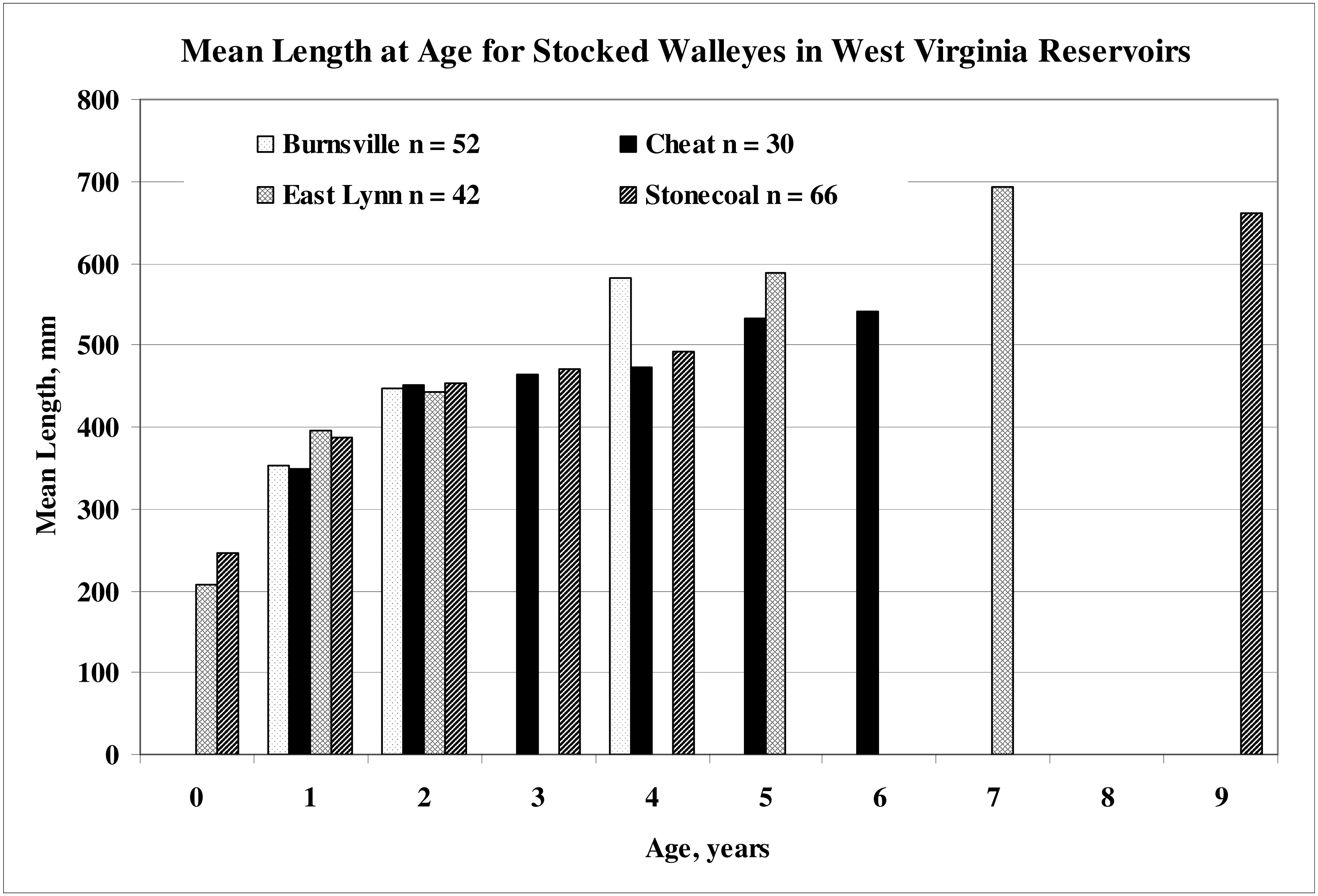


**Figure 16.** Mean length at age for walleyes from four West Virginia reservoirs, 2005 – 2009.

# Chapter 4: Adult Walleye Movement (Task 6)

As part of the Cheat Lake walleye restoration plan, a telemetry study was initiated by the WVDNR in 2007 to provide insight into habitat use of walleyes in Cheat Lake and investigate the relationship between walleye location and lake elevation fluctuations. WVNDR continued implanting acoustic tags into walleye and tracking them with telemetry equipment in 2008. However, personnel constraints and limited results in successfully tracking walleyes led to the WVDNR suspending telemetry efforts in 2009. The telemetry study will resume in 2011.

# Chapter 5: Physical and Chemical Water Quality Characteristics (Task 7)

## Introduction

As part of the FERC license agreement to address potential impacts from water withdrawal for hydropower, monitoring of dissolved oxygen (DO) and temperature was established by the WVDNR, PAFBC, and AES. In 2008 the WVDNR purchased a water quality meter that measures pH and conductivity in addition to water temperature and DO. This was done to provide insight to the potential negative impacts that acid mine drainage sources have on Cheat Lake's water quality.

## Methods

Reservoir operations were monitored throughout the study period and compared with fish surveys and limnological characteristics. Temperature, DO, pH, and conductivity profiles were conducted in Cheat Lake at water quality stations W1, W1A, and W3A at 1 or 2-meter depth intervals eight times from March through November (Figure 17). A hand-held water quality meter, Model WQC-24, made by DKK-TOA Corporation was used to conduct water quality profiles in 2009.

## Results

Temperature, DO, pH, and conductivity profiles were measured at three sites from March through November on eight separate occasions. Station W1 located near the hydro station showed temperature stratification beginning in mid-May and continuing into November (Table 8). DO levels began stratifying in July. The lowest DO concentrations were reached in September: 5.8 mg/l at the surface; 4.2 mg/l at seven meters; and 0.1 mg/l at 24 meters (Table 9). pH was greater than 6.0 in all months at all depths except during 10 days in May and an undetermined number of days in early November (Table 10). On May 7, a pH depression (<6.0) was observed throughout the main lake (Figure 18). However, pH was 6.5 in Rubles Run and 7.7 in Morgans Run, which are separated from the main lake. pH values were 6.0 and 6.2 at Sunset and Quarry Run; these embayments are not separated from the main lake. High spring flows (14,000 cfs) were associated with the pH depression (Figure 19). By May 17, pH throughout the lake was greater than 6.0 at all stations. Conductivity at station W1 ranged from 48 to 141µs/cm and was consistently higher during late summer and early fall (Table 11). AES monitors daily conductivity, DO, temperature, and pH in the tailwater and Cheat River downstream of the dam from April through October in accordance with the FERC license. Their monitoring indicates that DO values in the tailwater may drop below 5.0 mg/l for several hours on some days during July, August, and September. The discharge depth is approximately 14 meters.

Station W1A experienced minimal thermal and DO stratification in 2009 (Tables 12 - 13). Similar to W1, pH at W1A was depressed in May and to a lesser extent in November, but typically was greater than 6.0 (Table 14). Conductivity ranged from 52 to 166µs/cm and was consistently higher during late summer and early fall (Table 15).

Station W3A is representative of the flowing Cheat River and did not show thermal or DO stratification (Tables 16 and 17). pH was similar to other stations with values normally greater than 6.0, but was also depressed on May 7 (Table 18). Conductivity ranged from 55 to 227 µs/cm and was highest in July (Table 19).

## Conclusions

Water quality analysis indicated thermal stratification and low DO conditions do occur in Cheat Lake during the late summer and early fall months, specifically in the deepest part of the lake near the dam. These conditions are consistent with stratification conditions observed in other West Virginia reservoirs and do not appear to limit fish populations in the lake. Review of DO levels provided by AES indicated water releases from the lower strata of Cheat Lake during power generation did not cause anoxic conditions in the Cheat tailwater and Cheat River downstream from the hydro station. The reduction in the volume of oxygen-rich epilimnetic water from August through September reflects surface discharges during an extended period of low inflows.

Recorded pH values at the three water quality stations typically did not fall below 6.0 during 2009. However, in early May and to a lesser extent in November, pH throughout Cheat Lake fell below 6.0. The continuous water quality monitor deployed in Cheat River just upstream of the head of Cheat Lake recorded inflow pH values less than 6.0 for almost the entire month of May (Figure 19). However, lake pH was below 6.0 for only 10 days. High spring river flows (>14,000 cfs) in early May were associated with the pH depression. This indicates acid sources from mine drainage and/or acid precipitation are entering Cheat Lake and impacting water quality, specifically pH. Due to Cheat Lake's large volume of water diluting incoming river water and decreased retention time during power generation, negative impacts to the aquatic community from the pH depressions were not obvious, specifically during high spring flows associated with low pH. Differences in conductivity were not observed among water quality stations, though they were elevated during later summer and early fall at all stations.

**Table 8.** Temperature profiles collected at station W1 from March through November, 2009.

| Depth (m) | 1-Mar | 3-Apr | 7-May | 17-May | 23-Jul | 8-Sep | 8-Oct | 8-Nov |
|---|---|---|---|---|---|---|---|---|
| **Surface** | 4 | 10 | 14 | 25 | 25 | 24 | 19 | 12 |
| **1** | 4 | 10 | 12 | 25 | 25 | 24 | 19 | 12 |
| **2** | . | 10 | 12 | 24 | 25 | 24 | 19 | 12 |
| **3** | . | 10 | 12 | 24 | 25 | 24 | 19 | 12 |
| **4** | . | 10 | 12 | 24 | 25 | 24 | 19 | 12 |
| **5** | . | 10 | 12 | 22 | 24 | 24 | 19 | 12 |
| **6** | . | 10 | 12 | 21 | 24 | 24 | 19 | 12 |
| **7** | . | 10 | 12 | 21 | 24 | 24 | 19 | 11 |
| **8** | . | 10 | 12 | 20 | 23 | 24 | 19 | 10 |
| **9** | . | 10 | 12 | 20 | 22 | 23 | 19 | 10 |
| **10** | . | 10 | 12 | 19 | 22 | 23 | 19 | 10 |
| **12** | . | . | 12 | 18 | 21 | 22 | 18 | 10 |
| **14** | . | . | 12 | 17 | 20 | 21 | 17 | 9 |
| **16** | . | . | 12 | 16 | 20 | 21 | 17 | 10 |
| **18** | . | . | 12 | 16 | 18 | 20 | 17 | 9 |
| **20** | . | . | 12 | 15 | 16 | 17 | 16 | 9 |
| **22** | . | . | 12 | 15 | 15 | 15 | 16 | 9 |
| **24** | 4 | 7 | 12 | . | 14 | . | 15 | . |

**Table 9.** Dissolved oxygen profiles collected at station W1 from March through November, 2009.

| Depth (m) | 1-Mar | 3-Apr | 7-May | 17-May | 23-Jul | 8-Sep | 8-Oct | 8-Nov |
|---|---|---|---|---|---|---|---|---|
| **Surface** | 10.9 | 7.5 | 10.4 | 9.1 | 7.3 | 5.8 | 6.3 | 7.7 |
| **1** | 8.0 | 7.9 | 11.0 | 9.2 | 7.2 | 5.6 | 6.0 | 7.2 |
| **2** | . | 8.2 | 11.1 | 9.3 | 7.2 | 5.6 | 5.9 | 7.1 |
| **3** | . | 8.3 | 11.2 | 9.1 | 7.2 | 5.5 | 5.8 | 7.1 |
| **4** | . | 8.5 | 11.3 | 9.1 | 7.3 | 5.5 | 5.8 | 7.1 |
| **5** | . | 8.7 | 11.4 | 9.2 | 6.9 | 5.5 | 5.8 | 7.0 |
| **6** | . | 8.9 | 11.4 | 8.8 | 5.8 | 5.5 | 5.8 | 7.0 |
| **7** | . | 9.0 | 11.5 | 8.5 | 5.2 | 4.2 | 5.8 | 7.1 |
| **8** | . | 9.1 | 11.5 | 8.3 | 4.8 | 3.2 | 5.7 | 7.2 |
| **9** | . | 9.2 | 11.6 | 8.3 | 4.8 | 2.5 | 5.8 | 7.3 |
| **10** | . | 9.1 | 11.5 | 8.4 | 5.4 | 3.8 | 4.8 | 7.4 |
| **12** | . | . | 11.5 | 8.8 | 5.0 | 3.1 | 3.5 | 7.5 |
| **14** | . | . | 11.6 | 8.9 | 4.5 | 2.6 | 5.3 | 7.6 |
| **16** | . | . | 11.6 | 8.9 | 3.7 | 2.2 | 4.2 | 7.6 |
| **18** | . | . | 11.5 | 9.0 | 3.2 | 0.2 | 5.7 | 7.7 |
| **20** | . | . | 11.5 | 8.5 | 3.2 | 0.1 | 5.8 | 7.7 |
| **22** | . | . | 11.5 | 8.5 | 2.2 | 0.1 | 2.0 | 7.7 |
| **24** | 9.2 | 9.5 | 11.4 | . | 1.8 | . | 2.1 | . |

**Table 10.** pH profiles collected at station W1 from March through November, 2009.

| Depth (m) | 1-Mar | 3-Apr | 7-May | 17-May | 23-Jul | 8-Sep | 8-Oct | 8-Nov |
|---|---|---|---|---|---|---|---|---|
| **Surface** | 6.7 | 7.2 | 5.7 | 6.6 | 6.4 | 6.6 | 6.4 | 6.2 |
| **1** | 6.7 | 7.0 | 5.6 | 6.6 | 6.6 | 6.6 | 6.5 | 6.0 |
| **2** | . | 7.0 | 5.5 | 6.7 | 6.6 | 6.6 | 6.4 | 6.0 |
| **3** | . | 6.8 | 5.5 | 6.7 | 6.7 | 6.5 | 6.4 | 6.0 |
| **4** | . | 6.8 | 5.4 | 6.7 | 6.6 | 6.5 | 6.4 | 5.8 |
| **5** | . | 6.7 | 5.4 | 6.6 | 6.5 | 6.5 | 6.3 | 5.9 |
| **6** | . | 6.6 | 5.4 | 6.6 | 6.4 | 6.5 | 6.3 | 5.9 |
| **7** | . | 6.6 | 5.4 | 6.6 | 6.3 | 6.4 | 6.4 | 8.9 |
| **8** | . | 6.6 | 5.4 | 6.5 | 6.2 | 6.4 | 6.4 | 5.9 |
| **9** | . | 6.5 | 5.4 | 6.4 | 6.2 | 6.3 | 6.3 | 5.9 |
| **10** | . | 6.5 | 5.5 | 6.4 | 6.3 | 6.2 | 6.2 | 5.9 |
| **12** | . | . | 5.5 | 6.4 | 6.3 | 6.2 | 6.2 | 5.9 |
| **14** | . | . | 5.4 | 6.4 | 6.3 | 6.2 | 6.3 | 5.9 |
| **16** | . | . | 5.5 | 6.4 | 6.2 | 6.1 | 6.2 | 5.9 |
| **18** | . | . | 5.5 | 6.4 | 6.3 | 6.2 | 6.3 | 5.9 |
| **20** | . | . | 5.6 | 6.3 | 6.2 | 6.2 | 6.4 | 5.9 |
| **22** | . | . | 5.6 | 6.4 | 6.1 | 6.8 | 6.2 | 5.9 |
| **24** | 6.6 | 6.3 | 5.9 | . | 6.6 | . | . | . |

**Table 11.** Conductivity profiles collected at station W1 from March through November, 2009.

| Depth (m) | 1-Mar | 3-Apr | 7-May | 17-May | 23-Jul | 8-Sep | 8-Oct | 8-Nov |
|---|---|---|---|---|---|---|---|---|
| **Surface** | 87 | 69 | 74 | 91 | 129 | 114 | 124 | 70 |
| **1** | 83 | 66 | 75 | 92 | 127 | 121 | 124 | 72 |
| **2** | . | 66 | 75 | 91 | 127 | 118 | 133 | 74 |
| **3** | . | 65 | 75 | 89 | 129 | 119 | 134 | 74 |
| **4** | . | 65 | 74 | 91 | 129 | 118 | 134 | 68 |
| **5** | . | 65 | 74 | 92 | 134 | 117 | 134 | 69 |
| **6** | . | 65 | 72 | 90 | 141 | 117 | 133 | 70 |
| **7** | . | 65 | 71 | 89 | 133 | 114 | 133 | 74 |
| **8** | . | 65 | 69 | 81 | 129 | 105 | 133 | 63 |
| **9** | . | 65 | 67 | 72 | 109 | 90 | 149 | 60 |
| **10** | . | 65 | 66 | 65 | 89 | 74 | 162 | 59 |
| **12** | . | . | 63 | 59 | 84 | 69 | 140 | 56 |
| **14** | . | . | 63 | 61 | 92 | 62 | 135 | 55 |
| **16** | . | . | 59 | 48 | 96 | 59 | 121 | 52 |
| **18** | . | . | 56 | 46 | 98 | 80 | 110 | 51 |
| **20** | . | . | 53 | 55 | 69 | 83 | 100 | 51 |
| **22** | . | . | 49 | 88 | 57 | 96 | 95 | 48 |
| **24** | 135 | 65 | 53 | . | 112 | . | . | . |

**Table 12.** Temperature profiles collected at station W1A from March through November, 2009.

| Depth (m) | 1-Mar | 3-Apr | 7-May | 17-May | 23-Jul | 8-Sep | 8-Oct | 8-Nov |
|---|---|---|---|---|---|---|---|---|
| **Surface** | . | 10 | 14 | 24 | 25 | 24 | 19 | 12 |
| **1** | . | . | 13 | 24 | 25 | 24 | 19 | 12 |
| **2** | . | 10 | 13 | 23 | 25 | 24 | 19 | 12 |
| **3** | . | 10 | 13 | 23 | 25 | 24 | 19 | 11 |
| **4** | . | 9 | 13 | 23 | 24 | 24 | 19 | 11 |
| **5** | . | 9 | 13 | 22 | 24 | 24 | 19 | 11 |
| **6** | . | 9 | 13 | 22 | 24 | 24 | 19 | 11 |
| **7** | . | 9 | 13 | 21 | 23 | 24 | 19 | 11 |
| **8** | . | 9 | 13 | 20 | 23 | 24 | 19 | 11 |
| **9** | . | 9 | 13 | 20 | 22 | 23 | 19 | 10 |
| **10** | . | 9 | 13 | 19 | 22 | 23 | 18 | 10 |
| **11** | . | . | . | . | . | . | . | . |
| **12** | . | 9 | 13 | 17 | 21 | 22 | 18 | 9 |
| **13** | . | . | 13 | . | . | . | . | . |
| **14** | . | 9 | . | 17 | 21 | 22 | 17 | 9 |
| **15** | . | . | . | . | . | 22 | . | . |
| **16** | . | 8 | . | 16 | . | . | . | . |

**Table 13.** Dissolved oxygen profiles collected at station W1A from March through November, 2009.

| Depth (m) | 1-Mar | 3-Apr | 7-May | 17-May | 23-Jul | 8-Sep | 8-Oct | 8-Nov |
|---|---|---|---|---|---|---|---|---|
| **Surface** | . | 7.9 | 10.9 | 8.6 | 7.2 | 6.6 | 6.0 | 7.2 |
| **1** | . | . | 11.1 | 8.6 | 7.2 | 6.6 | 6.0 | 7.3 |
| **2** | . | 8.3 | 11.1 | 8.5 | 7.2 | 6.5 | 5.9 | 7.2 |
| **3** | . | 8.6 | 11.2 | 8.1 | 7.1 | 6.5 | 5.9 | 7.3 |
| **4** | . | 8.9 | 11.2 | 8.0 | 6.7 | 6.4 | 5.8 | 7.2 |
| **5** | . | 9.1 | 11.3 | 7.6 | 6.1 | 6.4 | 5.8 | 7.3 |
| **6** | . | 9.3 | 11.1 | 7.7 | 5.4 | 6.4 | 5.8 | 7.3 |
| **7** | . | 9.4 | 11.2 | 7.5 | 4.4 | 6.4 | 5.7 | 7.3 |
| **8** | . | 9.6 | 11.2 | 7.4 | 3.9 | 6.3 | 5.7 | 7.3 |
| **9** | . | 9.7 | 11.2 | 6.5 | 3.8 | 6.4 | 5.7 | 7.5 |
| **10** | . | 9.7 | 11.2 | 6.6 | 2.2 | 6.3 | 5.8 | 7.5 |
| **11** | . | . | . | . | . | . | . | . |
| **12** | . | 9.8 | 11.2 | 7.0 | 2.0 | 6.2 | 5.8 | 7.8 |
| **13** | . | . | 11.2 | . | . | . | . | . |
| **14** | . | 9.9 | . | 7.5 | 1.3 | 6.1 | 6.0 | 7.9 |
| **15** | . | . | . | . | . | 6.4 | . | . |
| **16** | . | 10.0 | . | 7.1 | . | . | . | . |

**Table 14.** pH profiles collected at station W1A from March through November, 2009.

| Depth (m) | 1-Mar | 3-Apr | 7-May | 17-May | 23-Jul | 8-Sep | 8-Oct | 8-Nov |
|---|---|---|---|---|---|---|---|---|
| **Surface** | . | 6.5 | 5.9 | 6.6 | 6.6 | 6.6 | 6.5 | 6.2 |
| **1** | . | . | 5.8 | 6.6 | 6.7 | 6.6 | 6.5 | 6.1 |
| **2** | . | 6.5 | 5.7 | 6.6 | 6.7 | 6.5 | 6.5 | 6.1 |
| **3** | . | 6.5 | 5.7 | 6.5 | 6.7 | 6.5 | 6.5 | 6.0 |
| **4** | . | 6.5 | 5.7 | 6.4 | 6.6 | 6.4 | 6.5 | 6.0 |
| **5** | . | 6.5 | 5.6 | 6.3 | 6.4 | 6.4 | 6.5 | 5.9 |
| **6** | . | 6.4 | 5.5 | 6.3 | 6.2 | 6.4 | 6.5 | 5.9 |
| **7** | . | 6.4 | 5.5 | 6.3 | 6.2 | 6.4 | 6.4 | 5.9 |
| **8** | . | 6.4 | 5.4 | 6.2 | 6.1 | 6.4 | 6.4 | 5.8 |
| **9** | . | 6.4 | 5.3 | 6.2 | 6.0 | 6.4 | 6.5 | 5.9 |
| **10** | . | 6.4 | 5.3 | 6.1 | 6.0 | 6.3 | 6.5 | 5.8 |
| **11** | . | . | 5.2 | . | . | . | . | . |
| **12** | . | 6.4 | 5.2 | 6.1 | 6.0 | 6.2 | 6.4 | 5.9 |
| **13** | . | . | . | . | . | . | . | . |
| **14** | . | 6.4 | . | 6.1 | 6.4 | 6.1 | 6.4 | 5.9 |
| **15** | . | . | . | . | . | 6.4 | . | . |
| **16** | . | 6.2 | . | 6.4 | . | . | . | . |

**Table 15.** Conductivity profiles collected at station W1A from March through November, 2009.

| Depth (m) | 1-Mar | 3-Apr | 7-May | 17-May | 23-Jul | 8-Sep | 8-Oct | 8-Nov |
|---|---|---|---|---|---|---|---|---|
| **Surface** | . | 61 | 80 | 104 | 131 | 119 | 122 | 61 |
| **1** | . | . | 75 | 104 | 133 | 130 | 126 | 63 |
| **2** | . | 61 | 76 | 108 | 130 | 126 | 130 | 65 |
| **3** | . | 57 | 76 | 106 | 127 | 127 | 30 | 64 |
| **4** | . | 57 | 79 | 108 | 133 | 132 | 130 | 62 |
| **5** | . | 54 | 79 | 106 | 166 | 131 | 130 | 63 |
| **6** | . | 54 | 76 | 105 | 156 | 129 | 130 | 63 |
| **7** | . | 54 | 76 | 99 | 152 | 133 | 12 | 63 |
| **8** | . | 54 | 78 | 97 | 141 | 131 | 128 | 64 |
| **9** | . | 54 | 79 | 92 | 133 | 127 | 126 | 63 |
| **10** | . | 54 | 79 | 89 | 121 | 127 | 127 | 61 |
| **11** | . | . | . | . | . | . | . | . |
| **12** | . | 52 | 78 | 63 | 93 | 99 | 118 | 63 |
| **13** | . | . | 74 | . | . | . | . | . |
| **14** | . | 54 | . | 54 | 96 | 75 | 101 | 61 |
| **15** | . | . | . | . | . | 79 | . | . |
| **16** | . | 73 | . | 61 | . | . | . | . |

**Table 16.** Temperature profiles collected at station W3A from March through November, 2009.

| Depth (m) | 1-Mar | 3-Apr | 7-May | 17-May | 23-Jul | 8-Sep | 8-Oct | 8-Nov |
|---|---|---|---|---|---|---|---|---|
| **Surface** | 10 | 10 | 14 | 20 | 23 | 22 | 15 | 9 |
| **1** | 10 | 10 | . | 20 | 23 | 21 | 15 | 9 |
| **2** | 10 | 10 | 14 | 20 | 23 | 21 | 15 | 8 |
| **3** | . | 10 | . | 20 | 23 | 21 | 15 | 8 |
| **4** | . | 10 | 14 | 20 | 23 | 21 | 15 | 8 |
| **5** | . | . | . | 20 | 23 | 21 | . | . |
| **6** | . | . | 14 | 20 | . | . | . | . |

**Table 17.** Dissolved oxygen profiles collected at station W3A from March through November, 2009.

| Depth (m) | 1-Mar | 3-Apr | 7-May | 17-May | 23-Jul | 8-Sep | 8-Oct | 8-Nov |
|---|---|---|---|---|---|---|---|---|
| **Surface** | 8.5 | 8.0 | 10.0 | 9.4 | 7.7 | 7.0 | 7.7 | 8.0 |
| **1** | 8.6 | | . | 9.5 | 7.7 | 6.9 | 7.8 | 8.3 |
| **2** | 8.7 | 8.6 | 10.4 | 9.5 | 7.7 | 6.8 | 7.9 | 8.3 |
| **3** | . | 8.9 | . | 9.5 | 7.7 | 6.8 | 7.9 | 8.3 |
| **4** | . | 9.0 | 10.7 | 9.5 | 7.7 | 6.8 | 7.9 | 8.3 |
| **5** | . | . | . | 9.5 | 7.6 | 6.8 | . | . |
| **6** | . | . | 10.9 | . | . | . | . | . |

**Table 18.** pH profiles collected at station W3A from March through November, 2009.

| Depth (m) | 1-Mar | 3-Apr | 7-May | 17-May | 23-Jul | 8-Sep | 8-Oct | 8-Nov |
|---|---|---|---|---|---|---|---|---|
| **Surface** | 7.3 | 6.4 | 5.8 | 6.7 | 6.9 | 6.7 | 6.9 | 6.3 |
| **1** | 6.9 | 6.4 | . | 6.8 | 6.9 | 6.7 | 6.8 | 6.3 |
| **2** | 6.6 | 6.5 | 5.8 | 6.8 | 7.0 | 6.8 | 6.8 | 6.3 |
| **3** | . | 6.5 | . | 6.8 | 7.0 | 6.8 | 6.8 | 6.2 |
| **4** | . | 6.4 | 5.8 | 6.8 | 7.0 | 6.8 | 6.8 | 6.2 |
| **5** | . | . | . | 6.8 | 6.7 | 6.8 | . | . |
| **6** | . | . | 5.8 | . | . | . | . | . |

**Table 19.** Conductivity profiles collected at station W3A from March through November, 2009.

| Depth (m) | 1-Mar | 3-Apr | 7-May | 17-May | 23-Jul | 8-Sep | 8-Oct | 8-Nov |
|---|---|---|---|---|---|---|---|---|
| **Surface** | 97 | 57 | 64 | 150 | 187 | 155 | 98 | 81 |
| **1** | 93 | 57 | . | 152 | 185 | 161 | 68 | 82 |
| **2** | 92 | 57 | 69 | 150 | 182 | 165 | 102 | 84 |
| **3** | . | 56 | . | 151 | 182 | 165 | 103 | 82 |
| **4** | . | 56 | 67 | 151 | 181 | 165 | 103 | 82 |
| **5** | . | . | . | 150 | 179 | 164 | . | . |
| **6** | . | . | 67 | . | . | . | . | . |

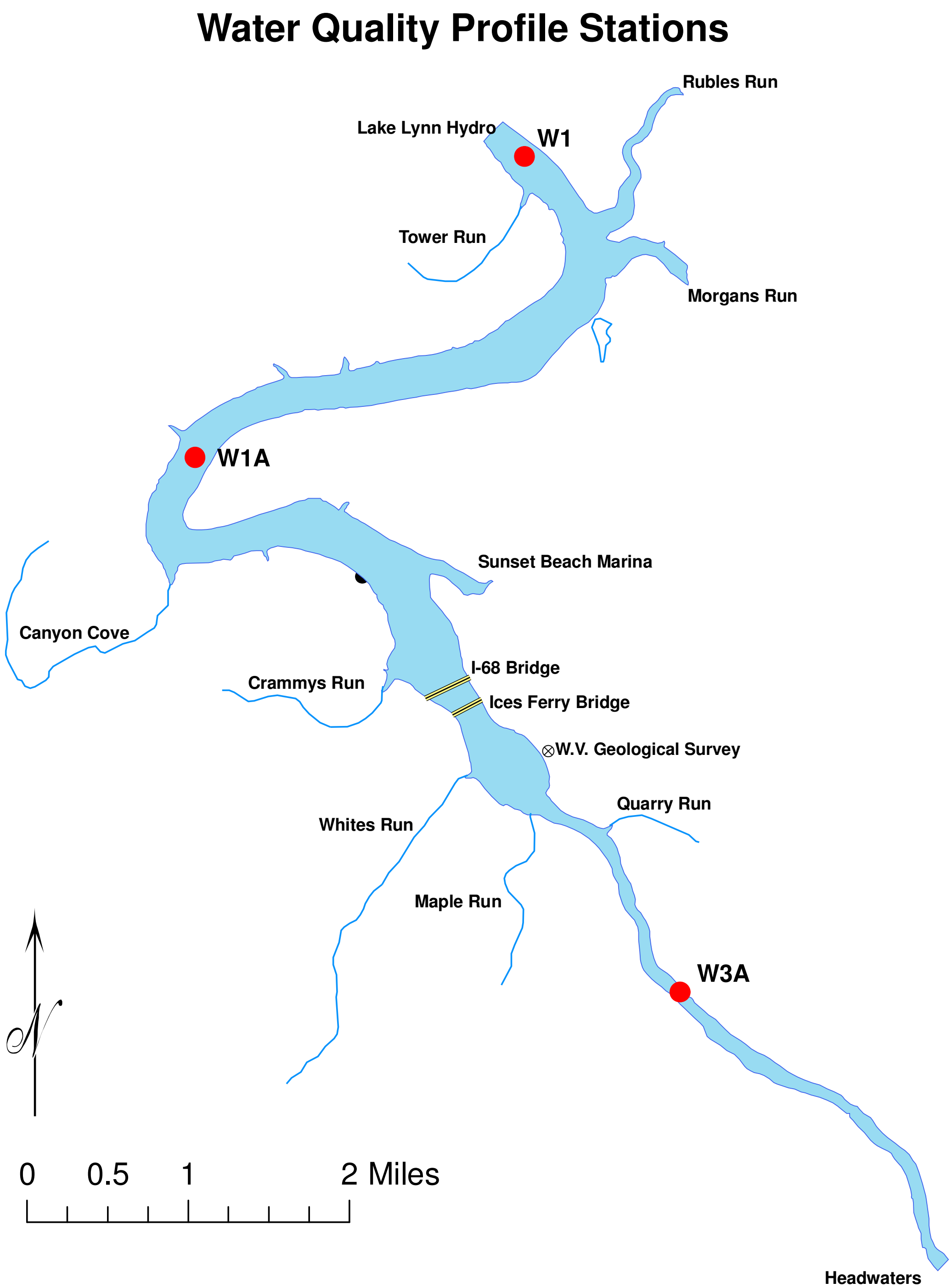


**Figure 17.** Cheat Lake water quality profile stations, 2009.

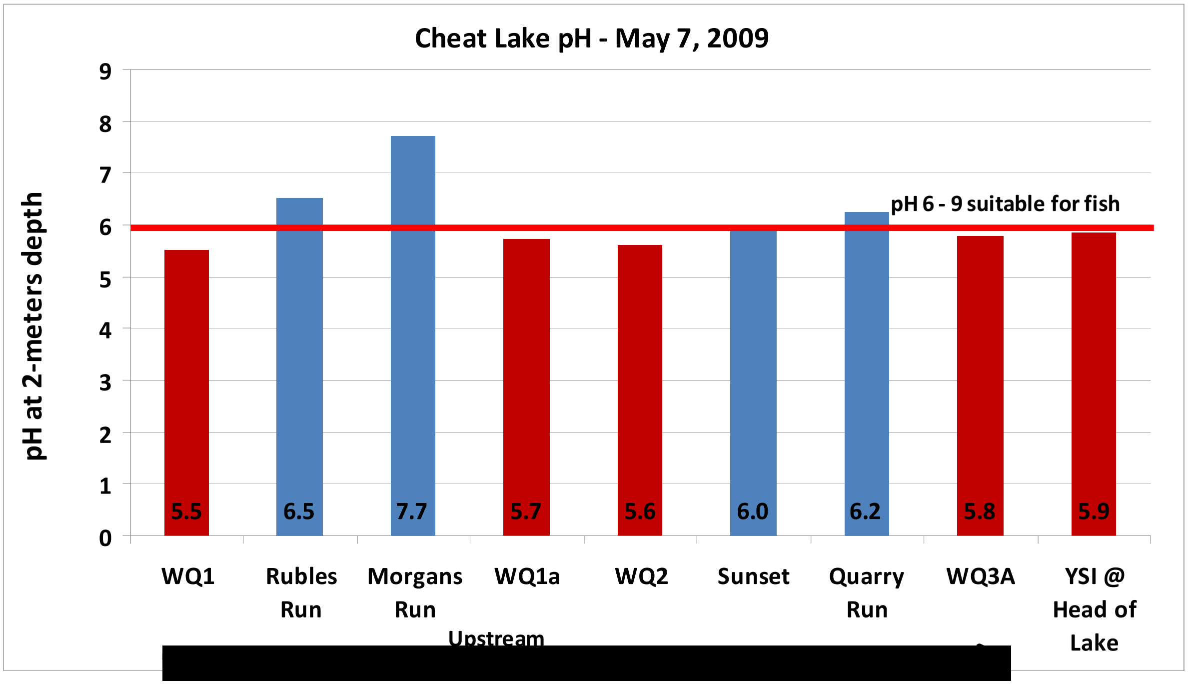


**Figure 18.** pH taken at 2m depth in the mainstem of Cheat Lake and embayments on May 7, 2009. A continuous water quality monitor deployed at the head of Cheat Lake provided pH measurements of Cheat River that were similar to pH values throughout Cheat Lake.

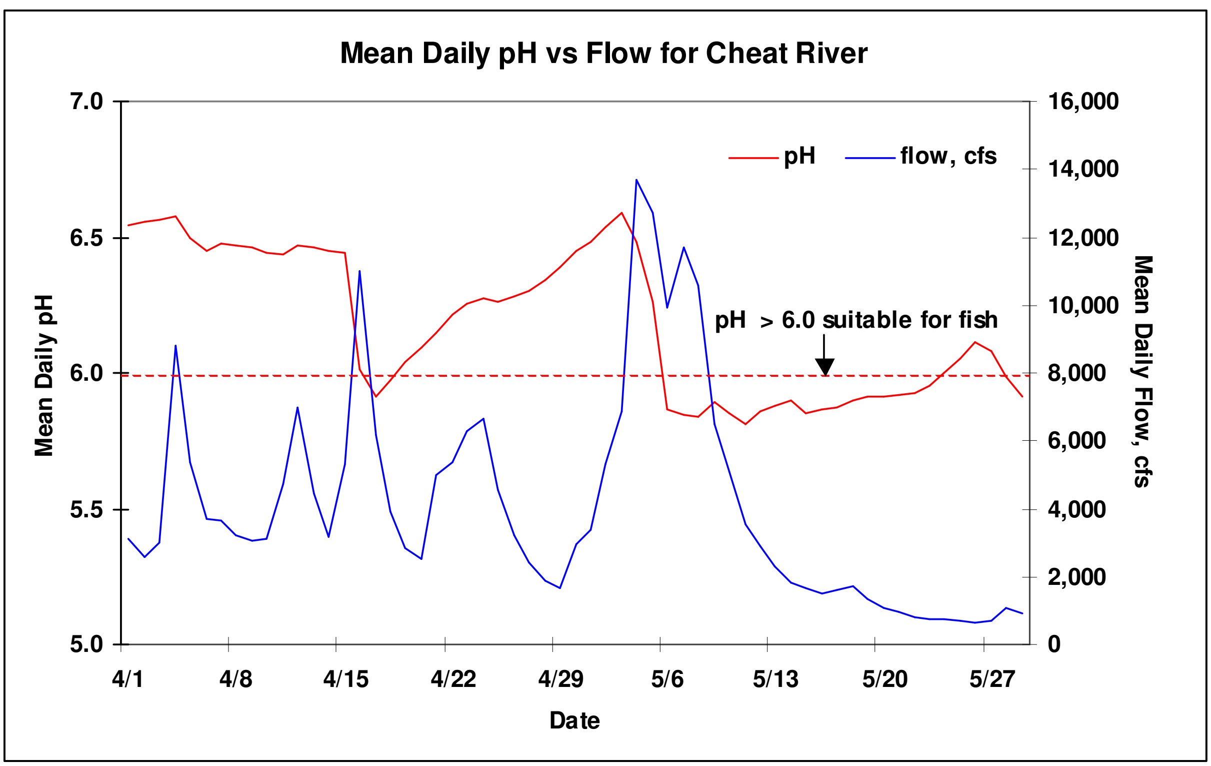


**Figure 19.** Mean daily pH for Cheat River entering Cheat Lake as recorded by a continuous water quality monitor deployed at the head of Cheat Lake. Mean daily flows (cfs) were obtained from U.S. Geological Survey gage near Rowlesburg and are provisional. High river flows (maximum mean daily = 13,700 cfs) were associated with an extended pH depression (< 6.0) in Cheat River and Cheat Lake in May 2009.

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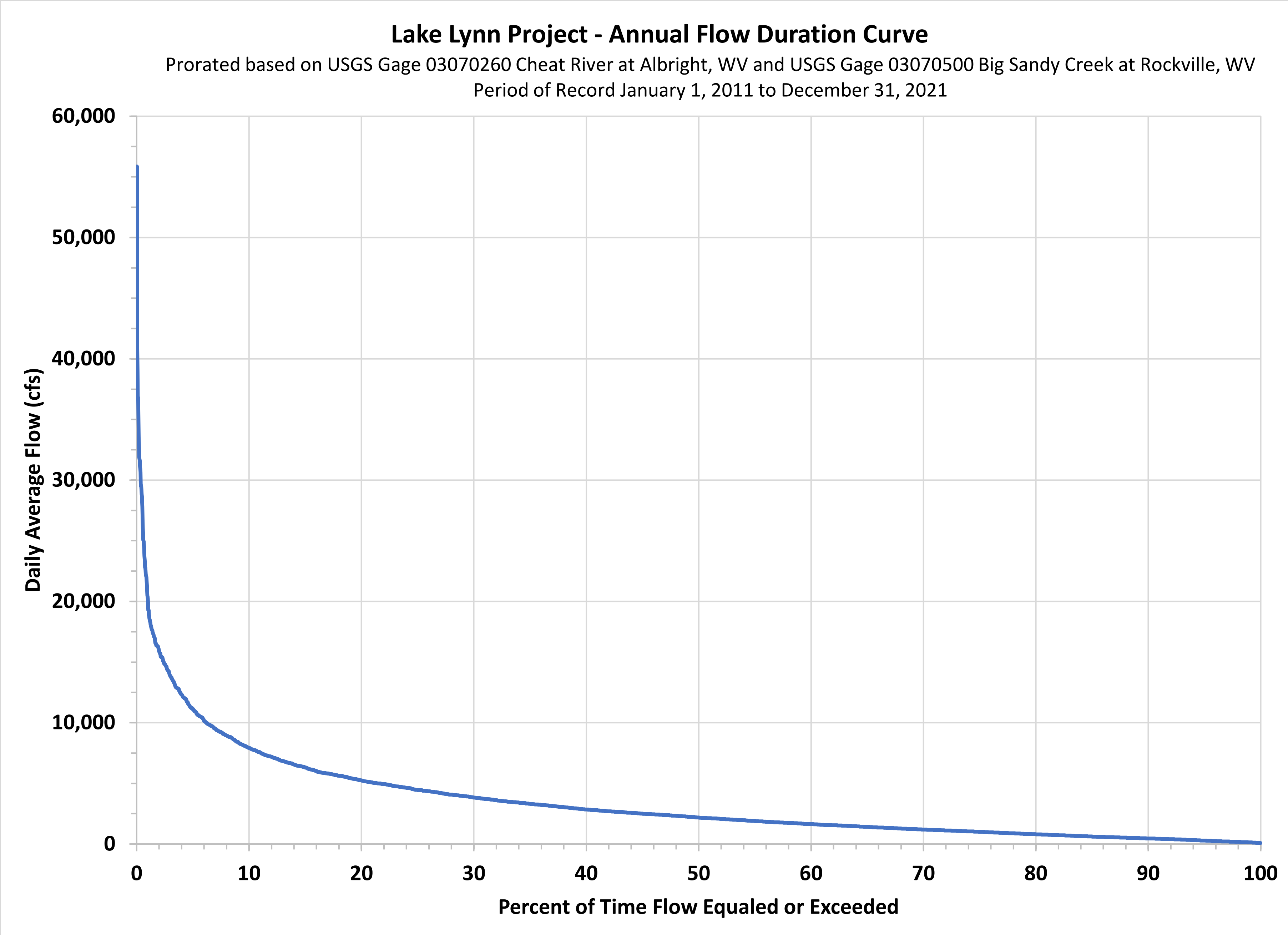
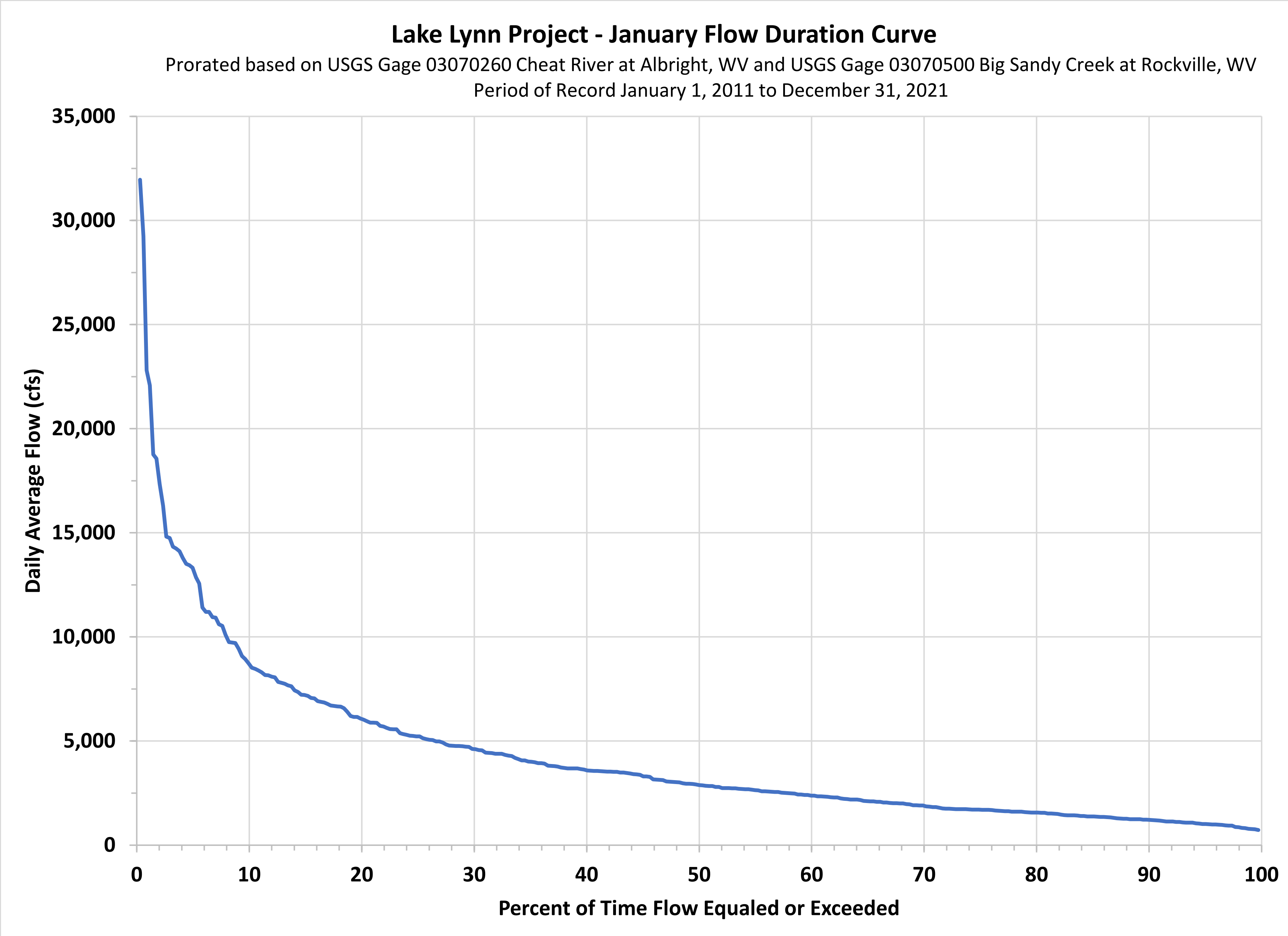
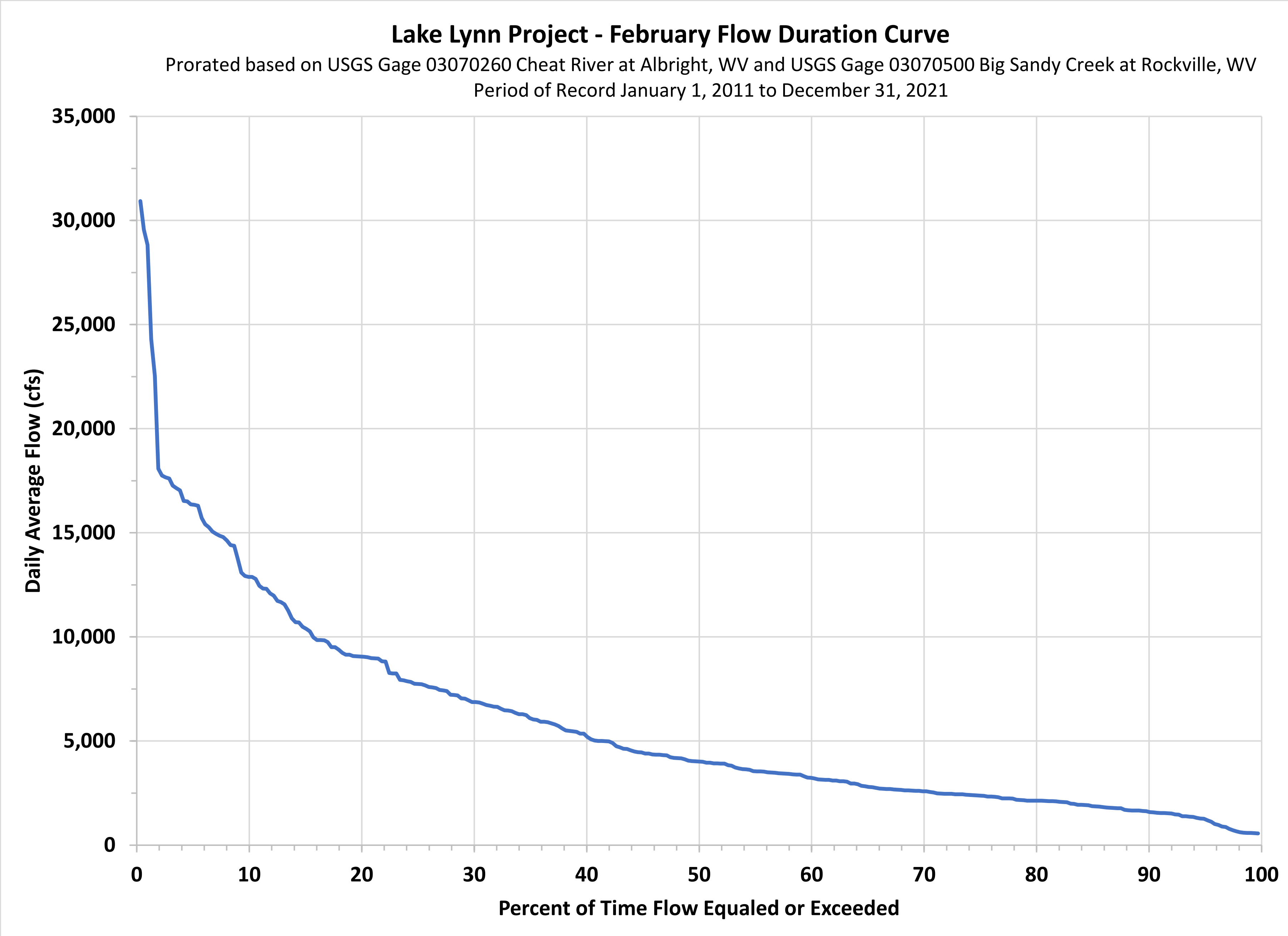
# APPENDIX C

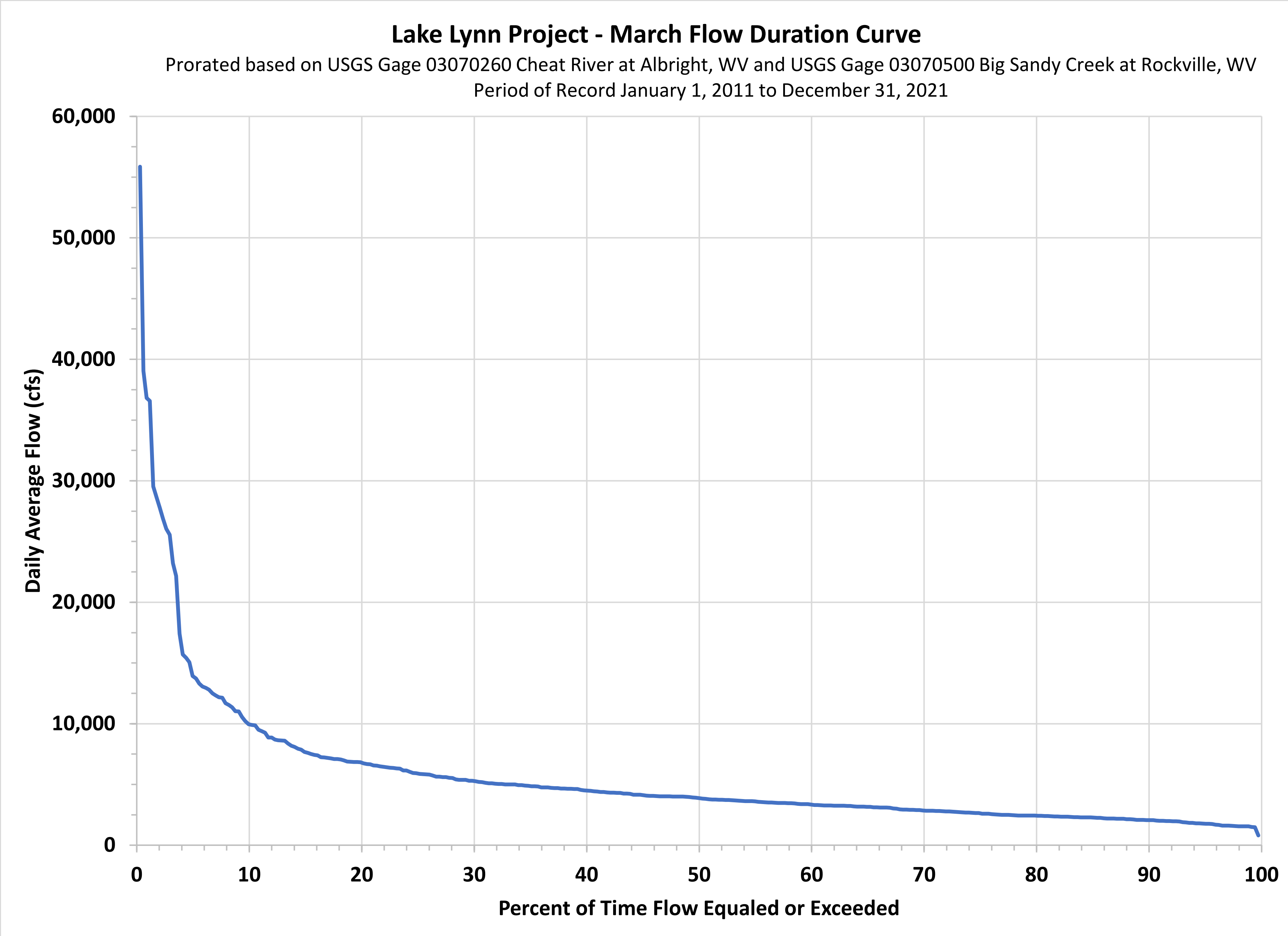
# FLOW DURATION CURVES


Lake Lynn Project - Annual Flow Duration Curve
Prorated based on USGS Gage 03070260 Cheat River at Albright, WV and USGS Gage 03070500 Big Sandy Creek at Rockville, WV
Period of Record January 1, 2011 to December 31, 2021
Daily Average Flow (cfs)
60,000
50,000
40,000
30,000
20,000
10,000
0
0
10
20
30
40
50
60
70
80
90
100
Percent of Time Flow Equaled or Exceeded

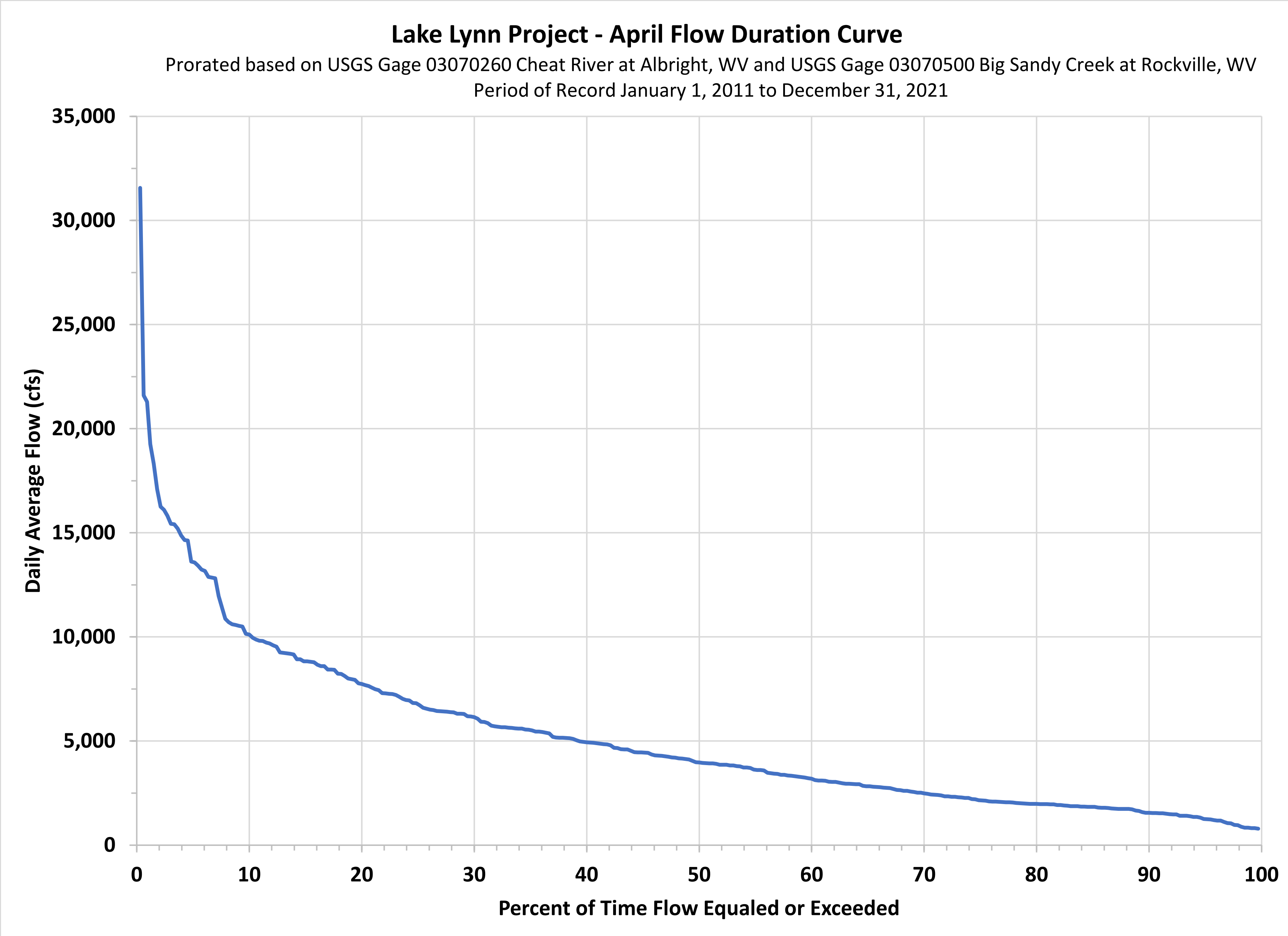


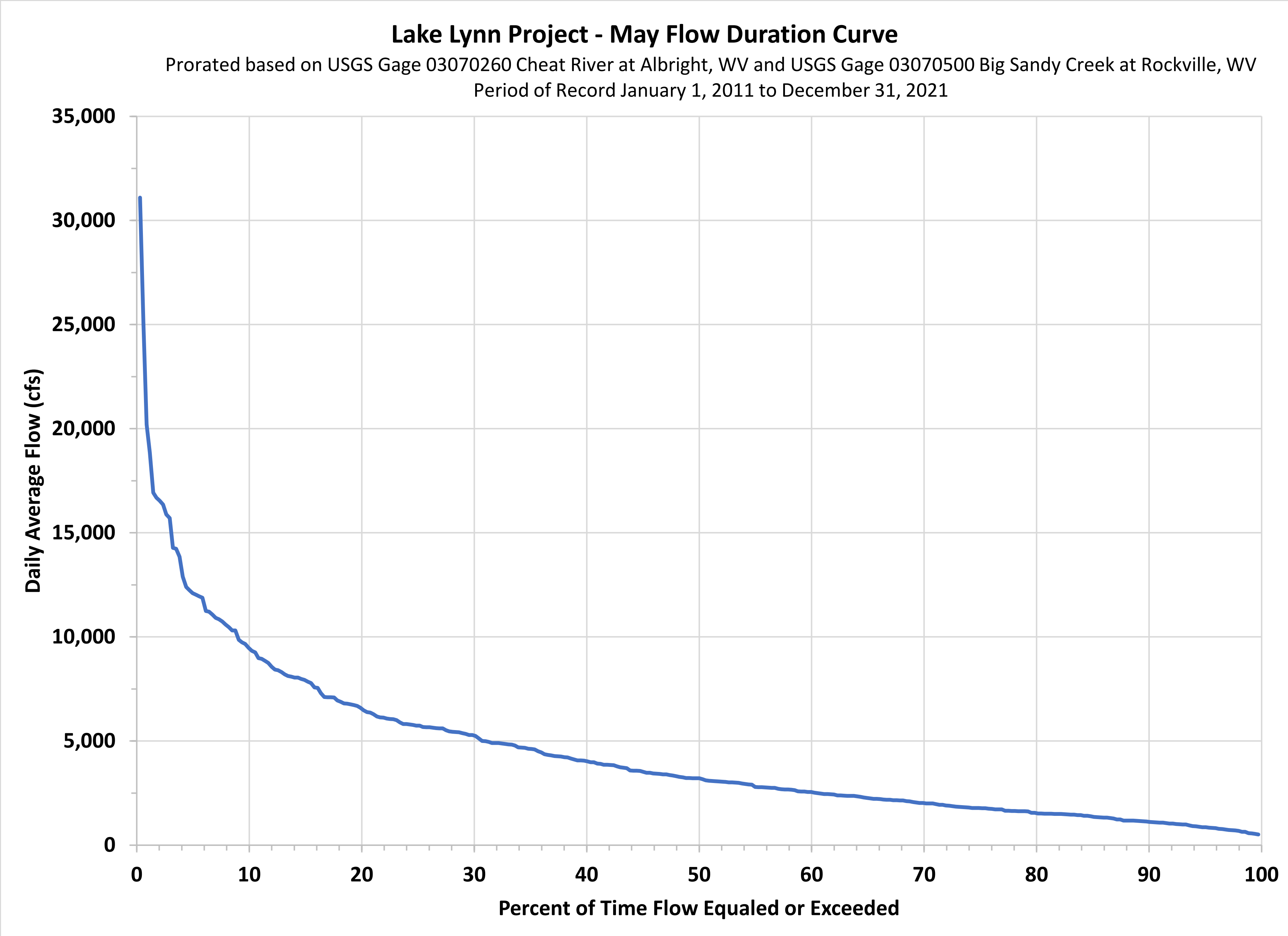
Lake Lynn Project - January Flow Duration Curve
Prorated based on USGS Gage 03070260 Cheat River at Albright, WV and USGS Gage 03070500 Big Sandy Creek at Rockville, WV
Period of Record January 1, 2011 to December 31, 2021
Daily Average Flow (cfs)
35,000
30,000
25,000
20,000
15,000
10,000
5,000
0
0
10
20
30
40
50
60
70
80
90
100
Percent of Time Flow Equaled or Exceeded

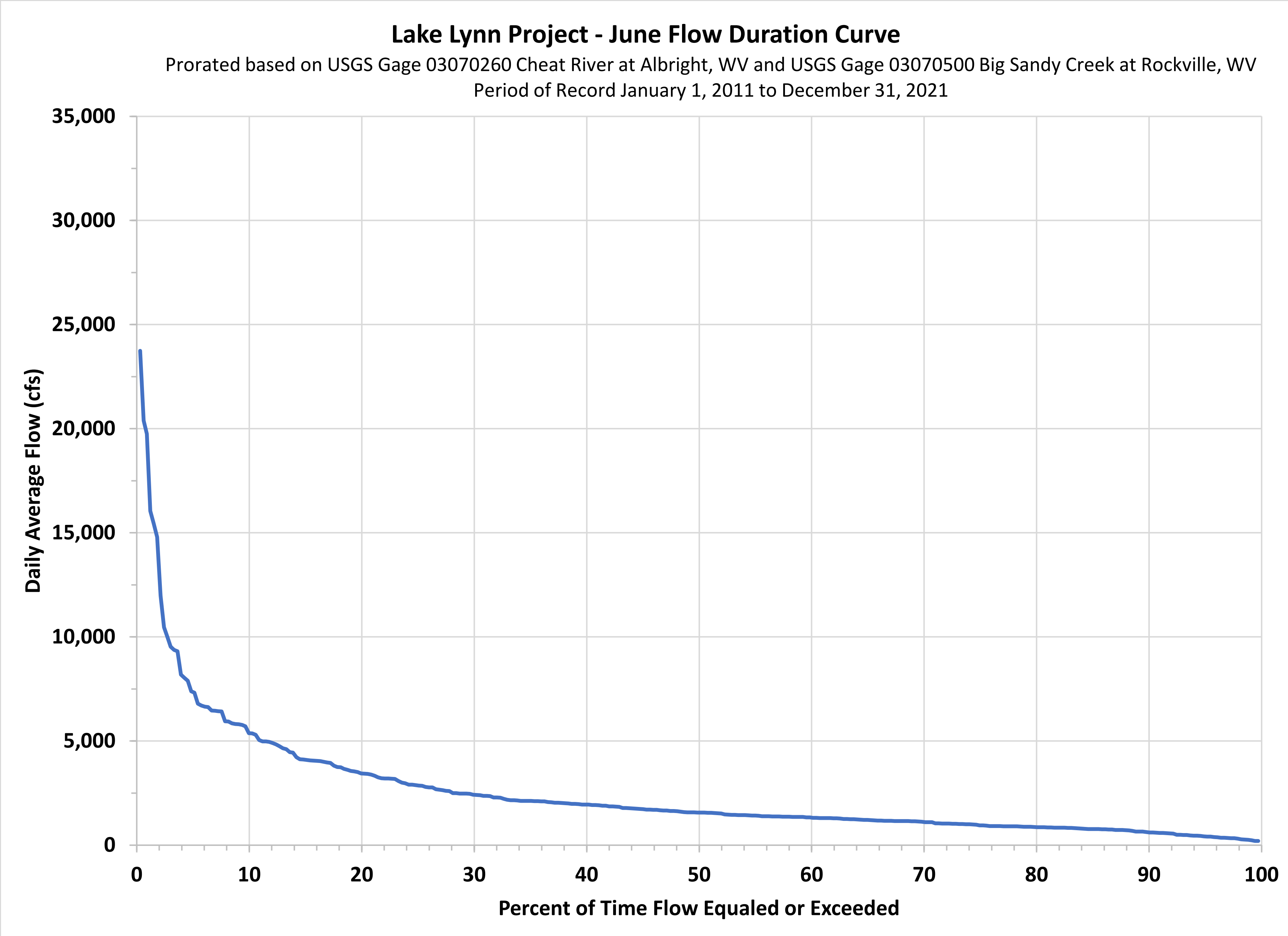

Lake Lynn Project - February Flow Duration Curve
Prorated based on USGS Gage 03070260 Cheat River at Albright, WV and USGS Gage 03070500 Big Sandy Creek at Rockville, WV
Period of Record January 1, 2011 to December 31, 2021
Daily Average Flow (cfs)
35,000
30,000
25,000
20,000
15,000
10,000
5,000
0
0
10
20
30
40
50
60
70
80
90
100
Percent of Time Flow Equaled or Exceeded

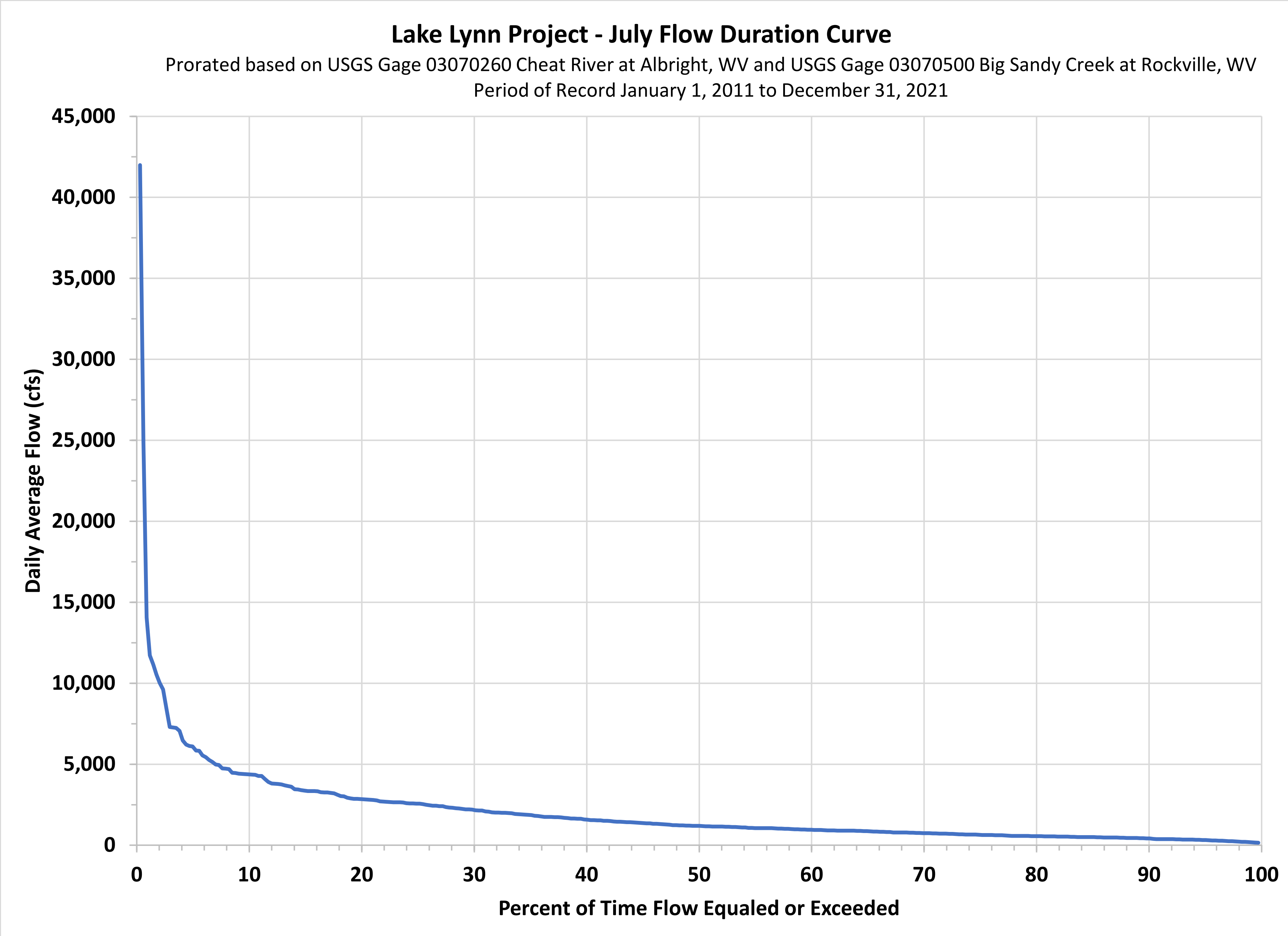


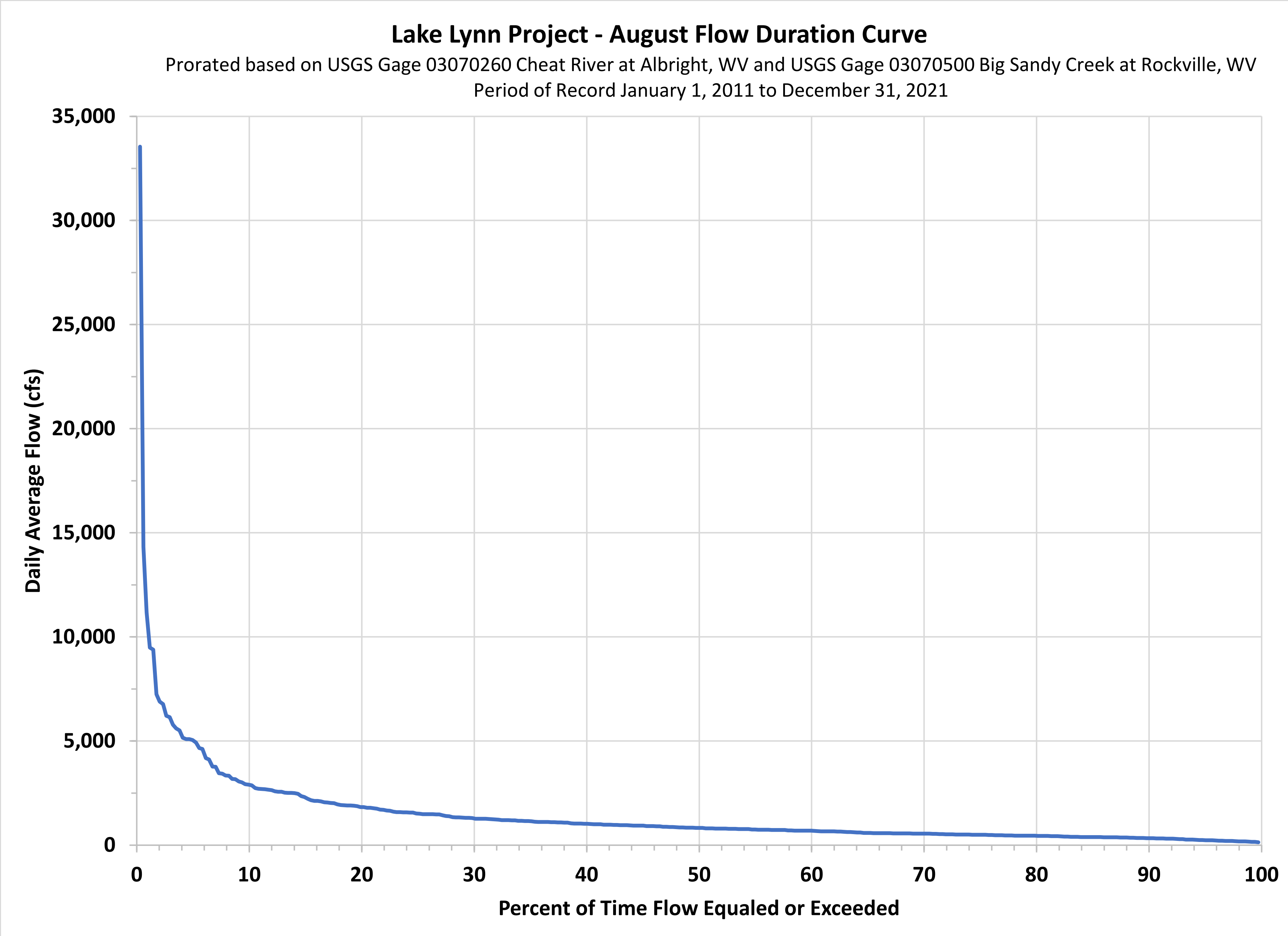
Lake Lynn Project - March Flow Duration Curve
Prorated based on USGS Gage 03070260 Cheat River at Albright, WV and USGS Gage 03070500 Big Sandy Creek at Rockville, WV
Period of Record January 1, 2011 to December 31, 2021
Daily Average Flow (cfs)
60,000
50,000
40,000
30,000
20,000
10,000
0
0
10
20
30
40
50
60
70
80
90
100
Percent of Time Flow Equaled or Exceeded

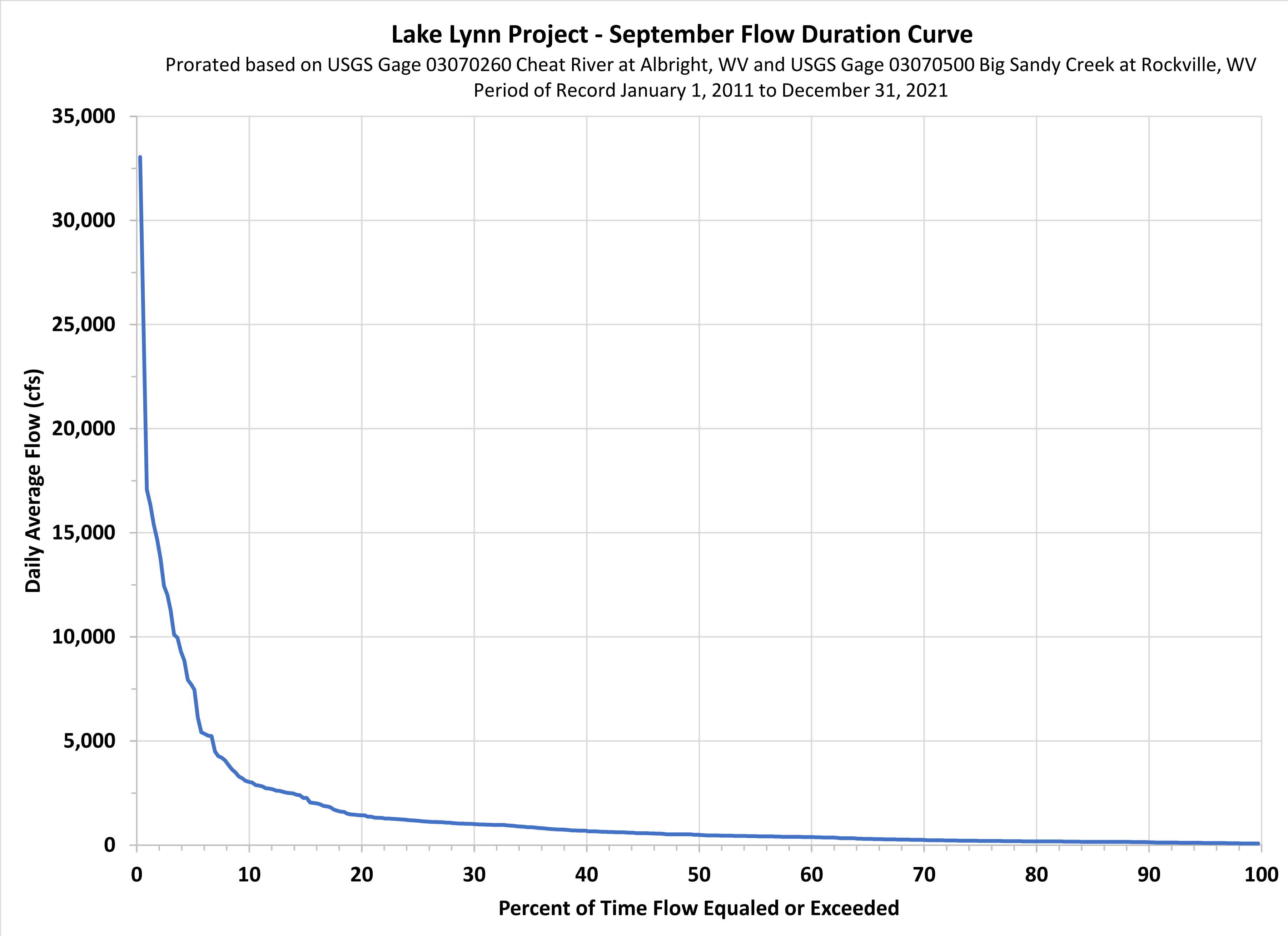

Lake Lynn Project - April Flow Duration Curve
Prorated based on USGS Gage 03070260 Cheat River at Albright, WV and USGS Gage 03070500 Big Sandy Creek at Rockville, WV
Period of Record January 1, 2011 to December 31, 2021
Daily Average Flow (cfs)
35,000
30,000
25,000
20,000
15,000
10,000
5,000
0
0
10
20
30
40
50
60
70
80
90
100
Percent of Time Flow Equaled or Exceeded

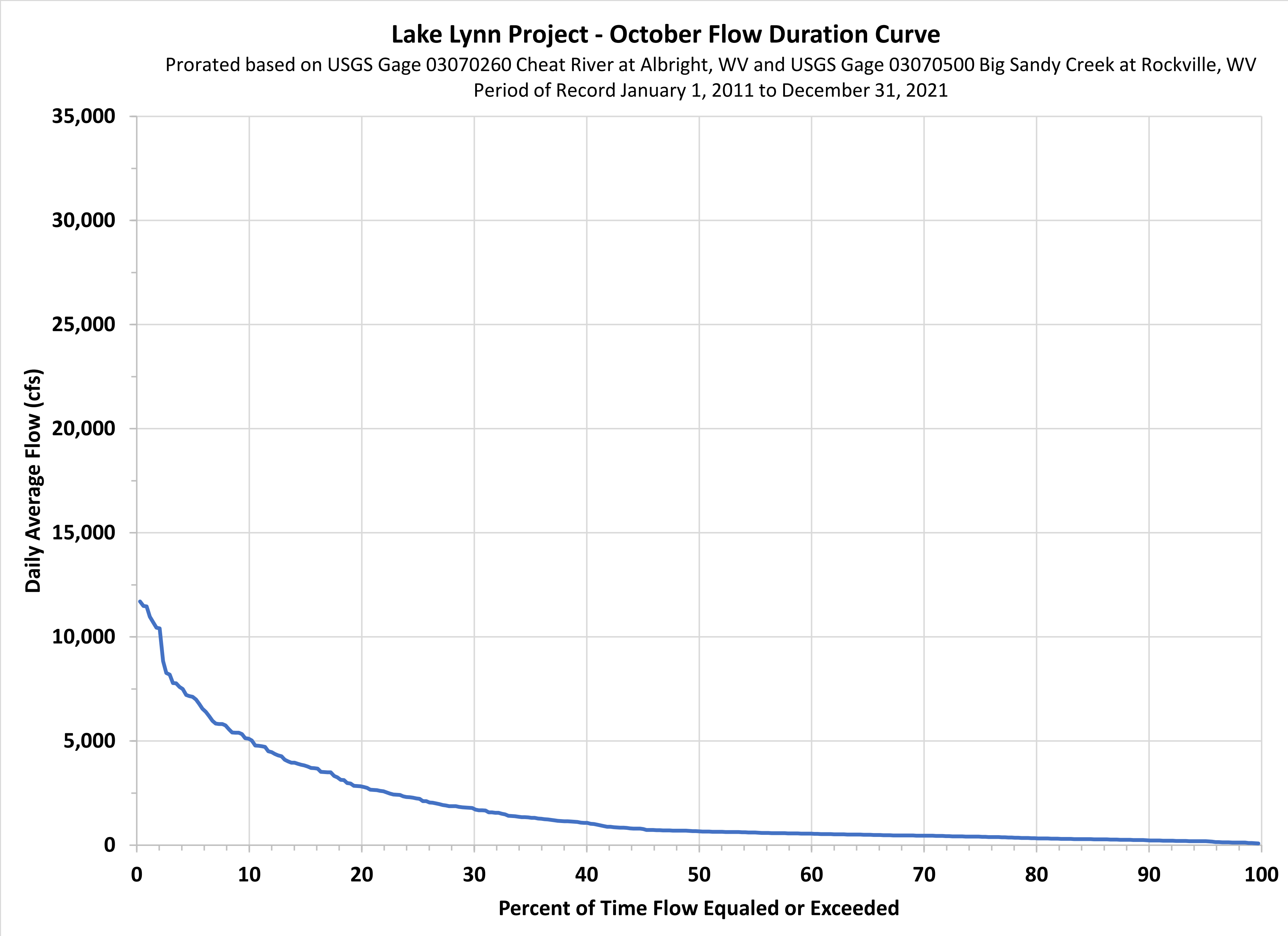

Lake Lynn Project - May Flow Duration Curve
Prorated based on USGS Gage 03070260 Cheat River at Albright, WV and USGS Gage 03070500 Big Sandy Creek at Rockville, WV
Period of Record January 1, 2011 to December 31, 2021
Daily Average Flow (cfs)
35,000
30,000
25,000
20,000
15,000
10,000
5,000
0
0
10
20
30
40
50
60
70
80
90
100
Percent of Time Flow Equaled or Exceeded

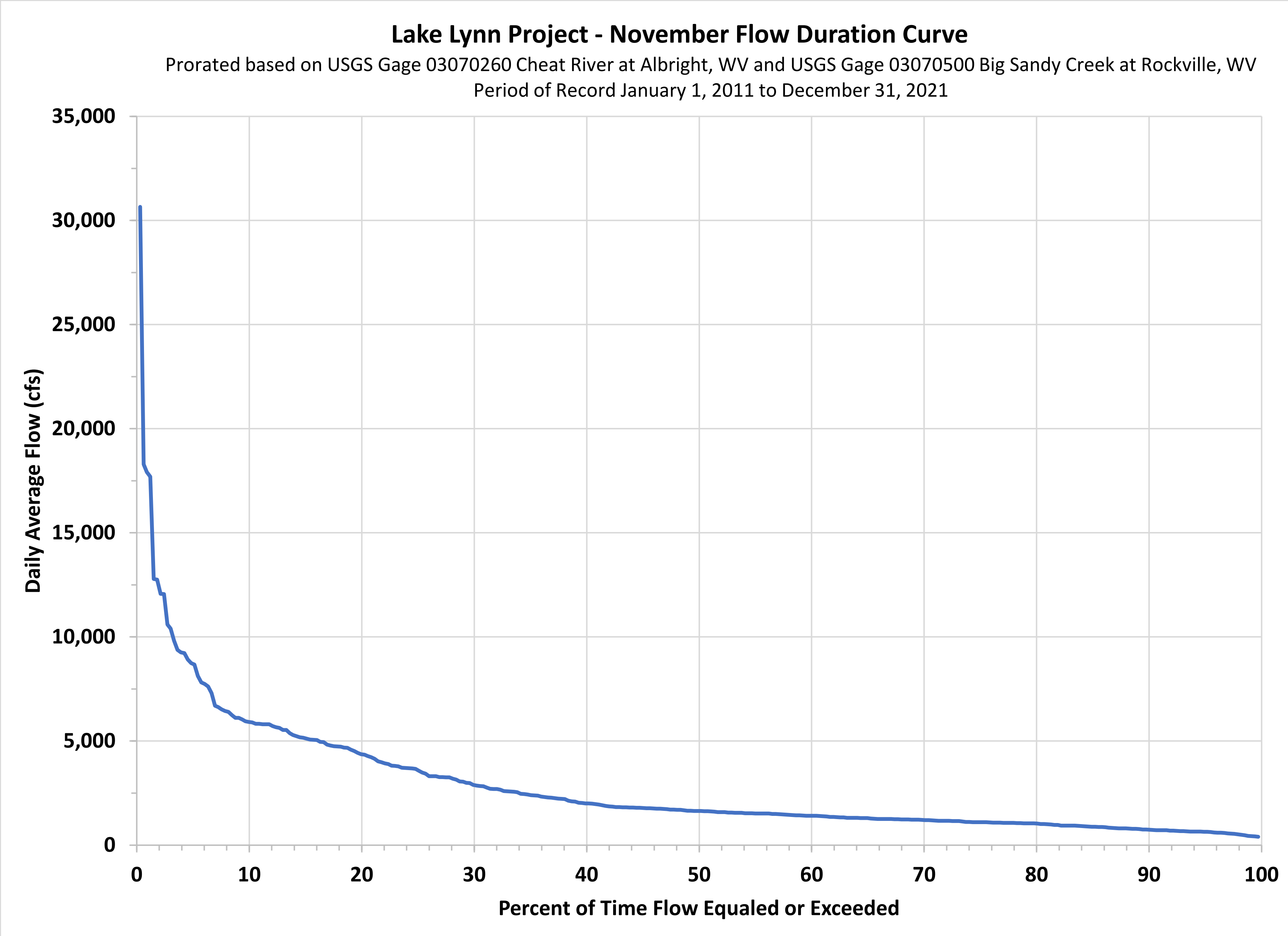

Lake Lynn Project - June Flow Duration Curve
Prorated based on USGS Gage 03070260 Cheat River at Albright, WV and USGS Gage 03070500 Big Sandy Creek at Rockville, WV
Period of Record January 1, 2011 to December 31, 2021
Daily Average Flow (cfs)
35,000
30,000
25,000
20,000
15,000
10,000
5,000
0
0
10
20
30
40
50
60
70
80
90
100
Percent of Time Flow Equaled or Exceeded

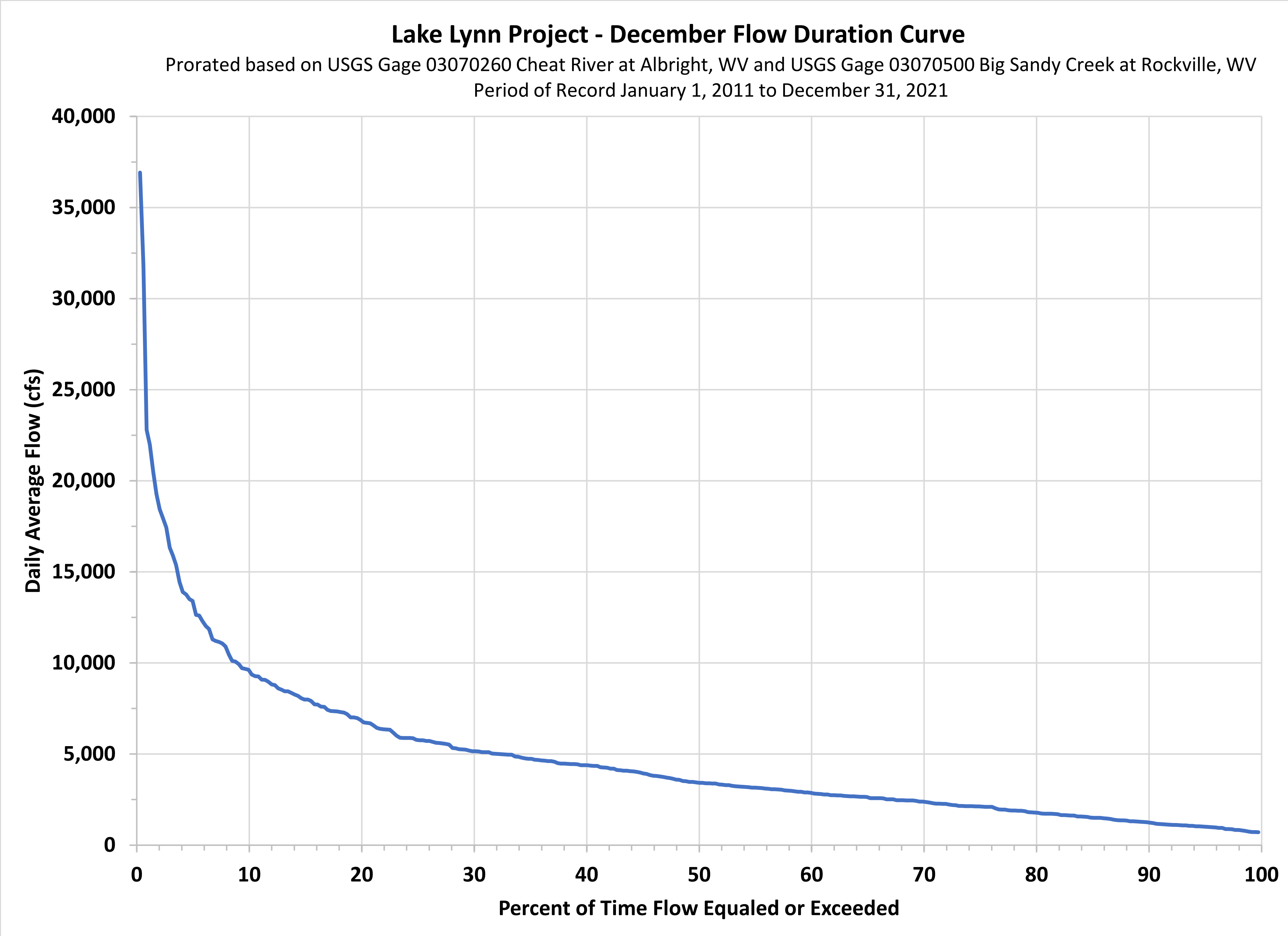

Lake Lynn Project - July Flow Duration Curve
Prorated based on USGS Gage 03070260 Cheat River at Albright, WV and USGS Gage 03070500 Big Sandy Creek at Rockville, WV
Period of Record January 1, 2011 to December 31, 2021
Daily Average Flow (cfs)
45,000
40,000
35,000
30,000
25,000
20,000
15,000
10,000
5,000
0
0
10
20
30
40
50
60
70
80
90
100
Percent of Time Flow Equaled or Exceeded


Lake Lynn Project - August Flow Duration Curve
Prorated based on USGS Gage 03070260 Cheat River at Albright, WV and USGS Gage 03070500 Big Sandy Creek at Rockville, WV
Period of Record January 1, 2011 to December 31, 2021
Daily Average Flow (cfs)
35,000
30,000
25,000
20,000
15,000
10,000
5,000
0
0
10
20
30
40
50
60
70
80
90
100
Percent of Time Flow Equaled or Exceeded


Lake Lynn Project - September Flow Duration Curve
Prorated based on USGS Gage 03070260 Cheat River at Albright, WV and USGS Gage 03070500 Big Sandy Creek at Rockville, WV
Period of Record January 1, 2011 to December 31, 2021
Daily Average Flow (cfs)
35,000
30,000
25,000
20,000
15,000
10,000
5,000
0
0
10
20
30
40
50
60
70
80
90
100
Percent of Time Flow Equaled or Exceeded


Lake Lynn Project - October Flow Duration Curve
Prorated based on USGS Gage 03070260 Cheat River at Albright, WV and USGS Gage 03070500 Big Sandy Creek at Rockville, WV
Period of Record January 1, 2011 to December 31, 2021
Daily Average Flow (cfs)
35,000
30,000
25,000
20,000
15,000
10,000
5,000
0
0
10
20
30
40
50
60
70
80
90
100
Percent of Time Flow Equaled or Exceeded


Lake Lynn Project - November Flow Duration Curve
Prorated based on USGS Gage 03070260 Cheat River at Albright, WV and USGS Gage 03070500 Big Sandy Creek at Rockville, WV
Period of Record January 1, 2011 to December 31, 2021
Daily Average Flow (cfs)
35,000
30,000
25,000
20,000
15,000
10,000
5,000
0
0
10
20
30
40
50
60
70
80
90
100
Percent of Time Flow Equaled or Exceeded


Lake Lynn Project - December Flow Duration Curve
Prorated based on USGS Gage 03070260 Cheat River at Albright, WV and USGS Gage 03070500 Big Sandy Creek at Rockville, WV
Period of Record January 1, 2011 to December 31, 2021
Daily Average Flow (cfs)
40,000
35,000
30,000
25,000
20,000
15,000
10,000
5,000
0
0
10
20
30
40
50
60
70
80
90
100
Percent of Time Flow Equaled or Exceeded

# APPENDIX D

# SPECIES LISTS

## Mammal Species that Potentially Occur in the Lake Lynn Project Vicinity

| Order | Family | Common Name | Scientific Name |
|---|---|---|---|
| Didelphimorphia | Didelphidae | Virginia opossum | *Didelphis virginiana* |
| Insectivora | Soricidae | long-tailed shrew | *Sorex dispar* |
| | | masked shrew | *Sorex cinereus* |
| | | northern short-tailed shrew | *Blarina brevicauda* |
| | | pygmy shrew | *Sorex hoyi* |
| | | smoky shrew | *Sorex fumeus* |
| | | southeastern shrew | *Sorex longirostris* |
| | Talpidae | eastern mole | *Scalopus aquaticus* |
| | | hairy-tailed mole | *Parascalops breweri* |
| | | star-nosed mole | *Condylura cristata* |
| Chiroptera | Vespertilionidae | big brown bat | *Eptesicus fuscus* |
| | | eastern pipistrelle | *Pipistrellus subflavus* |
| | | eastern red bat | *Lasiurus borealis* |
| | | hoary bat | *Lasiurus cinereus* |
| | | Indiana bat [1] | *Myotis sodalist* |
| | | northern long-eared bat [2] | *Myotis septentrionalis* |
| | | silver-haired bat | *Lasionycteris noctivagans* |
| | | Virginia big-eared bat [1] | *Corynorhinus townsendii* |
| Rodentia | Castoridae | American beaver | *Castor canadensis* |
| | Dipodidae | meadow jumping mouse | *Zapus hudsonius* |
| | | woodland jumping mouse | *Napaeozapus insignis* |
| | Erethizontidae | common porcupine | *Erethizon dorsatum* |
| | Muridae | Allegheny wood rat | *Neotoma magister* |
| | | black rat | *Rattus* |
| | | deer mouse | *Peromyscus maniculatus* |
| | | golden mouse | *Ochrotomys nuttalli* |
| | | house mouse | *Mus musculus* |
| | | meadow vole | *Microtus pennsylvanicus* |
| | | muskrat | *Ondatra zibethicus* |
| | | Norway rat | *Rattus norvegicus* |
| | | rock vole | *Microtus chrotorrhinus* |
| | | southern bog lemming | *Synaptomys cooperi* |
| | | southern red-backed vole | *Clethrionomys gapperi* |
| | | white-footed mouse | *Peromyscus leucopus* |

| Order | Family | Common Name | Scientific Name |
|---|---|---|---|
| | | woodland vole | *Microtus pinetorum* |
| Lagomorpha | Leporidae | Appalachian cottontail | *Sylvilagus obscurus* |
| | | eastern cottontail | *Sylvilagus floridana* |
| | | snowshoe hare | *Lepus americanus* |
| Carnivora | Canidae | coyote | *Canis latrans* |
| | | gray fox | *Urocyon cinereoargenteus* |
| | | red fox | *Vulpes* |
| | Felidae | bobcat | *Lynx rufus* |
| | Mephitidae | eastern spotted skunk | *Spilogale putorius* |
| | | striped skunk | *Mephitis* |
| | Mustelidae | fisher | *Martes pennant* |
| | | least weasel | *Mustela nivalis* |
| | | long-tailed weasel | *Mustela frenata* |
| | | mink | *Mustela vison* |
| | | fisher | *Martes pennant* |
| | | river otter | *Lutra canadensis* |
| Artiodactyla | Cervidae | white-tailed deer | *Odocoileus virginianus* |

Source: WVDNR 2001; WVDNR 2003; PGC 2019

[1]Federally Endangered

[2]Federally Threatened

**Amphibians and Reptiles that Potentially Occur in the Lake Lynn Project Vicinity**

| Family | Common Name | Scientific Name |
|---|---|---|
| Salamandridae | newt, red spotted | *Notophthalmus viridescens* |
| Ambystomatidae | salamander, Jefferson | *Ambystoma jeffersonianum* |
| | salamander, spotted | *Ambystoma maculatum* |
| | salamander, sarbled | *Ambystoma opacum* |
| Plethodontidae | salamander, green | *Aneides aeneus* |
| | salamander, northern dusky | *Desmognathus fuscus* |
| | salamander, seal | *Desmognathus monticola* |
| | salamander, Allegheny Mountain dusky | *Desmognathus ochrophaeus* |
| | salamander, northern spring | *Gyrinophilus porphyriticus* |
| | salamander, four-toed | *Hemidactylium scutatum* |
| | salamander, northern two-lined | *Eurycea bislineata* |
| | salamander, long-tailed | *Eurycea longicauda* |
| | salamander, eastern red-backed | *Plethodon cinereus* |
| | salamander, northern slimy | *Plethodon glutinosus* |
| | salamander, northern ravine | *Plethodon richmondi* |
| | salamander, Cheat Mountain[1] | *Plethodon nettingi* |
| | salamander, Wehrle's | *Plethodon wehrlei* |
| | salamander, northern red | *Pseudotriton r. ruber* |
| Bufonidae | toad, eastern american | *Bufo americanus* |
| | toad, fowler's | *Bufo fowleri* |
| Hylidae | peeper, northern spring | *Pseudacris crucifer* |
| | frog, mountain chorus | *Pseudacris brachyphona* |
| | treefrog, gray | *Hyla chrysoscelis* |
| Ranidae | bullfrog, American | *Rana catesbeiana* |
| | frog, northern green | *Rana clamitans melanota* |
| | frog, northern leopard | *Lithobates pipiens* |
| | frog, pickerel | *Rana palustris* |
| | frog, wood | *Rana sylvatica* |
| Chelydridae | turtle, common snapping | *Chelydra serpentine serpentina* |
| | turtle, eastern painted | *Chrysemys picta* |
| | turtle, northern map | *Graptemys geographica* |
| | turtle, eastern box | *Terrapene carolina* |
| Kinosternidae | turtle, common musk | *Kinosternon odoratus* |
| Phrynosomatidae | lizard, northern fence | *Sceloporus undulatus* |

| Family | Common Name | Scientific Name |
|---|---|---|
| Scincidae | skink, common five-lined | *Eumeces fasciatus* |
| Colubridae | racer, northern black | *Coluber constrictor* |
| | snake, northern ringneck | *Diadophis punctatus edwardsii* |
| | ratsnake, black | *Elaphe obsoleta* |
| | snake, eastern hognose | *Heterodon platirhinos* |
| | snake, eastern milk | *Lampropeltis Triangulum* |
| | snake, northern water | *Nerodia sipedon* |
| | snake, smooth green | *Opheodrys vernalis* |
| | snake, queen | *Regina septemvittata* |
| | snake, northern red-bellied | *Storeria o. occipitomaculata* |
| | gartersnake, eastern | *Thamnophis sirtalis* |
| Viperidae | copperhead, northern | *Agkistrodon contortrix* |
| | rattlesnake, timber | *Crotalus horridus* |

Source: Marshall 2019

[1]Federally Threatened

**Bird Species that Potentially Occur in the Lake Lynn Project Vicinity**

| Family | Common Name | Scientific Name |
|---|---|---|
| Gaviidae | loon, common | *Gavia immer* |
| | loon, red-throated | *Gavia stellata* |
| Podicipedidae | grebe, horned | *Podiceps auritus* |
| | grebe, pied-billed | *Podilymbus podiceps* |
| Pelecanidae | pelican, American white | *Pelecanus erythrorhynchos* |
| Phalacrocoracidae | cormorant, double-crested | *Phalacrocorax auritus* |
| Ardeidae | heron, great blue | *Ardea herodias* |
| | heron, green | *Butorides virescens* |
| | egret, cattle | *Bubulcus ibis* |
| | egret, great | *Ardea alba egretta* |
| | bittern, American | *Botaurus lentiginosus* |
| | bittern, least | *Ixobrychus exilis* |
| | swan, mute | *Cygnus olor* |
| | night-heron, black-crowned | *Nycticorax hoactii* |
| Anatidae | goose, Canada | *Branta canadensis* |
| | mallard | *Anas platyrhynchos* |
| | gadwall | *Anas strepera* |
| | pintail, northern | *Anas acuta* |
| | teal, green-winged | *Anas crecca carolinensis* |
| | teal, blue-winged | *Anas discors orphna* |
| | wigeon, American | *Anas americana* |
| | shoveler, northern | *Anas clypeata* |
| | duck, American black | *Anas rubripes* |
| | duck, wood | *Aix sponsa* |
| | canvasback | *Aythya valisineria* |
| | redhead | *Aythya americana* |
| | duck, ring-necked | *Aythya collaris* |
| | scaup, lesser | *Aythya affinis* |
| | goldeneye, common | *Bucephala clangula* |
| | bufflehead | *Bucephala albeola* |
| | merganser, common | *Mergus merganser* |
| | merganser, hooded | *Lophodytes cucullatus* |
| | duck, ruddy | *Oxyura jamaicensis* |
| Cathartidae | vulture, turkey | *Cathartes aura* |
| | vulture, black | *Coragyps atratus* |

| Family | Common Name | Scientific Name |
|---|---|---|
| | osprey | *Pandion haliaetus* |
| Accipitridae | harrier, northern | *Circus cyaneus* |
| | hawk, sharp-shinned | *Accipiter striatus velox* |
| | hawk, Cooper's | *Accipiter cooperii* |
| | goshawk, northern | *Accipiter gentilis* |
| | hawk, red-tailed | *Buteo jamaicensis* |
| | hawk, red-shouldered | *Buteo lineatus* |
| | hawk, broad-winged | *Buteo platypterus* |
| | hawk, rough-legged | *Buteo lagopus johannis* |
| | eagle, bald | *Haliaeetus leucocephalus* |
| | eagle, golden | *Aquila chrysaetos* |
| Falconidae | falcon, peregrine | *Falco peregrinus* |
| | kestrel, American | *Falco sparverius* |
| | merlin | *Falco columbarius* |
| Phasianidae | grouse, ruffed | *Bonasa umbellus* |
| | pheasant, ring-necked | *Phasianus colchicus* |
| | turkey, wild | *Meleagris gallopavo silvestris* |
| Odontophoridae | bobwhite, northern | *Colinus virginianus* |
| Rallidae | gallinule, common | *Gallinula galeata* |
| | coot, American | *Fulica americana* |
| | rail, Virginia | *Rallus limicola* |
| | sora | *Porzana carolina* |
| | moorhen, common | *Gallinula chloropus cachinnans* |
| Charadriidae | plover, semipalmated | *Charadrius semipalmatus* |
| | killdeer | *Charadrius vociferus* |
| Scolopacidae | yellowlegs, greater | *Tringa melanoleuca* |
| | yellowlegs, lesser | *Tringa flavipes* |
| | sandpiper, upland | *Bartramia longicauda* |
| | sandpiper, solitary | *Tringa solitaria* |
| | sandpiper, spotted | *Actitis macularia* |
| | sandpiper, semipalmated | *Calidris pusilla* |
| | sandpiper, least | *Calidris minutilla* |
| | sandpiper, pectoral | *Calidris melanotos* |
| | sandpiper, white-rumped | *Calidris fuscicollis* |
| | dunlin | *Calidris alpina* |
| | snipe, Wilson’s | *Gallinago delicata* |

| Family | Common Name | Scientific Name |
|---|---|---|
| | woodcock, American | *Scalopax minor* |
| Laridae | gull, Bonaparte's | *Chroicocephalus philidelphia* |
| | gull, ring-billed | *Larus delawarensis* |
| | gull, Herrington | *Larus argentatus* |
| Columbidae | pigeon, rock | *Columba livia* |
| | dove, mourning | *Zenaida macroura* |
| Cuculidae | cuckoo, yellow-billed | *Coccyzus americanus* |
| | cuckoo, black-billed | *Coccyzus erythropthalmus* |
| Tytonidae | owl, barn | *Tyto alba* |
| Strigidae | owl, long-eared | *Asio otus* |
| | owl, short-eared | *Asio flammeus* |
| | owl, great Horned | *Bubo virginianus* |
| | owl, barred | *Strix varia* |
| | owl, northern saw-whet | *Aegolius acadicus* |
| | screech-owl, eastern | *Megascops asio* |
| Caprimulgidae | whip-poor-will, eastern | *Antrostomus vociferus* |
| | nighthawk, common | *Chordeiles minor* |
| Apodidae | swift, chimney | *Chaetura pelagica* |
| Trochilidae | hummingbird, ruby-throated | *Archilochus colubris* |
| Alcedinidae | kingfisher, belted | *Megaceryle alcyon* |
| Picidae | woodpecker, red-headed | *Melanerpes erythrocephalus* |
| | woodpecker, red-bellied | *Melanerpes carolinus* |
| | sapsucker, yellow-bellied | *Sphyrapicus varius* |
| | woodpecker, downy | *Picoides pubescens* |
| | woodpecker, hairy | *Picoides villosus* |
| | flicker, northern | *Colaptes auratus* |
| | woodpecker, pileated | *Dryocopus pileatus* |
| Tyrannidae | flycatcher, olive-sided | *Contopus cooperi* |
| | wood-pewee, eastern | *Contopus virens* |
| | flycatcher, yellow-bellied | *Empidonax flaviventris* |
| | flycatcher, Acadian | *Empidonax virescens* |
| | flycatcher, willow | *Empidonax traillii* |
| | flycatcher, alder | *Empidonax alnorum* |
| | flycatcher, least | *Empidonax minimus* |
| | phoebe, eastern | *Sayornis phoebe* |
| | flycatcher, great crested | *Myiarchus crinitus* |

| Family | Common Name | Scientific Name |
|---|---|---|
| | kingbird, eastern | *Tyrannus* |
| Laniidae | shrike, loggerhead | *Lanius ludovicianus* |
| | shrike, northern | *Lanius excubitor* |
| Vireonidae | vireo, white-eyed | *Vireo griseus* |
| | vireo, blue-headed | *Vireo solitarius* |
| | vireo, yellow-throated | *Vireo flavifrons* |
| | vireo, warbling | *Vireo gilvus* |
| | vireo, Philadelphia | *Vireo philadelphicus* |
| | vireo, red-eyed | *Vireo olivaceus* |
| Corvidae | jay, blue | *Cyanocitta cristata* |
| | raven, common | *Corvus corax* |
| | crow, American | *Corvus brachyrhynchos* |
| | crow, fish | *Corvus ossifragus* |
| Alaudidae | lark, horned | *Eremophilla alpestris* |
| Hirundinidae | martin, purple | *Progne subis* |
| | swallow, tree | *Tachycineta bicolor* |
| | swallow, bank | *Tachycineta thalassina* |
| | swallow, rough-winged | *Stelgidopteryx serripennis* |
| | swallow, cliff | *Petrochelidon pyrrhonota* |
| | swallow, barn | *Hirundo rustica* |
| Paridae | chickadee, Carolina | *Poecile carolinensis* |
| | chickadee, black-capped | *Poecile atricapillus* |
| | titmouse, tufted | *Baeolophus bicolor* |
| Sittidae | nuthatch, red-breasted | *Sitta canadensis* |
| | nuthatch, white-breasted | *Sitta carolinensis* |
| Certhiidae | creeper, brown | *Certhia americana* |
| Troglodytidae | wren, Carolina | *Thryotherus ludovicianus* |
| | wren, house | *Troglodytes aedon* |
| | wren, winter | *Troglodytes hiemalis* |
| | wren, marsh | *Cistothorus palustris* |
| Regulidae | kinglet, golden-crowned | *Regulus satrapa* |
| | kinglet, ruby-crowned | *Regulus calendula* |
| Sylviidae | gnatcatcher, blue-gray | *Polioptila caerulea* |
| Turdidae | bluebird, eastern | *Sialia sialis* |
| | veery | *Catharus fuscescens* |
| | thrush, gray-cheeked | *Catharus minimus* |

| Family | Common Name | Scientific Name |
|---|---|---|
| | thrush, Swainson's | *Catharus ustulatus* |
| | thrush, hermit | *Catharus guttatus* |
| | thrush, wood | *Hylocichla mustelina* |
| | robin, American | *Turdus migratorius* |
| Mimidae | catbird, gray | *Dumetella carolinensis* |
| | mockingbird, northern | *Mimus polyglottos* |
| | thrasher, brown | *Toxostoma rufum* |
| Sturnidae | starling, european | *Sturnus vulgaris* |
| Motacillidae | pipit, American | *Anthus rubescens* |
| Bombycillidae | waxwing, Bohemian | *Bombycilla garrulus* |
| | waxwing, cedar | *Bombycilla cedrorum* |
| Calcariidae | longspur, lapland | *Calcarius lapponicus* |
| | bunting, snow | *Plectrophenax nivalis* |
| Parulidae | ovenbird | *Seiurus aurocapilla* |
| | warbler, worm-eating | *Helmitheros vermivorum* |
| | waterthrush, Louisiana | *Parkesia motacilla* |
| | waterthrush, northern | *Parkesia noveboracensis* |
| | warbler, black-and-white | *Mniotilta varia* |
| | warbler, golden-winged | *Vermivora chrysoptera* |
| | warbler, blue-winged | *Vermivora cyanoptera* |
| | warbler, orange-crowned | *Oreothlypis celata* |
| | warbler, Tennessee | *Oreothlypis peregrina* |
| | warbler, Nashville | *Oreothlypis ruficapilla* |
| | warbler, Connecticut | *Oporornis agilis* |
| | warbler, Kentucky | *Geothlypis, Formosa* |
| | warbler, mourning | *Geothlypis philadelphia* |
| | yellowthroat, common | *Geothlypis trichas* |
| | warbler, hooded | *Setophaga citrina* |
| | redstart, American | *Seophaga ruticilla* |
| | warbler, Cape May | *Setophaha tigrina* |
| | warbler, cerulean | *Setophaga cerulea* |
| | parula, northern | *Setophaga americana* |
| | warbler, magnolia | *Setophaga magnolia* |
| | warbler, blackburnian | *Setophaga fusca* |
| | warbler, yellow | *Setophaga petechia* |
| | warbler, chestnut-sided | *Setophaga pensylvanica* |

| Family | Common Name | Scientific Name |
|---|---|---|
| | warbler, black-throated blue | *Setophaga caerulescens* |
| | warbler, blackpoll | *Setophaga striata* |
| | warbler, bay-breasted | *Setophaga castanea* |
| | warbler, pine | *Setophaga pinus* |
| | warbler, prairie | *Setophaga discolor* |
| | warbler, palm | *Setophaga palmarum* |
| | warbler, yellow-throated | *Setophaga dominica* |
| | warbler, yellow-rumped | *Setophaga coronata* |
| | warbler, black-throated green | *Setophaga virens* |
| | warbler, Wilson's | *Cardellina pusilla* |
| | warbler, Canada | *Cardellina canadensis* |
| | chat, yellow-breasted | *Icteria virens* |
| Emberizidae | towhee, eastern | *Pipilo erythrophthalmus* |
| | sparrow, American tree | *Spizella arborea* |
| | sparrow, field | *Spizella pussila* |
| | sparrow, chipping | *Spizella passerina* |
| | sparrow, Savannah | *Passerculus sandwichensis* |
| | sparrow, vesper | *Pooecetes gramineus* |
| | sparrow, grasshopper | *Ammodramus savannarum* |
| | sparrow, Henslow's | *Ammodramus henslowii* |
| | sparrow, fox | *Passerella iliaca* |
| | sparrow, song | *Melospiza melodia* |
| | sparrow, Lincoln's | *Melospiza lincolnii* |
| | sparrow, swamp | *Melospiza georgiana* |
| | junco, dark-eyed | *Junco hyemalis* |
| | sparrow, white-crowned | *Zonotrichia leucophrys* |
| | sparrow, white-throated | *Zonotrichia albicollis* |
| Cardinalidae | tanager, summer | *Piranga rubra* |
| | tanager, scarlet | *Piranga olivacea* |
| | cardinal, northern | *Cardinalis* |
| | grosbeak, rose-breasted | *Pheucticus ludovicianus* |
| | bunting, indigo | *Passerina cyanea* |
| Icteridae | blackbird, rusty | *Euphagus carolinus* |
| | grackle, common | *Quiscalus quiscula* |
| | blackbird, red-winged | *Agelaius phoeniceus* |
| | cowbird, brown-headed | *Molothrus ater* |

| Family | Common Name | Scientific Name |
| --- | --- | --- |
| | bobolink | *Dolichonyx oryzivorus* |
| | meadowlark, eastern | *Sturnella magna* |
| | oriole, orchard | *Icterus spurius* |
| | oriole, Baltimore | *Icterus galbula* |
| Fringillidae | finch, purple | *Haemorhous purpureus* |
| | finch, house | *Haemorhous mexicanus* |
| | crossbill, red | *Loxia curvirostra* |
| | redpoll, common | *Acanthis flammea* |
| | siskin, pine | *Spinus pinus* |
| | goldfinch, American | *Spinus tristis* |
| Passeridae | sparrow, house | *Passer domesticus* |

Source: BBC 2014, Sibley 2014

## Botanical Species that Potentially Occur in the Lake Lynn Project Vicinity

| Common Name | Scientific Name | Common Name | Scientific Name |
|---|---|---|---|
| sugar maple | *Acer saccharum* | Clayton's sweetroot | *Osmorhiza claytonii* |
| black cohosh | *Actaea racemosa* | shortleaf pine | *Pinus echinata* |
| yellow buckeye | *Aesculus flava* | eastern white pine | *Pinus strobus* |
| yellow birch | *Betula alleghaniensis* | Virginia pine | *Pinus virginiana* |
| sweet birch | *Betula lenta* | black cherry | *Prunus serotina* |
| mockernut hickory | *Carya alba* | white oak | *Quercus alba* |
| bitternut hickory | *Carya cordiformis* | swamp white oak | *Quercus bicolor* |
| pignut hickory | *Carya glabra* | scarlet oak | *Quercus coccinea* |
| blue cohosh | *Caulophyllum thalictroides* | southern red oak | *Quercus falcata* |
| American beech | *Fagus grandifolia* | swamp chestnut oak | *Quercus prinus* |
| white ash | *Fraxinua americana* | northern red oak | *Quercus rubra* |
| mountain silverbell | *Halesia tetraptera* | northern red oak | *Quercus rubra* |
| black walnut | *Juglans nigra* | black oak | *Quercus velutina* |
| Canadian woodnettle | *Laportea canadensis* | bloodroot | *Sanguinaria canadensis* |
| yellow poplar | *Liriodendron tulipifera* | American basswood | *Tilia americana* |
| cucumber tree | *Magnolia acuminata* | eastern hemlock | *Tsuga canadensis* |
| mountain magnolia | *Magnolia fraseri* | Canadian white violet | *Viola canadensis* |
| blackgum | *Nyssa sylvatica* | | |

Source: NatureServe, 2009

# APPENDIX E

# STUDY REPORTS

# Desktop Fish Entrainment Assessment

## Lake Lynn Hydroelectric Project (FERC No. 2459)

**Prepared For**
Lake Lynn Generation, LLC
2 Bethesda Metro Center, Suite 1330
Bethesda, MD 20814

**Prepared By**
Normandeau Associates, Inc.
25 Nashua Rd
Bedford, NH, 03110
(603) 472-5191
www.normandeau.com

NORMANDEAU ASSOCIATES
ENVIRONMENTAL CONSULTANTS

**November 2022**

# Table of Contents

## List of Tables

## List of Figures

# 1 Introduction

Lake Lynn Hydro, LLC (Lake Lynn or Licensee) is in the process of relicensing the 51.2-megawatt (MW) Lake Lynn Hydroelectric Project (Project) (FERC No. 2459) with the Federal Energy Regulatory Commission (FERC or Commission). The Project is located on the Cheat River in Monongalia County, West Virginia and Fayette County, Pennsylvania. The current license for the Project expires November 30, 2024.

In an August 29, 2019 filing, the licensee submitted their Pre-Application Document (PAD), and their Notice of Intent (NOI) to seek a new license for the Project. In the same filing, the licensee also requested to use FERC's Traditional Licensing Process (TLP). The Licensee distributed the PAD and NOI simultaneously to Federal and state resource agencies, local governments, Native American tribes, members of the public, and others thought to be interested in the relicensing proceeding. In October 2019, FERC approved the use of the TLP. Following approval, Lake Lynn held a Joint Agency Meeting and site visit in December 2019. Following the Joint Meeting and Site Visit, resource agencies and other stakeholders were afforded the opportunity to comment on the PAD and to request resource studies that they deemed were needed to evaluate Project impacts on natural, cultural and recreational resources.

In response to the NOI/PAD filing and the Joint Meeting and Site Visit, Lake Lynn received written comments and study requests from the U.S. Fish and Wildlife Service (USFWS), West Virginia Division of Natural Resources (WVDNR), Cheat Lake Environment and Recreation Association (CLEAR), Friends of the Cheat (FOC), Monongahela River Trails Conservancy (MRTC), and individual residents in the local community.

Based on the comments received, Lake Lynn developed and distributed a draft Study Plan to the resource agencies and stakeholders on April 15, 2020 for review. Lake Lynn held a conference call/meeting on April 24, 2020 to review and discuss the draft Study Plan. The draft Study Plan has been revised based on the discussions and a Revised Study Plan (RSP) was issued in May 2020. As Lake Lynn is utilizing the TLP, there is no requirement to prepare a formal study plan document as is required in the Integrated Licensing Protocol (ILP), and therefore, there is no subsequent study plan determination by FERC. Nonetheless, Lake Lynn prepared the RSP distributed in May 2020 to document and share with resource agencies and stakeholders its plans for conducting resource studies and ongoing monitoring efforts in 2020 to inform the relicensing process.

This report was prepared on behalf of Lake Lynn to address the Desktop Fish Entrainment Assessment detailed in Section 3.1 of the RSP. The Desktop Fish Entrainment Assessment was requested by the USFWS and WVDNR to estimate the number of fish that are either entrained or impinged by Project operation and the associated rate of injury and mortality for fish that pass through the turbines during Project operation.

## 2 Study Objectives and Scope

The objective of this study was to conduct a desktop assessment of the potential for impingement/entrainment of selected target fish species at Lake Lynn, and to prepare a quantitative desktop estimate of the numbers of fish entrained at the Project. This Desktop Fish Entrainment Assessment provides the following:

- A description of the Project reservoir, intake structure, turbine units, and seasonal operational regime;
- A summary of available fisheries information historically collected in the Cheat River upstream of the Project;
- An overview of the life history and habitat requirements for target fish species;
- An assessment of impingement and entrainment potential as a function of (1) the existing rack spacing, (2) calculated approach velocities, (3) the physical dimensions of target fish species, and (4) the swim capabilities (i.e., burst speed) of target fish species;
- A review of information contained in the 1997 Electric Power Research Institute (EPRI) database to provide a summary of (1) the size class composition of target fish species, (2) entrainment densities of target fish species, and (3) calculated survival rates of target species for the subset of hydroelectric projects comparable to the Project;
- The calculation of site-specific turbine passage survival rates for target fish species using the USFWS Turbine Blade Strike Analysis Tool (TBSA); and
- The use of seasonal species/size class-specific entrainment densities from comparable projects and project-specific discharge volumes to generate estimates of numbers of fish entrained at the Project.

## 3 Methods

This study addresses the qualitative classification of impingement, entrainment, and the probability of turbine passage survival at the Project using a review of relevant biological criteria and physical Project characteristics for seven fish species of interest. Factors that can influence the potential for impingement or entrainment at a hydropower project include structural characteristics such as the size and depth of the intake structure, the velocity of water as it enters the intake structure, the location of the intake structure relative to fish habitat, and the biological and behavioral characteristics (e.g., size, movement or migration patterns, and habitat preferences) of the specific life stages of fish species of interest. The likelihood of impingement is also highly dependent on the physical features and water velocities found at or near the trash racks along with species-specific physiological capabilities (i.e., swim speed). Turbine survival rates are primarily affected by engineering factors such as the amount of head differential of a turbine, its number of blades, rotational speed, hydraulic capacity, and the length of an entrained fish.

In addition to the previously described qualitative entrainment assessment for the Project, a quantitative estimate of entrainment during generation at the Project was performed. The resulting entrainment estimates were then be combined with modeled and empirical based survival rates for fish passing through the Project turbine units. In the absence of site-specific entrainment data during generation at the Lake Lynn Project, the quantitative estimate developed as part of this desktop assessment relied on a combination of site-specific operations data and fish entrainment rates available from similar hydropower dams. Quantitative estimates of entrainment at the Project were calculated for all target fish species for which density data could be obtained from, the EPRI entrainment database. As a result, quantitative estimates of the entrainment totals for six of the target species and one surrogate species at the Lake Lynn Project are presented in this report.

## 3.1 Project Impoundment, Intake, and Turbine Description

The first step in the evaluation of the potential for fish impingement and entrainment was to describe the physical features of the impoundment, intake structure, and turbine units that will affect entrainment, impingement and turbine passage survival. Where possible, Project features and dimensions were obtained from available engineering drawings and written descriptions of the Project.

## 3.2 Life History and Habitat Requirements of Target Fish Species

A description of the life history, habitat requirements, and behavior of fish species was compiled to determine the likelihood of presence near the Project intakes and to evaluate entrainment potential. The “Traits Based Assessment” of Čada and Schweizer (2012) was used to qualitatively assess the potential entrainment risk for fish species, which considers each species’ primary location within the Project, preferred habitat, local movements and reproductive strategy. Species-specific behavioral requirements determine if and when a given life stage interacts with intake operation. The potential for each species to be susceptible to entrainment can be determined based on their life history characteristics in relation to the location of the Project’s intake structure.

Categories of entrainment potential based on the likelihood that a fish species/life stage will be located near the intake structures are described as:

- None - species/life stage (e.g., adult, spawning, or juvenile) are not known to prefer the habitat near the intake structures
- Minimal - species may only occasionally be found occupying the habitat near the intake structures
- Moderate - species routinely or seasonally found occupying the habitat near the intake structures
- High - species likely to be found occupying the habitat near the intake structures

## 3.3 Entrainment Potential of Target Fish Species

The distance between bars on a trash rack (i.e., clear spacing) can affect the likelihood of an individual fish being excluded from moving through the trash rack and entering the turbine intakes. Fish species and life stages with a body width greater than the clear spacing are physically excluded from passing through a trash rack and becoming entrained. Proportional estimates of body width to total length (scaling factor) were compiled by Smith (1985) for the identified target species. This scaling factor was then used to determine the minimum length of each species excluded from the intake by the trash racks at each of the Project intakes (Table 3-1). The clear spacing values were divided by the scaling factors to calculate the minimum length for each target species that would be excluded at the Project.

## 3.4 Electric Power Research Institute (EPRI) Database Review

The Electric Power Research Institute (EPRI) 1997 entrainment database provides results from entrainment field studies conducted at 43 hydroelectric facilities east of the Mississippi River using full-flow tailrace netting. The database contains site characteristics of each of these facilities, as well as the total number of individuals of each species collected at each of the sites. The species counts are separated into variable size classes ranging from 2 to 30 inches.

A comparison of the EPRI entrainment database was made to provide a literature-based assessment to compare with potential entrainment at the Project. To do so, the EPRI database was filtered for characteristics that match or are within a comparable range to those found at the Project which included the following:

- Trash rack clear spacing between 1.75 and 5.5 inches;
- Total powerhouse hydraulic capacities between 1300 and 6600 cfs;
- Plants operated in run-of-river mode or peaking facilities; and
- Target or surrogate fish species.

Collection totals from the set of comparable projects were summarized by the size classes provided in the database for the target species (or a closely related surrogate). In addition, the size class composition of the total number collected was summarized for each target species.

## 3.5 Impingement Potential of Target Fish Species

The ability for an individual fish to avoid being impinged or entrained at a powerhouse intake often depends on its swimming performance (Castro-Santos and Haro 2005). The swimming performance is directly related to the size of an individual fish; however, the swimming capability also varies among species based on morphological differences. Although there is no standard method that defines how swimming performance is measured, three commonly used definitions or types of swim speed are described in the scientific body of literature for fish (Katopodis and Gervais 2016). The three swim speed types, cruising, prolonged, and burst, are described as the following:

- Cruising or sustained swim speeds can be maintained indefinitely (Bain and Stevenson 1999);
- Prolonged swim speeds can be maintained between 5 and 8 minutes (Bain and Stevenson 1999); and
- Burst (also called startle, darting or sprint) swim speeds can be maintained for less than 20 seconds (Beamish 1978).

Burst swim speeds were used to assess if a fish can adequately escape involuntary impingement or entrainment. If a fish has a greater burst swim speed than the turbine intake approach velocity, it is capable of moving away from the intake flow field to avoid interaction. To assess swimming capabilities for the target fish species of interest, burst swim speeds were compiled from the available scientific literature.

To ascertain whether or not a certain size fish of a particular species is likely to be impinged or entrained, the burst swim speeds were compared to the calculated approach velocity of the intake trash racks at the maximum hydraulic capacity of the Project. The approach velocity at the Project intake was calculated using the velocity equation:

$$Q = V * A$$

Where:

$\mathrm{Q} = \text{flow rate (cfs)}$

$\mathrm{V} = \text{approach velocity (fps); and}$

$\mathrm{A} = \text{area (square feet)}$

Fish species and sizes whose burst swim speeds are less than the approach velocity at the Project intake are likely to be impinged at the trash racks if their body widths are greater than the trash rack spacing. If the body width of a fish is less than the trash rack spacing and its burst swim speed is less than the approach velocity, it is likely to be entrained.

## 3.6 Turbine Survival Evaluation

To estimate survival of fish that are entrained through turbines at the Project, theoretical predictions were used to estimate a survival rate using a blade-strike model developed by the Department of Energy (Franke et al. 1997) that uses various turbine, fish and operations characteristics of a hydroelectric project to calculate a turbine blade strike and survival probability. This model was further modified by the United States Fish and Wildlife Service which produced the Turbine Blade Strike Analysis (TBSA) model that determines the fraction of a population of fish that are killed by blade strike passing through a hydroelectric project (Towler and Pica 2018). TBSA creates a normally distributed population of fish described by its number, mean length, and standard deviation of length that are routed through hazards at a hydroelectric project, e. g., a turbine. Monte Carlo simulations are performed to determine the percentage of individuals subjected to turbine blade strike. The blade strike probabilities are based on the Project turbine specifications and calculated using methods outlined in Franke et al. (1997). The probability of blade strike in the model is based on several factors, including the number of runner blades, fish length, runner blade speed, turbine type, runner diameter, turbine efficiency, and total discharge. These factors are inputs into the model which predicts survival for a fish of any species at a designated length. Table 3-2 lists the turbine specifications used as input into the TBSA model which was used to predict turbine passage survival estimates up to the maximum lengths (rounded to whole inch) of each target fish species that could entrain through the existing trash rack spacing at the Project. Lastly, the TBSA model simulations were run using a correlation factor of 0.2 which is the recommended conservative value (Towler and Pica 2018).

## 3.7 Electric Power Research Institute (EPRI) Turbine Survival Database Review

Similar to the comparison of the EPRI entrainment database review, the EPRI 1997 turbine survival database was reviewed to provide an equitable literature-based comparison of the turbine survival estimates calculated for the Project. To do so, the EPRI database was filtered for characteristics that match or are similar to those found at Lake Lynn. The following are the characteristics selected from the database for comparison to the Project:

- Francis turbines;
- Head rating similar to 81.5 ft;
- Hydraulic capacity rating equal to or less than 10,143 cfs; and
- Target or surrogate fish species.

The immediate, 24-hour, and 48-hour, and control survival estimates were selected, if available, as they provided the greatest range of time difference post-turbine passage for each species.

## 3.8 Qualitative Assessment of Entrainment and Turbine Survival Potential

Data collected during the literature review and site-specific evaluation process (i.e., habitat and life history, swim speeds, and turbine survival model estimates) were used to compile a qualitative assessment of the potential entrainment of target fishes. The qualitative assessment used a multi-step rank of:

- High (H)
- Moderate (M)
- Low (L)

Desktop impingement and entrainment assessments assigned an overall entrainment potential rank to each member of the suite of target species considered based on consideration of habitat and life history, swim speed relative to intake velocity, and minimum exclusion lengths relative to trash rack spacing. In general, fish with life history attributes that include obligatory downstream migration are given a rating of 'High', while those with juvenile life history stages placing them in the vicinity of the intakes or as adults with swim speeds not necessarily greater than the approach velocity are labeled as 'Moderate' risk. Species with life history attributes that generally keep them away from the intakes or fish that had a burst swim speed greater than the intake velocity are listed as a 'Low' risk for entrainment. In relation to swim speed, regardless of life stage, fish are considered 'High' risk if the maximum burst speed does not exceed the intake velocity, 'Moderate' risk if the intake velocity falls within the range of burst swim speed, and 'Low' risk if the burst swim speed completely exceeded the intake velocity.

The entrainment potential classification for trash rack spacing depended on the minimum body length exclusion results. If the minimum exclusion length for the existing trash rack spacing was longer than the standard length for a juvenile or adult (i.e., many individuals of that species and life stage are likely to be shorter than the minimum exclusion length) it received a "High" entrainment risk potential. A "Moderate" entrainment risk potential was applied when the minimum exclusion length overlapped with a portion of the individuals that would be expected to achieve that length by the life stage indicated. A "Low" entrainment risk potential was applied when the minimum exclusion length of a trash rack was less than the standard length of the life stage being considered.

The risk categories for the turbine survival potential were based on the TBSA model estimates. TBSA results were converted to a qualitative ranking system similar to Winchell et al. (2000) for standard lengths of the juvenile and adult life stages. "High" survival potential was applied to estimates greater than 85%, "Moderate" for estimates between 70-85%, and "Low" for estimates less than 70%.

## 3.9 Quantitative Assessment of Entrainment and Turbine Survival Potential

In addition to the previously described qualitative entrainment assessment for the Project, a quantitative estimate of entrainment during generation at the Project was calculated. The resulting entrainment estimate could then be combined with modeled and empirical based survival rates for fish passing through the Project turbine units.

In the absence of site-specific entrainment data during generation at the Project, the quantitative estimate presented relied on a combination of site-specific discharge data and surrogate fish entrainment rates available from comparable projects found in the EPRI database. Quantitative estimates of entrainment at the Project were calculated for all target and surrogate fish species selected for this study. As a result, quantitative estimates of the entrainment totals are presented for six the target species and one surrogate species.

**Table 3–1. Lake Lynn Project impoundment and intake characteristics**

| Site Characteristic | Lake Lynn Project | | | |
|---|---|---|---|---|
| Normal Full Pond Elevation (ft) | 870 | | | |
| Operating Mode | dispatchable peaking hydroelectric facility with storage capability | | | |
| Surface Area at Normal Full Pond (acres) | 1,729 | | | |
| Total Storage Volume (acre-feet) | 72,000 | | | |
| Impoundment Length (miles) | 13 | | | |
| Total Hydraulic Capacity (cfs) | 10,768 | | | |
| | **Unit 1** | **Unit 2** | **Unit 3** | **Unit 4** |
| Upper Rack Elevation (ft) | 874 | 874 | 874 | 874 |
| Bottom Rack Elevation (ft) | 828 | 828 | 828 | 828 |
| Trash Rack Spacing (in) | 4 | 4 | 4 | 4 |
| Trash Rack Height (ft) | 42 | 42 | 42 | 42 |
| Trash Rack Width (ft) | 25.625 | 25.625 | 25.625 | 25.625 |
| Trash Rack Surface Area (sq. ft) | 1,076 | 1,076 | 1,076 | 1,076 |
| Maximum Turbine Discharge (cfs) | 2,700 | 2,668 | 2,700 | 2,700 |
| Intake approach velocity (fps) | 2.5 | 2.5 | 2.5 | 2.5 |

**Table 3–2. Lake Lynn Project turbine characteristics**

| Project | Lake Lynn | | | |
|---|---|---|---|---|
| Turbine ID | 1 | 2 | 3 | 4 |
| Turbine Type | Francis | Francis | Francis | Francis |
| Number of Blades | 16 | 17 | 16 | 16 |
| Runner Diameter (ft) | 10.8 | 10.8 | 10.8 | 10.8 |
| Runner Diameter at Inlet (ft) | 7.1 | 7.3 | 7.1 | 7.1 |
| Runner Diameter at Discharge (ft) | 10.1 | 10.2 | 10.1 | 10.1 |
| Runner Height (ft) | 3.8 | 3.9 | 3.8 | 3.8 |
| Head (ft) | 81.5 | 81.5 | 81.5 | 81.5 |
| Rotational Speed (rpm) | 133.3 | 133.3 | 133.3 | 133.3 |
| Max Discharge (cfs) | 2,700 | 2,668 | 2,700 | 2,700 |
| Peak Efficiency (%) | 94.0% | 94.0% | 94.0% | 94.0% |

# 4 Results

## 4.1 Description of Project Features

### *4.1.1 Project Reservoir and Features*

The Lake Lynn Project is located on the Cheat River in Monongalia County, West Virginia and Fayette County, Pennsylvania, approximately 10 miles northeast of Morgantown, West Virginia. The Project has a drainage area of 1,411 square miles and is located about 3.7 miles upstream of the confluence with the Monongahela River. The surface area of the Project impoundment is 1,729 acres with a gross storage of 72,000 acre-ft (Table 3-1). The impoundment stretches approximately 13 miles upstream and has a normal full pond elevation of 870 ft NGVD. The Project reservoir can be used for storage as the Project is operated as a dispatchable peaking hydroelectric facility with storage capability.

### *4.1.2 Powerhouse, Intake Structure, and Trash Racks*

The Lake Lynn Project powerhouse was built in 1926 and houses four horizontal Francis turbines, each connected to a generator. The four unit intakes are screened by a series of racks that span a total horizontal distance of 102.5 feet and a vertical distance of 42 feet resulting in an intake area of 4,304 $ft^2$. The intake rack structure is comprised of eight separate racks, two for each unit. Intake racks at Lake Lynn are 4-inch clear spacing.

### *4.1.3 Downstream Bypass*

There is currently no downstream bypass facility at the Lake Lynn Project.

### *4.1.4 Turbine Units*

The Lake Lynn Project includes four horizontal Francis turbines with a combined generating capacity of 51.2 MW. Units 1, 3, and 4 have a maximum hydraulic capacity of 2,700 cfs, whereas Unit 2 has a hydraulic capacity of 2,668 cfs. At the time of initial construction all four units were identical. During 2018 PE Hydro completed a turbine replacement and upgrade on Unit 2. As a result, the specific physical characteristics for Unit 2 differ slightly from those for Units 1, 3, and 4 and result in a slightly decreased hydraulic capacity (see Table 3-2 for unit specifics).

### *4.1.5 Project Operations*

The Project is operated as a dispatchable peaking hydroelectric facility with storage capability. The facility's ponding capability varies by season and allows for peaking. The Project produces a long-term average generation of 140,352 MWh of clean electricity annually, which is enough to power 13,495 homes (Cube Hydro Partners, 2019). The current FERC License requires that the Licensee operate the Project to maintain Cheat Lake between 868 and 870 ft NGVD from May 1 through October 31, between 857 and 870 ft from November 1 through March 31, and between 863 ft and 870 ft from April 1 through April 30, each year. The current FERC License requires the Licensee release a minimum flow of 212 cfs from the dam with an absolute minimum flow of 100 cfs regardless of inflow.

Although the above-mentioned operational parameters do allow for some peaking and storage, during the six-month period between May 1 and October 31, the Project operates most like a run-of-river station with a maximum fluctuation in headpond level of 2 feet (between 868 and 870 ft NGVD). For the rest of the year, more fluctuation is permitted. Due to the seasonal shifts in operations, this report has included comparisons with other facilities which operate as either run-of-river or peaking.

## 4.2 Life History and Habitat Requirements of Target Fish Species

The fish assemblage of the Cheat River is generally indicative of a moderately sized, low-gradient, mid-Atlantic river. Target species for this analysis were selected in a manner which captured a variety in life history strategies exhibited by fishes in the area. Target species were included because they are either native or naturally occurring fish species within the Project areas, actively managed, or valued as a game species.

The target species selected for inclusion in the Desktop Fish Entrainment Assessment were:

- Bluegill;
- Channel catfish;
- Smallmouth bass;
- Walleye;

- Golden redhorse;
- Emerald shiner; and
- Gizzard shad.

A brief description of the life history characteristics for each target fish species is provided below. A summary of their habitat preferences and behaviors that influence the likelihood of entrainment is provided in Table 4-1.

### *4.2.1 Cheat Lake Community Sampling*

Biological monitoring was conducted in Cheat Lake and Cheat Lake Embayment from 2005 to 2009 in accordance with the current FERC license for the Project. Surveys conducted include night boat electrofishing and gill netting during May and October, when water levels were low. From 2011 to 2015, fish were also sampled from eight sites in Cheat Lake, consistent with previous surveys. A total of 8,338 fishes from 35 species were collected from 2011 to 2015. Species richness was found to have substantially increase in the riverine zone, increasing from 8 species in 1990 to an average of 23 species captured from 2011 to 2015. An increase in sportfish and non-game fish species was also found when compared to previous studies. Specifically, sportfish in highest abundance included bluegill, smallmouth bass, largemouth bass, yellow perch, and channel catfish. Non-game species included emerald shiner, mimic shiner, logperch, brook silverside, and gizzard shad (Smith and Welsh 2015). Table 4-2 presents a summary of the temporal trends in fish species CPUE from 1990 to 2014.

### *4.2.2 Bluegill (Lepomis macrochirus)*

Bluegill are relatively sedentary and are commonly found in the littoral zone of lakes, ponds, and reservoirs, as well as quiet, slow flowing waters of streams and rivers. Adults and juveniles seek cover in the form of submerged structure like woody debris intermixed with submerged aquatic vegetation (Stuber et al. 1982a; Stuber et al. 1982b; Aho et al. 1986; Werner 2004). Sunfish species spawn in shallow littoral areas in the spring and summer when water temperatures are above 18°C. They are known to be prolific breeders. Their nests are constructed in sand and gravel near woody debris and aquatic vegetation in water depths less than five feet. They reach sexual maturity at one year of age, with an average length is 4 to 6 inches (Smith 1985). Generally, juvenile bluegill remain in shallow, protected habitats such as coves and flooded tributary mouths following cessation of parental care. Flooding, which can result in a rapid drop in water temperature and excessive siltation, and excessive lowering of the water level during spawning are the two most common habitat-related reasons for reproductive failure (Becker 1983). Strong orientation to cover and preference for shallower, off-channel habitats generally limits this family of fishes to exposure to impingement and entrainment through hydroelectric projects.

### *4.2.3 Channel Catfish (Ictalurus punctatus)*

Channel catfish inhabit large, warm lakes, rivers, ponds and reservoirs, as well as both clear, rapidly flowing channels to turbid, mud-bottomed ones. They occupy a variety of substrate types and can be found in moving or still water (Jenkins and Burkhead 1993). Adults are usually found in pools, or under log jams during the day and riffles at night. They are also known to be tolerant of water with low oxygen and light levels. Channel catfish reach maturity between ages 4-6, with relatively slow growth. They reach an average length of 12-24 inches (Jenkins and Burkhead 1994). Spawning begins in late May and continues through early July when water temperatures range from 21-30°C. Males will build a nest and guard eggs until hatched. Fry begin to school in compact balls, which are guarded by adults until young reach about one inch long and disperse (Becker 1983). Juveniles feed primarily on plankton and insect larvae, but feed on any available invertebrate, fishes, and some plants as they mature (Jenkins and Burkhead 1994).

### *4.2.4 Smallmouth Bass (Micropterus dolomieu)*

Smallmouth bass inhabit a range of aquatic habitats, but adults prefer flowing reaches downstream of riffles or bedrock outcrops. These areas provide cover and flows that convey food items. Habitat depth preferences tend to vary seasonally with fish inhabiting shallow littoral zones in the spring and early summer, moving deeper as waters become warmer. Smallmouth bass generally move into deep water and become inactive during winter. Smallmouth bass typically reach maturity at 3-4 years of age and reach an average length between 12-16 inches (Jenkins and Burkhead 1994). Spawning occurs in early May when water temperatures range from 16-22°C, with males constructing gravel and rock lined nests that are 2-ft to 3-ft in diameter (Jenkins and Burkhead 1994). Nests are often located downstream of large objects such as boulders, ledges, or fallen trees. The coarse substrate and ledge of the main stem provides spawning habitat for smallmouth. Rooted aquatic vegetation provides rearing and cover habitat for young of year (YOY) and juveniles in shallow, slower moving reaches. The diet of the smallmouth bass ranges from a variety of aquatic invertebrates for younger bass to fish, frogs and small mammals as larger adults (Smith 1985). They are known as ambush predators, using vegetation or structure (i.e., rocks, stumps) as cover to prey on smaller fish and invertebrates.

### *4.2.5 Walleye (Sander vitreus)*

Walleye inhabit medium to large, clear lakes, rivers, and impoundments with loose, shifting sediment such as detritus, sand, gravel rubble, and boulders (Jenkins and Burkhead 1994). They are generally found in deeper waters during the day and tend to move into shallower areas during heavy cloud cover and at night for feeding. Walleye are also known to have excellent visual acuity in low light levels. On average, walleye reach a length between 12-14 inches, with some individuals reaching over 30 inches of length. Male walleye reach maturity at 2 to 4 years, whereas females mature at 3 to 6 years. They spawn in the early spring following ice out when water temperatures reach 2.2°C to 15.6 °C. Walleye congregate before spawning and spawn over gravel or rocky substrates in water generally 2 to 4 feet deep (Smith 1985; Jenkins and Burkhead 1993). Females can deposit more than 100,000 eggs, which hatch in two weeks. The eggs are slightly adhesive and settle between rocks, and hatch after 15-30 days. After their small yolk has been fully absorbed into their digestive system, juvenile walleye will feed on zooplankton and fly larvae. As they approach adulthood, their diet consists primarily of fish, crayfish and leeches (Smith 1985), feeding opportunistically.

### *4.2.6 Golden Redhorse (Moxostoma erythurum)*

The golden redhorse occupies a broad spectrum of warm water habitats, including large creeks and rivers, natural lakes and impoundments (Jenkins and Burkhead 1993), but are known to prefer moderate to large streams with some current. It can tolerate a moderate amount of silting, but is most abundant in clear, unpolluted streams with large pools and well-defined riffles. Juveniles tend to inhabit shallow areas. They reach an average length of around 12-18 inches and reach sexual maturity at 3-5 years of age. Spawning occurs in mid to late spring, with ideal temperatures ranging from 10-22.5 °C. Spawning is known to take place in late spring in moderate sized streams over gravel riffles but may also occur in small tributaries. The golden redhorse forages on the bottom of pools for food, preying on aquatic insects, invertebrates, and detritus (Jenkins and Burkhead 1993).

The golden redhorse was not identified in any of the seven comparable hydroelectric projects within the EPRI entrainment database. As such, the shorthead redhorse (*Moxostoma macrolepidotum*) was chosen as a surrogate. This species share a genus with the golden redhorse, and are documented to have closely related life histories, as well as similar morphologies (Smith 1985).

### *4.2.7 Emerald Shiner (Notropis atherinoides)*

The emerald shiner inhabits large, open rivers, lakes and reservoirs, as well as runs of rivers with low or moderate gradient. They prefer clear water over sand or gravel, and often aggregate in large schools in mid-water or near surface (Page and Burr 1991). They form large schools that move into deeper water for overwintering. This species spawns in the late spring or early summer. Spawning may occur over various substrates, but primarily over gravel (Smith 1983). Females lay up to 2,000 to 3,000 eggs, which hatch 24-36 hours after fertilization. After hatching, fry remain on the substrate for 2-4 days before forming schools. The emerald shiner feeds primarily zooplankton, as well as green algae and diatoms, while juveniles feed almost solely on protozoans (Smith 1983). They reach an average size of 2.5-3.5 inches long (Jenkins and Burkhead 1993).

#### *4.2.8 Gizzard Shad (Dorosoma cepedianum)*

The gizzard shad is a pelagic, schooling fish with a variety of habitats. It prefers pools and runs in medium streams, or rivers with low to moderate gradient. This species is also found in reservoirs, lakes, swamps, floodwater pools, estuaries, brackish bays and marine waters. While many populations are diadromous (residing in coastal waters and returning to freshwater environments to spawn), the Cheat River population is known to be landlocked and does not participate in annual migration. They reach maturity by age 2 or 3, and typically spawn between April and June in temperate latitudes (Jenkins and Burkhead 1993). Spawning takes place in freshwater sloughs, ponds, and lakes at near-surface depths, occasionally over vegetation and debris. Eggs are demersal and attach to algae or rocks. This species is known to have a very high spawning potential, with fecundity ranging from 22,400-543,910 eggs per female (Jenkins and Burkhead 1993). Gizzard shad are filter feeders, feeding almost solely on plankton from the water column (Jenkins and Burkhead 1993). Gizzard shad are also known to be extremely sensitive to changes in temperature and dissolved oxygen, becoming moribund as water temperatures decrease below 56°F and die at about 38°F (Williamson and Nelson 1985). Die-offs are frequent in fall and late summer when water temperature drops. Juvenile gizzard shad typically pass downstream out of reservoirs during fall and early winter, and their tendency to become moribund as their lower temperature threshold is approached may make this species susceptible to entrainment. This species reaches an average length of 9-14 inches (Jenkins and Burkhead 1993).

## Table 4–1. General habitat use and behavior of target fish species

| Common Name | Life Stage | Habitat Requirement | Behavioral Movements | Likelihood of Proximity to Intakes |
|---|---|---|---|---|
| **Bluegill** | Adult Spawning | Shallow water over fine gravel | None | Low |
| | Adult | Shallow water with vegetation and structure, or high in water column over deep water | Local migration to deeper water in winter and summer for thermal refuge | |
| | Juvenile | Shallow water with vegetation and structure | None | |
| **Channel catfish** | Adult Spawning | Warm, slow or stagnant water over soft sediments in open water or areas with vegetation | Will form aggregations and build nests in areas of soft sediments | Low |
| | Adult | | None | |
| | Juvenile | | | |
| **Smallmouth bass** | Adult Spawning | Gravel with shallow water | May travel to smaller streams to spawn | Low |
| | Adult | Clear water with boulders, rocky shoals, riffles, or structural cover | Occasionally moves to deep water during the day, forms aggregation in deep water in winter | Low |
| | Juvenile | | None | Low |
| **Walleye** | Adult Spawning | Shallow shoreline areas, shoals, riffles | Moves to near-shore areas or tributaries to spawn | Low |
| | Adult | Pools moderate turbidity and substantial areas of rocky substrate | Moves to near-shore areas at night to feed | Low |
| | Juvenile | | | |
| **Shorthead redhorse** | Adult Spawning | Gravelly runs and riffles | May migrate out of large rivers to smaller streams to spawn | Low |
| | Adult | Rocky pools, runs, and riffles in moderate to large streams | None | Low |
| | Juvenile | | | Low |
| **Emerald shiner** | Adult Spawning | Near surface in open water over gravel shoals | None | Low |
| | Adult | Large, open areas of variable turbidity | Local migration to deeper water in winter | Low |
| | Juvenile | | None | Low |
| **Gizzard shad** | Adult Spawning | Surface water in low-gradient areas | Migrate in large schools in surface waters | Low |
| | Adult | Non-migratory; found near substrate for filter feeding | May be susceptible to seasonal low water temperatures | High |
| | Juvenile | Shallow, near-shore water | May move downstream out of reservoirs in cooler months; susceptible to "cold shock" | High |

**Table 4–2. Temporal trends in fish CPUE from boat electrofishing in Cheat Lake**

| Species | 1990 | 1997 | 1998 | 2001 | 2005 | 2008 | 2011 | 2014 | Grand Total |
|---|---|---|---|---|---|---|---|---|---|
| Banded Darter | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.50 | 0.00 | 0.50 | 0.11 |
| Black Crappie | 0.22 | 0.00 | 0.11 | 0.00 | 0.00 | 0.50 | 2.50 | 3.75 | 0.81 |
| Bluegill | 8.44 | 15.08 | 11.56 | 30.11 | 12.5 | 186 | 10.5 | 27.25 | 36.59 |
| Bluntnose Minnow | 0.22 | 0.00 | 0.00 | 9.11 | 10.5 | 14.25 | 7.75 | 0.75 | 5.38 |
| Brook Silverside | 4.00 | 5.00 | 4.89 | 11.33 | 6.00 | 37.25 | 11.25 | 5.75 | 10.58 |
| Brown Bullhead | 5.11 | 0.00 | 0.56 | 0.00 | 0.00 | 0.00 | 0.50 | 0.00 | 0.59 |
| Common Carp | 0.89 | 2.67 | 2.56 | 2.33 | 3.50 | 1.25 | 0.25 | 0.75 | 1.88 |
| Emerald Shiner | 7.11 | 21.67 | 20.56 | 25.67 | 5.00 | 7.25 | 125.50 | 22.25 | 29.30 |
| Chain Pickerel | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.25 | 3.00 | 0.37 |
| Channel Catfish | 0.22 | 0.42 | 0.22 | 1.00 | 0.75 | 3.00 | 1.00 | 2.00 | 1.05 |
| Channel Darter | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.50 | 0.06 |
| Gizzard Shad | 0.00 | 0.00 | 0.22 | 2.44 | 1.00 | 0.75 | 5.75 | 0.00 | 1.31 |
| Golden Redhorse | 0.00 | 0.92 | 1.67 | 1.33 | 4.25 | 4.25 | 19.50 | 40.00 | 8.39 |
| Golden Shiner | 0.00 | 0.00 | 0.11 | 0.11 | 0.00 | 0.50 | 0.00 | 0.00 | 0.10 |
| Greenside Darter | 0.00 | 0.00 | 0.00 | 0.33 | 0.00 | 0.00 | 0.00 | 1.25 | 0.20 |
| Green Sunfish | 0.22 | 0.00 | 0.33 | 2.11 | 1.75 | 19.50 | 1.25 | 10.50 | 4.21 |
| Flathead Catfish | 0.00 | 0.25 | 0.33 | 0.00 | 0.25 | 0.00 | 0.00 | 0.25 | 0.14 |
| Freshwater Drum | 0.44 | 0.58 | 0.56 | 0.78 | 0.75 | 1.00 | 0.50 | 3.00 | 0.93 |
| Hybrid Striped Bass | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.25 | 0.00 | 0.03 |
| Hybrid Sunfish | 1.56 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.25 | 0.25 | 0.19 |
| Johnny Darter | 0.00 | 0.00 | 0.11 | 0.44 | 0.00 | 3.25 | 0.00 | 1.75 | 0.67 |
| Largemouth Bass | 2.44 | 2.75 | 3.89 | 3.67 | 8.50 | 4.50 | 9.50 | 17.50 | 6.39 |
| Logperch | 0.00 | 1.42 | 3.33 | 3.11 | 10.75 | 1.50 | 2.25 | 14.00 | 4.52 |
| Longnose Gar | 0.00 | 0.00 | 0.00 | 0.22 | 0.00 | 0.50 | 0.25 | 1.25 | 0.27 |
| Mimic Shiner | 0.89 | 0.00 | 0.00 | 33.78 | 5.50 | 54.50 | 12.75 | 29.50 | 17.55 |
| Northern Hogsucker | 0.00 | 0.00 | 0.33 | 0.00 | 0.50 | 0.25 | 0.00 | 0.25 | 0.17 |
| Northern Pike | 0.22 | 0.08 | 0.22 | 0.11 | 0.75 | 0.00 | 0.00 | 0.00 | 0.17 |
| Popeye Shiner | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.25 | 0.03 |
| Pumpkinseed | 4.67 | 1.75 | 2.33 | 1.22 | 0.50 | 3.75 | 0.50 | 0.50 | 1.81 |
| Quillback | 0.00 | 0.33 | 0.00 | 0.00 | 0.00 | 0.00 | 0.75 | 0.25 | 0.15 |
| Rainbow Darter | 0.00 | 0.00 | 0.22 | 0.00 | 0.00 | 0.00 | 0.00 | 2.50 | 0.32 |
| River Carpsucker | 0.00 | 0.00 | 0.22 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.04 |
| Rock Bass | 0.67 | 0.42 | 3.33 | 2.11 | 0.25 | 6.50 | 2.00 | 11.25 | 3.32 |
| Rosyface Shiner | 0.00 | 0.00 | 0.00 | 0.00 | 30.25 | 3.50 | 0.00 | 0.00 | 3.86 |
| Sauger | 0.00 | 0.67 | 2.44 | 1.78 | 1.50 | 1.50 | 4.25 | 4.50 | 2.17 |
| Smallmouth Redhorse | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.50 | 0.00 | 0.06 |
| Silver Redhorse | 1.56 | 0.25 | 0.78 | 0.00 | 0.00 | 0.25 | 0.00 | 11.25 | 1.61 |
| Silver Shiner | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 5.00 | 0.00 | 6.25 | 1.29 |
| Smallmouth Bass | 0.44 | 6.42 | 5.78 | 4.78 | 5.00 | 18.50 | 27.00 | 35.50 | 12.41 |

| Species | 1990 | 1997 | 1998 | 2001 | 2005 | 2008 | 2011 | 2014 | Grand Total |
|---|---|---|---|---|---|---|---|---|---|
| Spottail Shiner | 0.22 | 1.67 | 1.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.25 | 0.41 |
| Spotted Bass | 0.22 | 0.75 | 0.00 | 1.00 | 2.25 | 4.75 | 3.25 | 8.75 | 2.45 |
| Spotfin Shiner | 0.22 | 0.00 | 0.00 | 0.67 | 7.25 | 9.00 | 0.50 | 0.25 | 2.08 |
| Walleye | 0.00 | 0.00 | 0.00 | 1.00 | 0.00 | 0.50 | 6.25 | 2.00 | 1.17 |
| Warmouth | 0.22 | 0.00 | 0.00 | 0.00 | 0.00 | 0.25 | 0.00 | 0.00 | 0.05 |
| White Bass | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 3.50 | 0.00 | 0.40 |
| White Sucker | 0.00 | 0.00 | 0.00 | 0.00 | 0.25 | 0.00 | 0.00 | 0.00 | 0.03 |
| White Crappie | 0.00 | 0.33 | 0.00 | 0.67 | 0.00 | 0.00 | 0.00 | 0.00 | 0.15 |
| Yellow Bullhead | 0.44 | 0.08 | 0.11 | 0.33 | 0.00 | 0.00 | 0.00 | 0.50 | 0.18 |
| Yellow Perch | 9.56 | 7.92 | 24.22 | 14.00 | 1.75 | 0.25 | 1.25 | 22.75 | 11.25 |

*Reproduced from the Lake Lynn PAD (Table 5.11).

## 4.3 Entrainment Potential of Target Fish Species

The calculated minimum exclusion lengths for each of the seven target fish species relative to the existing 4-inch clear spacing at Lake Lynn intake structure are presented in (Table 4-3). As described in Section 3.3, a scaling factor derived from the proportional estimates of body width to total length were used to determine the minimum length of each target species that would be excluded from entraining through the existing intake rack spacing at the Project (i.e., minimum exclusion size = rack clear spacing/scaling ratio).

The majority of the calculated estimates yielded lengths for target species that are unlikely to be present in the Project (i.e., a length outside of the range expected for the species in the vicinity of the Lake Lynn Project). For example, the minimum size of gizzard shad predicted to be excluded by a 4-inch intake rack is 38.1 inches—a length not attained by this species. In cases where the maximum size of the species did not exceed the minimum exclusion size, a designation of 'none' was applied (Table 4-3). Only channel catfish and walleye had a calculated minimum exclusion length (25.5 and 31.0 inches, respectively) lower than the upper end of the expected range of body lengths for those species in the Project area. The existing 4-inch intake rack spacing alone is not expected to eliminate the potential for entrainment of bluegill, smallmouth bass, shorthead redhorse, emerald shiner or gizzard shad at Lake Lynn.

## 4.4 Electric Power Research Institute (EPRI) Entrainment Database Review

A total of ten hydroelectric projects in the EPRI 1997 database met the selection criteria for similarity to Lake Lynn (Table 4-4) and six of the seven target species were represented in the collective subset of data from the ten identified facilities. Due to limited information on entrainment of the golden redhorse, the shorthead redhorse was utilized as a surrogate for this database review. As mentioned in section 4.2.6, the golden redhorse and shorthead redhorse share similar life histories, as well as occupy similar habitats (moderately sized streams with some current and well-defined riffles) (Jenkins and Burkhead 1993).

The length frequency distribution for the entrainment of target fish species at the ten representative hydroelectric projects from the EPRI data base are presented in Figures 4-1 (by species) and 4-2 (cumulative). The majority of individuals representing target fish species entrainment at the ten representative projects were less than or equal to four inches in length (85% of reported individuals). Individuals greater than 10 inches were limited to a minor percentage of four target species (channel catfish, shorthead redhorse, smallmouth bass and walleye, representing 4%, 13%, 11%, and 9% of all individuals entrained, respectively).

**Table 4–3. Minimum length for target fish to be excluded from entrainment based on existing trash rack spacing**

| Common Name | Scaling Factor for Body Width[1] | Typical Length (inches) for target species juveniles and adults potentially encountered at the Lake Lynn Project | | Calculated Minimum Exclusion Length (inches)* |
|---|---|---|---|---|
| Bluegill | 0.133 | Juvenile | 1.0-3.0[1] | None |
| | | Adult | 4.0-6.0[1] | |
| Channel catfish | 0.157 | Juvenile | 2.0-10.0[1] | 25.5 |
| | | Adult | 10.5-50.0[2] | |
| Smallmouth bass | 0.128 | Juvenile | 2.0-7.0[2] | None |
| | | Adult | 8.0-27.0[2] | |
| Walleye | 0.129 | Juvenile | 2.0-11.0[1] | 31.0 |
| | | Adult | 12.0-36.0[1&3] | |
| Shorthead redhorse | 0.13 | Juvenile | 2.0-10.0[2] | None |
| | | Adult | 14-18[1] | |
| Emerald shiner | 0.108 | Juvenile | 1.0-4[1] | None |
| | | Adult | 5 [1] | |
| Gizzard shad | 0.105 | Juvenile | 2.0-7.0[4] | None |
| | | Adult | 10.0-14.0[1] | |

* "None" indicates that the calculated exclusion length exceeds the maximum length expected for the species at Lake Lynn.
1 Smith, C. L. 1985. The Inland Fishes of New York State. Albany, NY. New York Department of Environmental Conservation.
2 Rohde F. C., Arndt R. G., Foltz, J. W., Quattro, J. M. 2009. Freshwater Fishes of South Carolina. University of South Carolina. University of South Carolina Press.
3 Pennsylvania Fish and Boat Commission. 2020. Gallery of Pennsylvania Fishes. Perches and Darters. Site accessed 12/8/20. https://www.fishandboat.com/Fish/PennsylvaniaFishes/GalleryPennsylvaniaFishes/Pages/PerchesandDarters.aspx
4 Pennsylvania Fish and Boat Commission. 2020. Gallery of Pennsylvania Fishes. Herrings. Site accessed 12/8/20. https://www.fishandboat.com/Fish/PennsylvaniaFishes/GalleryPennsylvaniaFishes/Pages/Herrings.aspx

**Table 4–4. Hydroelectric facility characteristics from the EPRI entrainment database comparable to Lake Lynn**

| Facility Name | Total Plant Capacity (cfs) | Operating Mode | Trash Rack Spacing (in) |
|---|---|---|---|
| Centralia | 3,640 | ROR | 3.5 |
| Crowley | 2,400 | ROR | 2.375 |
| Sandstone Rapids | 1,300 | PK | 1.75 |
| Schaghticoke | 1,640 | ROR | 2.125 |
| Twin Branch | 3,200 | ROR | 3 |
| Sherman Island | 6,600 | PK | 3.125 |
| Herrings | 3,610 | ROR | 4.125 |
| Townsend Dam | 4,400 | ROR | 5.5 |
| E.J. West | 5,400 | NA | 4.5 |
| Caldron Falls | 1,300 | PK | 2 |
| | | | |
| Lake Lynn | 10,143 | PK/ROR | 4 |

ROR = Run-of-river, PK= Peaking

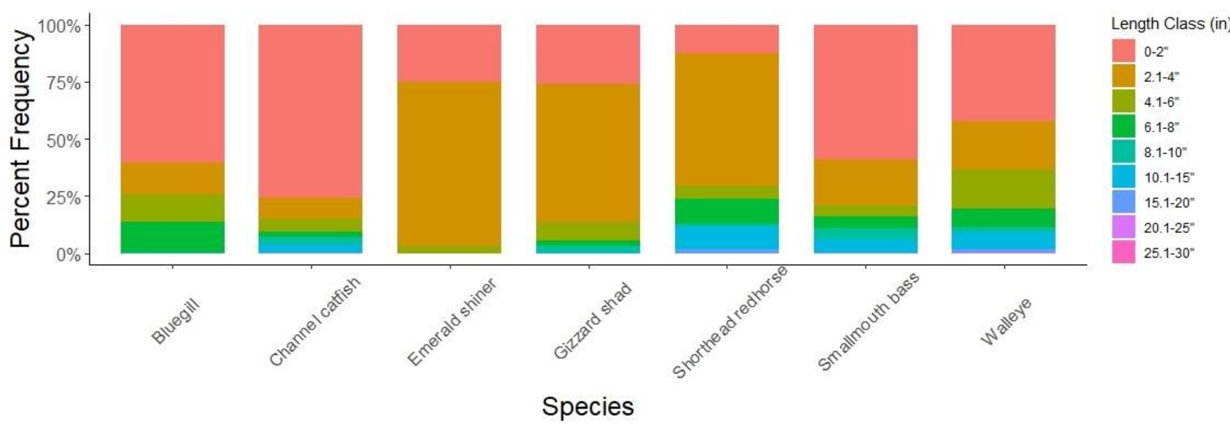



**Figure 4–1. Length class composition by target fish species from the subset of comparable hydroelectric projects within the EPRI 1997 database.**

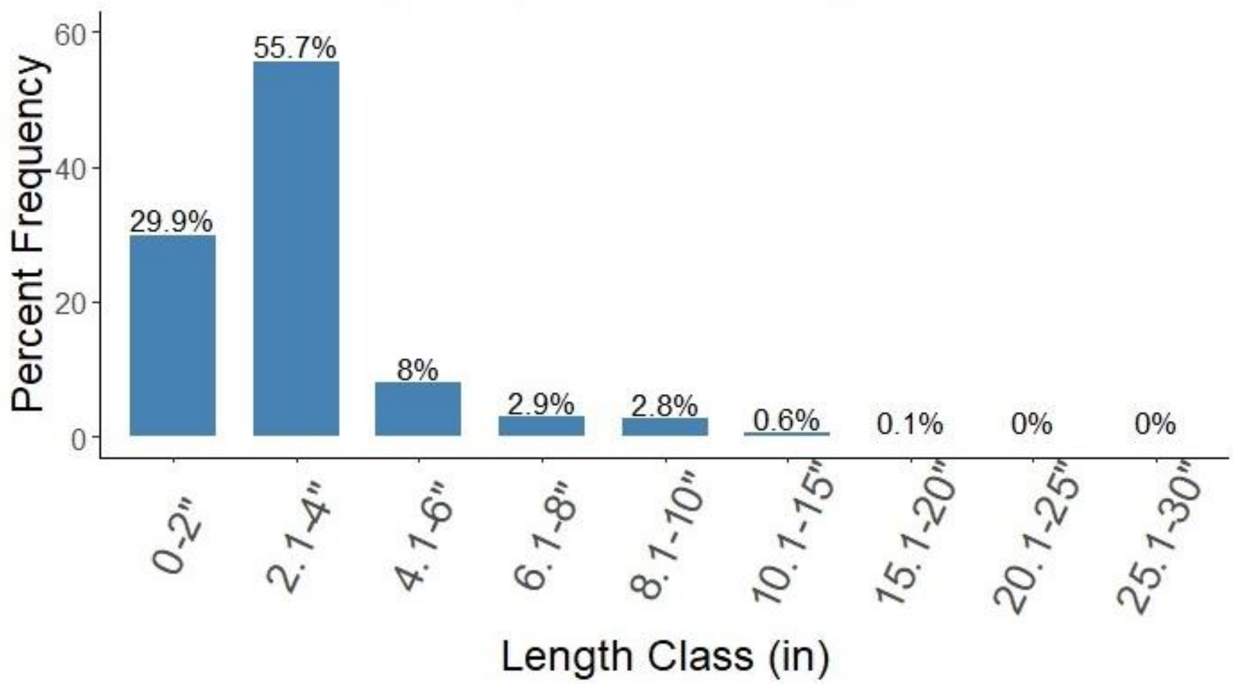



**Figure 4–2. Length class composition for target fish species combined from the subset of comparable hydroelectric projects within the EPRI 1997 database.**

## 4.5 Impingement Potential of Target Fish Species

A summary of burst swim speeds determined for each of the seven target fish species is presented in Table 4-5. These data were obtained using the Swim Speed & Swim Time Tool[1] (Katopodis and Gervais 2016; Di Rocco and Gervais 2020). The expected size range for each of the seven target fish species was evaluated relative to the data available in the Swim Speed & Swim Time Tool and five representative lengths were chosen for burst speed estimation from the database. For each target fish species, the five representative lengths included the upper and lower bounds of the anticipated size range for the Project area as well as the 25$^{th}$, 50$^{th}$, and 75$^{th}$ percentile lengths within that range. Each unique species-length combination was input into the Swim Speed & Swim Time Tool and produced a relationship for swim speed and swim time for a particular body length. For each body length selected to be assessed for each species, the following estimates were recorded:

1. Speed (ft/s) achieved by 97.5% of individuals of species X at body length Y for 3 seconds;
2. Speed (ft/s) achieved by 87.5% of individuals of species X at body length Y for 3 seconds;

[1] Available online at: http://www.fishprotectiontools.ca/speedtime.html

3. Speed (ft/s) achieved by 50% of individuals of species X at body length Y for 3 seconds;
4. Speed (ft/s) achieved by 12.5% of individuals of species X at body length Y for 3 seconds; and
5. Speed (ft/s) achieved by 2.5% of individuals of species X at body length Y for 3 seconds.

It is understood that burst swim speeds may vary greatly among different fish species as well as among sizes of the same species. However, variation exists within individuals of the same species and size class. Katopodis and Gervais (2016) demonstrate ascending physical capabilities as a smaller portion of the test fish are represented by each speed rating. For example, 97.5% of bluegill in the 6-inch size class are expected to be capable of achieving a speed of 2.98 fps for a period of 3 seconds, while only 2.5% of bluegill of the same size are expected to be able to achieve a speed of 6.96 fps for 3 seconds. For the purposes of this desktop evaluation values representing the 50$^{th}$ percentile of swim speed over a three second period were selected as representative of a fishes burst swim capability. The 50$^{th}$ percentile speed rating for the minimum, median, and maximum size of each of the seven target fish species is provided in Table 4-5. The full range of swim speed estimates for target fish species generated using the Swim Speed & Swim Time Tool are provided in Appendix A.

Figure 4-3 provides a visual representation of the reported burst speeds for the target species and size classes relative to the calculated intake velocities at the Project turbine units. The species and sizes of target fish likely to become impinged are those whose burst swim speeds are less than the approach velocity at the Project intake. The calculated intake approach velocity for each of the four Project turbines is 2.5 fps.

Four species-length class combinations have burst speeds less than the calculated intake velocities under maximum discharge conditions at Lake Lynn (Table 4-5). These species-length classes are the minimum sizes considered for bluegill (1.6 fps), channel catfish (2.4 fps), smallmouth bass (2.4 fps), and emerald shiner (2.3 fps). All other species-length class combinations were deemed capable of achieving a burst speed in excess of the project intake velocity—thus reducing the likelihood of impingement or entrainment at the Lake Lynn Project. It should be noted that of the four species-size class combinations with burst speeds lower than the calculated approach velocities, all would have a higher probability of being entrained than impinged as they will fit through the existing rack spacing at the Project.

Although the full range of body lengths assessed for gizzard shad as part of this evaluation are capable of a burst speed in excess of the calculated Project intake velocities, they will be a primary focus within the quantitative entrainment assessment due to the propensity for this species to experience extreme lethargy in cold temperatures (see Section 4.2.8). During periods of low water temperature gizzard shad tend to be less capable of escaping entrainment due to their tendency to become moribund.

**Table 4–5. Burst swim speed information compiled from scientific literature for target fish species**

| Common Name | Size potentially encountered in WV/PA (in) | Size included in burst speed estimate based on data availability | Burst Speed (fps) at minimum size[5] | Burst Speed (fps) at median size[5] | Burst Speed (fps) at maximum size[5] |
|---|---|---|---|---|---|
| Bluegill | 1.0-6.0[1] | 1.0-6.0 | 1.6* | 3.4 | 4.6 |
| Channel catfish | 2.0-50.0[1&2] | 2.0-21.0 | 2.4* | 6.8 | 9.7 |
| Smallmouth bass | 2.0-27.0[2] | 2.0-15.0 | 2.4* | 5.6 | 8.0 |
| Walleye | 2.0-36.0[1&3] | 2.0-20.0 | 3.6 | 10.6 | 15.4 |
| Shorthead redhorse | 2.0-10.0[1&2] | 2.0-10 | 3.6 | 7.2 | 10.0 |
| Emerald shiner | 1.0-5[1] | 1.0-3.0 | 2.3* | 3.6 | 4.7 |
| Gizzard shad | 2.0-7.0[4] | 2.0-7 | 5.2 | 9.3 | 12.7 |
| | 10.0-14.0[1] | 10.0-14 | 16.2 | 18.4 | 20.4 |

*Highlighted cells denote swim speeds that are slower than the intake velocity of one or more units at the Project
1 Smith, C. L. 1985. The Inland Fishes of New York State. Albany, NY. New York Department of Environmental Conservation.
2 Rohde F. C., Arndt R. G., Foltz, J. W., Quattro, J. M. 2009. Freshwater Fishes of South Carolina. University of South Carolina. University of South Carolina Press.
3 Pennsylvania Fish and Boat Commission. 2020. Gallery of Pennsylvania Fishes. Perches and Darters. Site accessed 12/8/20. https://www.fishandboat.com/Fish/PennsylvaniaFishes/GalleryPennsylvaniaFishes/Pages/PerchesandDarters.aspx
4 Pennsylvania Fish and Boat Commission. 2020. Gallery of Pennsylvania Fishes. Herrings. Site accessed 12/8/20. https://www.fishandboat.com/Fish/PennsylvaniaFishes/GalleryPennsylvaniaFishes/Pages/Herrings.aspx
5 Katopodis, C, and R Gervais. 2016. Fish Swimming Performance Database and Analyses. DFO Can. Sci. Advis. Sec. Res. Doc. 2016/002., 550.

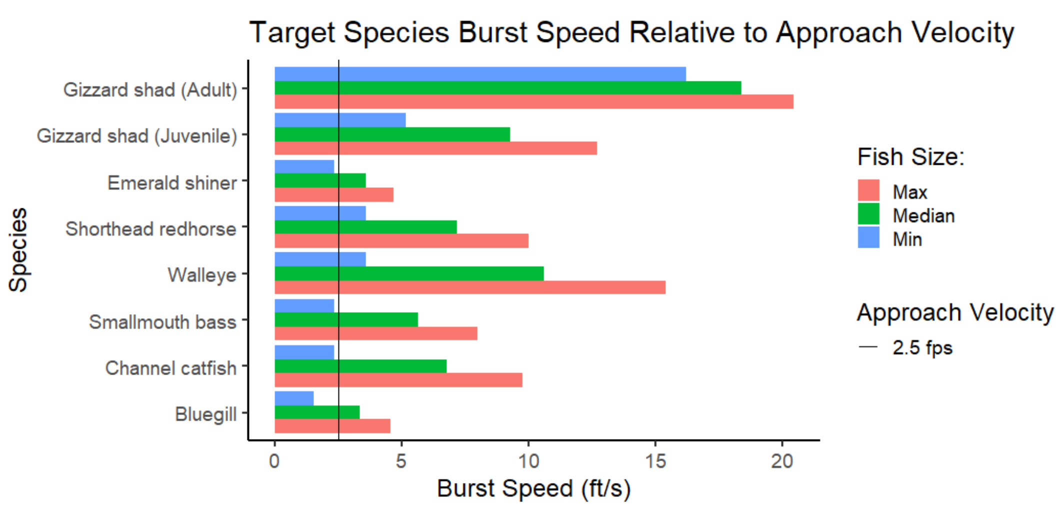



**Figure 4–3. Burst swim speed of target fish species compared to calculated approach velocities at the Lake Lynn intakes.**

## 4.6 Turbine Survival Evaluation

Tables 4-6 and 4-7 provide a summary of the calculated TBSA turbine survival estimates for fish entrained at Francis Units 1, 3, and 4 and Francis Unit 2, respectively. Survival values were estimated for the range of body lengths anticipated to be prone to entrainment based upon the minimum exclusion sizes presented in Table 4-3. As would be expected, estimates of turbine passage were inversely related to body length with highest survival estimated for fish at 2 inches of length (~94%) and the lowest for fish at 30 inches of length (10-15%).

## 4.7 Electric Power Research Institute (EPRI) Turbine Survival Database Review

Upon review of the EPRI (1997) survival database, two hydroelectric facilities had comparable characteristics for a direct comparison with Lake Lynn (Table 4-8). However, previously quantified survival rates were available in the EPRI survival database for only two of the target species evaluated as part of this assessment (bluegill and walleye; Table 4-9). When examined across comparable site locations, estimates of 48-hour latent survival based on recovered 4-inch bluegill ranged from 66% to 100%. Latent 48-hour survival based on recovered walleye was 77% for individuals ranging between 6-25 inches.

In general, survival through turbines is related to fish size, with the smaller fish entrained typically having higher survival rates than larger fish. Winchell et al. (2000) provides a review of the EPRI (1997) database, and a generalized summary of survival based on turbine type, runner speed, and fish size (Table 4-10). Winchell et al. (2000) reports mean survival rates (all fish species combined) for low-speed Francis units to range from 93.9% for fish ≤ 4 inches to 73.2% for fish ≥ 12 inches.

## 4.8 Qualitative Assessment of Entrainment and Turbine Survival Potential

Evaluating entrainment potential of the seven target fish species at the Project required combining and synthesizing the species-specific behavioral traits, life stages, and swimming capabilities and comparing them to the Project's unique intake, water conveyance and infrastructure characteristics. The blending of these factors yielded a qualitative assessment of whether or not an individual of the target fish species will potentially entrain through the Project's intakes or not. If a fish becomes entrained, a secondary evaluation of the potential of that individual surviving passage through the Project's turbines depended primarily on its length and the physical dimensions as well as operating conditions of the turbines at the time of passage. The final qualitative assessment of the potential for surviving downstream passage at the Project took into consideration and summarized all of the factors that influenced entrainment and turbine passage. The results of this qualitative assessment are presented in Table 4-11.

Entrainment potential as a function of behavior, habitat use and life history was ranked as 'low' for nearly all of the target fish species considered in this evaluation with the exception of gizzard shad. The lack of high-quality aquatic habitat in the immediate vicinity of the intake structure coupled with the fact that none of those fish species are considered an obligatory migrant contributed to the low entrainment potential. With regards to gizzard shad, their susceptibility to colder water temperatures and downstream movement of juvenile individuals during the fall season resulted in a qualitative entrainment rank of 'high' for the species. When considered on its own, the existing 4-inch intake rack spacing at the Project resulted in an entrainment potential rank of 'high" for nearly all species and life stages. Only adult channel catfish and walleye are expected to achieve a minimum exclusion length suitable to physically avoid entrainment at the Project with the existing 4-inch intake rack spacing. Conversely, the calculated approach velocities for the turbine units at Lake Lynn under maximum generation conditions resulted in an entrainment potential rank of 'low' for adults of nearly all seven of the target fish species. The juvenile life stage for several of the target fish species (bluegill, channel catfish, smallmouth bass, and emerald shiner) received an entrainment potential rank of moderate to high due to their reported burst swim capabilities relative to approach velocities at the Project intake. Gizzard shad are capable of reaching a burst swim speed in excess of calculated approach velocities at Lake Lynn. However, to account for their reaction to lowered thermal conditions they were assigned a more conservative rank of 'moderate' relative to swim capabilities at the intake.

When the four factors summarized in Table 4-11 are considered it is likely that gizzard shad will have the highest susceptibility to entrainment at the Project. Their seasonal behavior and response to cold temperatures may make them more vulnerable than the other species considered in this evaluation. The other six target fish species are not anticipated to be present in the immediate vicinity of the intake under most conditions. In the event that they are it is expected that the adult life stage for those six target species have the ability to exceed approach velocities at the intake area or in the case of two species may be effectively screened by the intake rack. If present in the immediate intake area the juvenile life stages of those six species will have a higher likelihood of entrainment due to their slower burst speeds and small body size. However, as noted in Tables 4-6 and 4-7 fish under six inches in length are expected to have a high rate of survival following downstream passage via the Lake Lynn turbine units. These size classes are representative of juvenile fish species (Table 4-11).

**Table 4–6. TBSA predicted survival estimates for passage through Units 1, 3 or 4 at Lake Lynn for body lengths with a probability of entrainment based on rack spacing and minimum exclusion length**

| Unit | Units 1, 3, and 4 | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Fish Body Length | 2 in | 4 in | 6 in | 8 in | 10 in | 12 in | 14 | 19 | 24 | 30 |
| Survival rate | 94.6% | 88.5% | 82.8% | 77.7% | 73.9% | 67.9% | 60.7% | 43.7% | 32.6% | 15.5% |

Values calculated for Units 1, 3, 4 at maximum rated capacity (2,425 cfs per unit), 80% efficiency, and correlation coefficient = 0.2

**Table 4–7. TBSA predicted survival estimates for passage through Unit 2 at Lake Lynn for body lengths with a probability of entrainment based on rack spacing and minimum exclusion length**

| Unit | Unit 2 | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Fish Body Length | 2 in | 4 in | 6 in | 8 in | 10 in | 12 in | 14 | 19 | 24 | 30 |
| Survival rate | 93.7% | 87.9% | 81.8% | 74.1% | 68.6% | 62.7% | 56.8% | 40.1% | 27.8% | 9.9% |

Values calculated for Unit 2 at maximum rated capacity (2,868 cfs), 80% efficiency, and correlation coefficient = 0.2

**Table 4–8. Hydroelectric facility characteristics from the EPRI turbine survival database comparable to the Lake Lynn Project**

| Facility Name | Turbine Type | Rated Head (ft) | Rated Flow (cfs) Per unit | Speed (rpm) | Runner Diameter (ft) | Runner Blades |
|---|---|---|---|---|---|---|
| E.J. West | Francis (vertical) | 63 | 2,450 | 112.5 | 10.9 | 15 |
| Hardy | Francis (vertical) | 100 | 1,500 | 163.6 | 7 | 16 |
| | | | | | | |
| Lake Lynn unit 1,3 & 4 | Francis | 81.5 | 2425 | 133.3 | 10.8 | 16 |
| Lake Lynn unit 2 | Francis | 81.5 | 2868 | 133.3 | 10.8 | 17 |

**Table 4–9. Turbine survival estimates of target species from the EPRI turbine survival database**

| Project Name | Species | Length (in) | | Based on Number Released | | | Based on number recovered | | | Control | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Min | Max | Immediate Survival (%) | 24-hr. Survival (%) | 48-hr. Survival (%) | Immediate Survival (%) | 24-hr. Survival (%) | 48-hr. Survival (%) | Immediate Survival (%) | 24-hr. Survival (%) | 48-hr. Survival (%) |
| E.J. West | Bluegill | - | 4 | 1.26 | - | 1.71 | 1.11 | - | 1.51 | 0.79 | - | 0.36 |
| | Bluegill | - | 4 | 0.44 | - | 0.41 | 0.7 | - | 0.66 | 0.93 | - | 0.58 |
| | Bluegill | - | 4 | 0.21 | - | 0.24 | 0.59 | - | 0.67 | 0.99 | - | 0.62 |
| Hardy | Bluegill | 4.7 | 7.3 | 0.98 | 0.91 | 0.93 | 0.96 | 0.9 | 0.92 | 1 | 1 | 0.98 |
| | Bluegill | 3.1 | 5.9 | 0.77 | 0.67 | 0.71 | 0.97 | 0.85 | 0.9 | 1 | 0.98 | 0.93 |
| | Walleye | 5.8 | 25 | 0.83 | 0.83 | 0.81 | 0.8 | 0.8 | 0.77 | 0.97 | 0.94 | 0.94 |

**Table 4–10. Fish survival rates for generating units comparable to Project based on EPRI (1997) database and summarized by Winchell (2000)**

| Turbine Type | Runner Speed (rpm) | Hydraulic Capacity (cfs) | Fish Size (mm) | Average immediate survival (all species combined) | | |
|---|---|---|---|---|---|---|
| | | | | Minimum | Maximum | Mean |
| Lake Lynn Units 1, 3, 4 (Francis) | 133.3 | 2,425 each | N/A | | | |
| Lake Lynn Unit 2 (Francis) | 133.3 | 2,868 each | N/A | | | |
| Radial Flow (Francis) Winchell (2000) | <250 | 440-1,600 | <100 | 85.9% | 100% | 93.9% |
| | | 370-1,600 | 100-199 | 74.8% | 100% | 91.6% |
| | | 370, 2,450 | 200-299 | 59.0% | 100% | 86.9% |
| | | 440-1,600 | 300+ | 36.1% | 100% | 73.2% |

**Table 4–11. Burst swim speed information compiled from scientific literature for target fish species**

| Species and Life Stage | | Entrainment Potential | | | Turbine Survival Potential |
|---|---|---|---|---|---|
| | | Behavior, Habitat and Life History | Body Size compared to Trash Rack Clear Spacing (4-inch) | Swim Speed compared to Approach Velocity (2.5 fps) | |
| **Bluegill** | Adult | L | H | L | H-M |
| | Juvenile | | | H | H |
| **Channel Catfish** | Adult | L | M | L | M-L |
| | Juvenile | | H | H | H |
| **Smallmouth Bass** | Adult | L | H | L | M-L |
| | Juvenile | | | H | H |
| **Walleye** | Adult | L | M | L | M-L |
| | Juvenile | L | H | L | H |
| **Shorthead Redhorse** | Adult | L | H | L | M-L |
| | Juvenile | | | L | H |
| **Emerald Shiner** | Adult | L | H | L | H |
| | Juvenile | | | H | H |
| **Gizzard Shad** | Adult | L | H | M* | M-L |
| | Juvenile | | | M* | H |

*Likelihood relative to burst speed is low, however, this species is susceptible is to lethargic behavior during the winter months, leading to less responsive burst movements

## 4.9 Quantitative Assessment of Entrainment and Turbine Survival Potential

Information contained in the EPRI (1997) data compilation and other sources were used to compile a qualitative assessment of the potential entrainment of target fishes at Lake Lynn (see Section 4.8 of this report). Likewise, a desktop approach, relying on modeled and empirical data, was conducted to provide estimates of fish survival during turbine entrainment (see Section 4.6 of this report). In addition to the previously described qualitative entrainment assessment for the Lake Lynn Project, a quantitative estimate of entrainment during generation at the Project was calculated. The resulting entrainment estimate was then combined with modeled survival rates for fish passing through the Project turbine units.

In the absence of site-specific entrainment data at the Lake Lynn Project, the quantitative estimates presented here relied on a combination of site-specific operations data and surrogate fish entrainment rates available from similar hydroelectric projects. Quantitative estimates of entrainment at Lake Lynn were calculated for each of the target fish species. As noted in Section 4.8, the susceptibility to colder water temperatures and downstream movement of juvenile individuals during the fall season described in the literature for gizzard shad can result in seasonal increases in entrainment for that species.

### *4.9.1 Site-Specific Operations Data*

Flow duration curves for the Project were obtained from Appendix E of the PAD and used to develop estimated values of turbine unit discharge for use in the quantitative entrainment analysis. Values for the 10$^{th}$, 25$^{th}$, 50$^{th}$, 75$^{th}$, and 90$^{th}$ exceedance conditions were extracted from the flow duration curves for each calendar month. For each month-exceedance condition combination, values were adjusted for station capacity. For instances where the river flow was in excess of station capacity it was assumed the Project was operating at its capacity of 10,768 cfs and for instances where the river flow was less than station capacity it was assumed the Project was operating at the available inflow less the required 212 cfs minimum flow. The resulting discharge rate (i.e., cubic feet per second) was applied to the full month (i.e., cfs * 86,400 seconds per day * no. days per month) to generate an estimate of the total volume ($ft^3$) of water passing through the Project turbines. The resulting monthly volume estimates for the five exceedance conditions are presented in Table 4-12.

### *4.9.2 Summary of Fisheries Entrainment Data*

Of the 43 projects contained in the EPRI (1997) database, a total of ten (Table 4-4) were identified for comparison to Lake Lynn for evaluation of entrained species and sizes (see Section 4.4) and two projects were identified for evaluation of survival (see Section 4.7). Of the ten comparable projects used for evaluation of entrainment, only one, Townsend Dam, included volume based entrainment density information for all seven of the target fish species included in this evaluation. Townsend Dam is located in New Brighton, PA, so is also a reasonable comparison due to its relative proximity to the Lake Lynn Project. Fisheries entrainment rate data collected during netting studies conducted during the early 1990’s at Townsend Dam were selected as the best available surrogate of entrainment rate data for the full set of target species considered at the Lake Lynn Project.

Within any comparison among hydroelectric projects, site-specific differences in facilities and equipment as well as the manner in which they are operated will exist. Townsend Dam has a smaller hydraulic capacity (4,400 cfs) in comparison to that at Lake Lynn (10,143 cfs), two turbines versus four, and is operated in a true run-of-river mode. The section of the Beaver River (a tributary within the Ohio River basin) upstream of Townsend Dam is more riverine in nature (0.9 mile impoundment) than the larger Cheat Lake located upstream of Lake Lynn Project (13 mile impoundment). Lastly, the intake rack clear spacing at Townsend dam is 5.5 inches, while the Lake Lynn spacing is 4 inches.

In addition to differences between the stations and their source water bodies, variability in the relative proportions and densities of individual fish species within the community needs to be considered and may be influenced by a variety of factors including water quality, habitat availability, flow, and overall productivity. For example, relative abundance data for gizzard shad collected during eight sampling seasons by boat electrofishing in Cheat Lake suggests the species is the twentieth most frequently sampled species. However, gizzard shad comprised the vast majority of entrainment samples collected at Townsend Dam (88%). As a result, available gizzard shad density data from Minetto Dam in Fulton, NY and the Richard B. Russell pump storage station on the Savannah River, GA/SC were also used to provide a range of estimates of entrainment for the species at Lake Lynn. Based on the identified available entrainment density information, the following estimates were generated for the target species considered in this evaluation:

- Bluegill – based on available monthly entrainment rates from Townsend Dam;
- Channel catfish – based on available monthly entrainment rates from Townsend Dam;
- Smallmouth bass – based on available monthly entrainment rates from Townsend Dam;
- Walleye – based on available monthly entrainment rates from Townsend Dam;
- Emerald shiner – based on available monthly entrainment rates from Townsend Dam;
- Shorthead redhorse – based on available monthly entrainment rates from Townsend Dam; and
- Gizzard shad – based on available monthly entrainment rates from Townsend Dam, Minetto Dam, and Richard B. Russell pump storage.

Entrainment monitoring at Townsend and Minetto Dams was conducted during all months of the year and at the Richard B. Russell Project was conducted during the months of April-November. The quantitative estimates of entrainment at the Lake Lynn Project presented in this report reflect all available data, with some months being blank because individuals of a particular species were not entrained at the comparison projects. The EPRI (1997) data compilation provides the total number of collected fish by species and adjusted for net collection efficiency as well as the total volume of water sampled through the collection nets. Theoretical estimates of entrainment densities for target and surrogate species were calculated on a monthly basis using the equation:

$$D_i = \frac{C_x}{G_x}$$

where:

$D_i$ = density of fish species A per cubic foot of sampling flow;

$C_x$ = count of the number of fish species A during month $x$, and

$G_x$ = sampling volume in cubic feet for month $x$.

Monthly entrainment rates used to calculate estimated entrainment for target fish species at Lake Lynn are provided in Appendix B. Tables in Appendix B provide the reported monthly values for raw number of individuals collected, volume of water sampled ($ft^3$), and the resulting species-specific density ($\#/ft^3$) for each target species at the comparison projects.

### *4.9.3 Quantitative Estimates of Entrained Individuals by Species*

Monthly operating volumes for the 50% exceedance condition (Table 4-12) and target species densities obtained from comparative projects were used to calculate estimates of entrainment during generation at Lake Lynn (Table 4-13)[2]. Based on the assumption that entrainment rates observed at Townsend Dam and reported by EPRI (1997) are an accurate representation of entrainment rates for the target fish species at Lake Lynn, an estimated 7,167 channel catfish, 6,114 bluegill, 2,102 walleye, 891 smallmouth bass, 124 emerald shiner, and 115 redhorse are entrained on an annual basis at the Project. Estimates of annual entrainment count for gizzard shad at Lake Lynn vary widely dependent on the comparative project selected. Based on the assumption that the reported entrainment rates for gizzard shad at the Townsend, Minetto, and Richard B. Russell Projects are representative of those for gizzard shad at Lake Lynn, annual entrainment for the species ranges from 265 individuals up to 14 million individuals (Table 4-13). The extreme variation in the predicted entrainment estimates for gizzard shad at Lake Lynn calculated using densities from the three comparative projects suggests that the species can be susceptible to entrainment, particularly during the colder months of the year. However, the assumption that site-specific entrainment rates for this species are readily transferable between sites may not be appropriate.

### *4.9.4 Predicted Entrainment Survival*

The predicted number of entrained individuals for each target fish species (Table 4-13) was combined with the estimated survival rates for turbine units at Lake Lynn obtained using the TBSA to calculate the estimated number of individuals lost during turbine passage. Prior to calculation, the total entrainment estimates for each target species were categorized into length classes based on proportions observed for catch at the project from which the data were

[2] A full listing of entrainment estimates for target species under the range of exceedance conditions in Table 5-1 can be found in Appendix C.

reported by EPRI (1997). Estimated numbers of entrained individuals within each length class were then used in combination with modelled survival rates for passage through the Lake Lynn turbines to obtain an estimate of mortality for each species at the Lake Lynn Project. A species-specific mortality rate was then calculated as the proportion of the total entrainment estimate for each species represented by individuals predicted to be lost during turbine passage.

Table 4-14 provides a summary of the estimated monthly number of each target fish species entrained at Lake Lynn broken out by length class proportions associated with the site-specific entrainment rates reported for other hydroelectric projects by EPRI (1997). Based on the assumption that entrainment rates observed at Townsend Dam and reported by EPRI (1997) are an accurate representation of entrainment rates for the target fish species at Lake Lynn and incorporation of the size-specific turbine survival rates obtained during the TBSA exercise, an estimated 1,470 channel catfish, 706 bluegill, 557 walleye, 160 smallmouth bass, 16 emerald shiner, and 42 redhorse are lost during turbine passage on an annual basis at the Project. When viewed as a percentage of the total number estimated to be entrained on an annual basis at Lake Lynn under a median flow condition, these numbers represented between 12 and 37% of the total number for each species estimated to be entrained.

Similar to the estimates of abundance for entrained gizzard shad (see Section 4.9.3), the estimated rate of mortality for the species varied widely depending on which of the projects in the EPRI 1997 database was used as a source for “representative” density data. Estimated percent mortality for entrained gizzard shad ranged from a low of 8% using Townsend Dam density data, to a high of 35% using Richard B. Russell density data. This wide range of these estimates further highlights the idea that site-specific entrainment data for gizzard shad may not be transferable between sites.

**Table 4–12. Monthly generation volume (ft3) at Lake Lynn as estimated from site-specific flow curves provided in Appendix E of PAD**

| % Exceeded | JAN | FEB | MAR | APR | MAY | JUN |
|---|---|---|---|---|---|---|
| **10** | 2.88E+10 | 2.60E+10 | 2.63E+10 | 2.79E+10 | 2.88E+10 | 2.72E+10 |
| **25** | 2.18E+10 | 2.60E+10 | 1.83E+10 | 2.40E+10 | 2.88E+10 | 9.21E+09 |
| **50** | 1.10E+10 | 2.47E+10 | 1.00E+10 | 1.19E+10 | 1.46E+10 | 4.40E+09 |
| **75** | 4.70E+09 | 7.23E+09 | 5.67E+09 | 5.58E+09 | 6.77E+09 | 3.11E+09 |
| **90** | 2.48E+09 | 3.44E+09 | 2.51E+09 | 4.08E+09 | 3.88E+09 | 1.73E+09 |
| **% Exceeded** | **JUL** | **AUG** | **SEP** | **OCT** | **NOV** | **DEC** |
| **10** | 2.07E+10 | 7.05E+09 | 2.79E+10 | 2.88E+10 | 2.47E+10 | 2.88E+10 |
| **25** | 8.26E+09 | 4.70E+09 | 5.32E+09 | 1.03E+10 | 1.77E+10 | 2.20E+10 |
| **50** | 4.01E+09 | 3.41E+09 | 1.46E+09 | 3.13E+09 | 8.06E+09 | 1.01E+10 |
| **75** | 2.29E+09 | 1.90E+09 | 9.27E+08 | 1.59E+09 | 3.16E+09 | 4.98E+09 |
| **90** | 1.69E+09 | 1.39E+09 | 7.73E+08 | 1.18E+09 | 1.60E+09 | 2.69E+09 |

**Table 4–13. Estimated entrainment for target fish species at Lake Lynn under a 50% exceedance condition and calculated using entrainment density data reported by EPRI (1997) at the Townsend, Minetto Richard B. Russell Projects. Unless otherwise indicated estimates are based on density data collected at the Townsend Project**

| Species | JAN | FEB | MAR | APR | MAY | JUN | JUL | AUG | SEP | OCT | NOV | DEC |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Gizzard shad (Townsend Dam) | 143,547 | 12,126 | 144,870 | 2,009 | 1,230 | 58 | 76,477 | 10,083 | 100,225 | 1,907,612 | 795,825 | 11,142,179 |
| Gizzard shad (Minetto) | 7,802 | 3,238 | 3,065 | 507 | 10 | 0 | 10 | 94,618 | 84 | 173,556 | 384,933 | 390 |
| Gizzard shad (Richard B. Russell) | 0 | 0 | 0 | 73 | 0 | 12 | 80 | 29 | 0 | 16 | 55 | 0 |
| Smallmouth bass | 0 | 0 | 35 | 57 | 434 | 202 | 118 | 25 | 18 | 0 | 0 | 0 |
| Bluegill | 199 | 485 | 526 | 344 | 1,013 | 260 | 177 | 89 | 36 | 629 | 1,828 | 527 |
| Walleye | 119 | 291 | 35 | 172 | 217 | 0 | 89 | 25 | 18 | 22 | 103 | 1,010 |
| Emerald shiner | 80 | 0 | 0 | 0 | 0 | 0 | 44 | 0 | 0 | 0 | 0 | 0 |
| Channel catfish | 0 | 291 | 245 | 287 | 4,558 | 665 | 429 | 433 | 171 | 43 | 0 | 44 |
| Shorthead redhorse | 0 | 0 | 0 | 115 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

**Table 4–14. Estimated entrainment of target fish species at at Lake Lynn under a 50% exceedance condition adjusted for survival using predicted size-specific rates generated for Units 1, 3, and 4 using the TBSA model**

| Species | | Size Class (Inches) | | | | | | | | | | Estimated Total for Lake Lynn | Percent Total Mortality |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 0-2 | 2-4 | 4-6 | 6-8 | 8-10 | 10-15 | 15-20 | 20-25 | 25-30 | 30+ | | |
| Gizzard shad (Townsend Dam) | Proportion of fish entrained | 47.2% | 46.8% | 3.9% | 0.9% | 1.1% | 0.1% | 0.0% | 0.0% | 0.0% | 0.0% | 14,336,240 | 8% |
| | Calculated Mortality | 358,715 | 698,516 | 88,421 | 26,060 | 39,714 | 3,963 | 18 | 0 | 0 | 0 | 1,215,408 | |
| Gizzard shad (Minetto) | Proportion of fish entrained | 0.0% | 26.3% | 59.4% | 13.7% | 0.6% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 668,213 | 15% |
| | Calculated Mortality | 6 | 18,295 | 62,292 | 19,145 | 985 | 11 | 0 | 0 | 0 | 0 | 100,735 | |
| Gizzard shad (Richard B. Russell) | Proportion of fish entrained | 0.0% | 6.7% | 0.0% | 0.0% | 0.0% | 93.3% | 0.0% | 0.0% | 0.0% | 0.0% | 265 | 35% |
| | Calculated Mortality | 0 | 2 | 0 | 0 | 0 | 90 | 0 | 0 | 0 | 0 | 92 | |
| Smallmouth bass | Proportion of fish entrained | 7.4% | 14.8% | 40.7% | 7.4% | 25.9% | 3.7% | 0.0% | 0.0% | 0.0% | 0.0% | 891 | 18% |
| | Calculated Mortality | 3 | 14 | 57 | 14 | 60 | 12 | 0 | 0 | 0 | 0 | 160 | |
| Bluegill | Proportion of fish entrained | 19.3% | 50.9% | 19.9% | 9.4% | 0.6% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 6,114 | 12% |
| | Calculated Mortality | 63 | 324 | 191 | 120 | 9 | 0 | 0 | 0 | 0 | 0 | 706 | |
| Walleye | Proportion of fish entrained | 0.00% | 2.00% | 2.00% | 35.18% | 22.72% | 34.09% | 4.00% | 0.00% | 0.00% | 0.00% | 2,102 | 27% |
| | Calculated Mortality | 0 | 4 | 7 | 151 | 103 | 252 | 40 | 0 | 0 | 0 | 557 | |

| Species | | Size Class (Inches) | | | | | | | | | | Estimated Total for Lake Lynn | Percent Total Mortality |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 0-2 | 2-4 | 4-6 | 6-8 | 8-10 | 10-15 | 15-20 | 20-25 | 25-30 | 30+ | | |
| **Emerald shiner** | Proportion of fish entrained | 0.0% | 60.0% | 40.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 124 | 13% |
| | Calculated Mortality | 0 | 8 | 8 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 16 | |
| **Channel catfish** | Proportion of fish entrained | 1.1% | 14.0% | 40.3% | 18.3% | 14.0% | 7.5% | 4.3% | 0.5% | 0.0% | 0.0% | 7,167 | 21% |
| | Calculated Mortality | 4 | 104 | 454 | 274 | 260 | 197 | 152 | 24 | 0 | 0 | 1,470 | |
| **Shorthead redhorse** | Proportion of fish entrained | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 100.0% | 0.0% | 0.0% | 0.0% | 0.0% | 115 | 37% |
| | Calculated Mortality | 0 | 0 | 0 | 0 | 0 | 42 | 0 | 0 | 0 | 0 | 42 | |

# 5 Summary

The Cheat River supports both warm water and cool water fish species including popular game species such as largemouth bass, smallmouth bass, trout, crappie, walleye, and channel catfish. Community data for biological sampling conducted upstream of Lake Lynn in Cheat Lake documented 35 fish species between 2011 and 2015. Seven species were identified as representative of that community and were included in this desktop assessment of fish entrainment at the Project (bluegill, channel catfish, smallmouth bass, walleye, emerald shiner, golden redhorse, and gizzard shad). Life history information for the target fish species was reviewed and based on the available habitat requirements and behavioral responses to environmental conditions it was determined that gizzard shad are the target species most susceptible to entrainment at the Project. Gizzard shad are abundant in reservoirs where they are found and tend to school together in the pelagic zone. These fish may be present in the vicinity of the Project intakes and could be entrained. Though they are capable of swimming against intake velocities, they may follow the flow or become entrained while attempting to escape predators. These fishes will succumb or become moribund at prolonged cold-water temperatures below about 38°F. Young gizzard shad may move downstream out of reservoirs during fall and early winter and their tendency to become moribund as their lower temperature threshold is approached furthers their susceptibility to entrainment. As a result, entrainment of shad tends to peak in the fall and winter in reservoirs where they are abundant. The entrainment potential for the remaining target fish species is expected to be low given the lack of high-quality aquatic habitat in the immediate vicinity of the intake structure coupled with the fact that none of the additional fish species are considered obligatory migrants.

Nearly all of the target fish species are unlikely to attain a minimum body size that would be excluded based solely on the existing 4-inch clear spacing at the Project intakes. Only two species, channel catfish and walleye, are likely to achieve a size too large to fit through the existing intake racks. Intake approach velocities, a factor impacting involuntary entrainment and impingement, were calculated at 2.5 fps. When these intake velocities are considered, only the smallest size classes (i.e., less than 2 inch) of bluegill, channel catfish, smallmouth bass and emerald shiner are at risk of entrainment due to burst swim capabilities less than the calculated approach velocities. Reported burst swim capabilities for the larger size classes of those species as well as all size classes for the remaining three target species are in excess of the expected intake velocities. This is further supported by a review of the EPRI (1997) database which resulted in ten hydroelectric projects with similar characteristics to Lake Lynn at which entrainment studies were conducted. Six of the target species and one surrogate species were identified in the entrainment data from the ten comparable projects and the majority of fish entrained were less than 4 inches in length.

In general, entrainment for most of the target fish species considered during this evaluation is not anticipated to be high at Lake Lynn. As demonstrated at comparable hydroelectric projects (EPRI 1997), the majority of individuals representing the target fish species were less than four inches in length (i.e., likely representative of primarily juvenile fish). Relative to Lake Lynn, the entrainment of juvenile life stages of target species during generation at the Project is probably incidental as they are likely more abundant in shoreline littoral habitat than the pelagic or deep-water benthic habitat in front of the Lake Lynn intake rack structure. Gizzard shad are the target species most likely to be seasonally entrained during periods of low water temperatures. However, due to their high burst speed swimming capability at all sizes, they are expected to have relatively low entrainment susceptibility during the warmer months of the year.

In the event individuals are entrained, TBSA assessments were conducted for fish lengths representative of the size range of target species with potential to fit through the existing rack spacing at Lake Lynn. The TBSA analysis produced a range of survival estimates for turbine survival through the four Francis units at the Project and were slightly higher for Units 1, 3, and 4 than for the recently modified Unit 2. Within the range of size classes evaluated, survival increased with decreasing body size, a trend also identified in a review of the EPRI (1997) database and consistent with the findings in Winchell et al. (2000). Survival rates calculated for size classes representative of juvenile life stages (i.e., those less than or equal to six inches) ranged from 84-95%.

In addition to the qualitative evaluation for the seven target fish species, quantitative estimates of entrainment and entrainment survival were calculated. Density data available from the EPRI (1997) database was combined with estimated monthly generation volumes to calculate estimates of monthly entrainment for the seven target species. It is important to note that the monthly entrainment estimates are based on the assumption that entrainment rates observed at projects reported by EPRI (1997) are an accurate representation of entrainment rates for the target fish species at Lake Lynn. Assuming this is accurate, annual entrainment estimates for species other than gizzard shad ranged from a low of 115 individuals (redhorse) to a high of 7,167 individuals (channel catfish). Three different sets of monthly entrainment density data were pulled from the EPRI (1997) database to calculate estimates for gizzard shad entrainment at the Project and produced a wide range of estimates with the highest estimate over 14 million individuals entrained annually and a low estimate of 265 individuals entrained annually. The wide range of estimated annual entrainment numbers suggest that entrainment rates for gizzard shad may not be readily transferable between sites.

Entrainment estimates for each target species were adjusted to reflect the predicted survival rates generated during the TBSA analysis for the Lake Lynn turbine units. The percentage of the annual entrainment expected to experience mortality was generally low, ranging from 12% of entrained individuals for bluegill to 37% of entrained individuals for redhorse. Similar to the observations for overall abundance, the estimates for the rate of entrainment mortality for gizzard shad varied from a low of 8% of entrained individuals when based on density information available from Townsend Dam to 35% of entrained individuals when based on density information available from Richard B. Russell.

In summary, entrainment potential for most of the target species is anticipated to be low due to a low likelihood of encountering the Project intakes and the lack of obligatory migrants within the system. Of the seven target fish species, gizzard shad are the most likely to be exposed to entrainment at Lake Lynn given their lowered activity and ability to respond during periods of low water temperatures.

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# Appendix A: Supporting Information for Burst Speed Analysis

| Bluegill | | | | | |
|---|---|---|---|---|---|
| % Indicates portion of test fish able to achieve speed listed (fps) for 3 seconds | | | | | |
| Size (in) | 97.50% | 87.50% | 50% | 12.50% | 2.50% |
| 1 | 1.01 | 1.21 | **1.55** | 1.99 | 2.37 |
| 2.25 | 1.63 | 1.94 | 2.49 | 3.19 | 3.81 |
| 3.5 | 2.19 | 2.61 | **3.35** | 4.30 | 5.12 |
| 4.75 | 2.60 | 3.10 | 3.97 | 5.09 | 6.07 |
| 6 | 2.98 | 3.54 | **4.56** | 5.84 | 6.96 |

| Channel catfish | | | | | |
|---|---|---|---|---|---|
| % Indicates portion of test fish able to achieve speed listed (fps) for 3 seconds | | | | | |
| Size (in) | 97.50% | 87.50% | 50% | 12.50% | 2.50% |
| 2 | 1.54 | 1.83 | **2.35** | 3.02 | 3.58 |
| 6.75 | 3.21 | 3.81 | 4.89 | 6.30 | 7.48 |
| 11.5 | 4.43 | 5.28 | **6.76** | 8.66 | 10.34 |
| 16.25 | 5.48 | 6.53 | 8.40 | 10.76 | 12.83 |
| 21 | 6.37 | 7.58 | **9.74** | 12.50 | 14.90 |

| Smallmouth bass | | | | | |
|---|---|---|---|---|---|
| % Indicates portion of test fish able to achieve speed listed (fps) for 3 seconds | | | | | |
| Size (in) | 97.50% | 87.50% | 50% | 12.50% | 2.50% |
| 2 | 1.54 | 1.83 | **2.35** | 3.02 | 3.58 |
| 5.25 | 2.79 | 3.31 | 4.27 | 5.48 | 6.53 |
| 8.5 | 3.71 | 4.40 | **5.64** | 7.25 | 8.63 |
| 11.75 | 4.53 | 5.38 | 6.89 | 8.86 | 10.53 |
| 15 | 5.22 | 6.20 | **7.97** | 10.20 | 12.17 |

| Walleye | | | | | |
|---|---|---|---|---|---|
| % Indicates portion of test fish able to achieve speed listed (fps) for 3 seconds | | | | | |
| Size (in) | 97.50% | 87.50% | 50% | 12.50% | 2.50% |
| 2 | 1.87 | 2.45 | **3.61** | 5.32 | 6.99 |
| 6.5 | 3.94 | 5.18 | 7.61 | 11.22 | 14.73 |
| 11 | 5.48 | 7.22 | **10.60** | 15.62 | 20.51 |
| 15.5 | 6.79 | 8.92 | 13.16 | 19.36 | 25.43 |
| 20 | 7.97 | 10.47 | **15.39** | 22.67 | 29.76 |

| Shorthead redhorse | | | | | |
|---|---|---|---|---|---|
| % Indicates portion of test fish able to achieve speed listed (fps) for 3 seconds | | | | | |
| Size (in) | 97.50% | 87.50% | 50% | 12.50% | 2.50% |
| 2 | 1.87 | 2.45 | **3.61** | 5.32 | 6.99 |
| 4 | 2.88 | 3.77 | 5.58 | 8.20 | 10.79 |
| 6 | 3.71 | 4.89 | **7.19** | 10.56 | 13.88 |
| 8 | 4.53 | 5.94 | 8.73 | 12.86 | 16.90 |
| 10 | 5.18 | 6.79 | **10.01** | 14.73 | 19.36 |

| Emerald shiner | | | | | |
|---|---|---|---|---|---|
| % Indicates portion of test fish able to achieve speed listed (fps) for 3 seconds | | | | | |
| Size (in) | 97.50% | 87.50% | 50% | 12.50% | 2.50% |
| 1 | 1.21 | 1.59 | **2.34** | 3.45 | 4.53 |
| 1.5 | 1.62 | 2.14 | 3.14 | 4.63 | 6.07 |
| 2 | 1.87 | 2.45 | **3.61** | 5.32 | 6.99 |
| 2.5 | 2.20 | 2.89 | 4.27 | 6.27 | 8.24 |
| 3 | 0.24 | 3.19 | **4.69** | 6.92 | 9.09 |

| Gizzard shad (Juvenile) | | | | | |
|---|---|---|---|---|---|
| % Indicates portion of test fish able to achieve speed listed (fps) for 3 seconds | | | | | |
| Size (in) | 97.50% | 87.50% | 50% | 12.50% | 2.50% |
| 2 | 4.17 | 4.56 | **5.18** | 5.87 | 6.43 |
| 3.25 | 6.04 | 6.59 | 7.51 | 8.53 | 9.35 |
| 4.5 | 7.45 | 8.17 | **9.29** | 10.56 | 11.55 |
| 5.75 | 8.76 | 9.58 | 10.93 | 12.40 | 13.58 |
| 7 | 10.20 | 11.16 | **12.70** | 14.44 | 15.81 |

| Gizzard shad (Adult) | | | | | |
|---|---|---|---|---|---|
| % Indicates portion of test fish able to achieve speed listed (fps) for 3 seconds | | | | | |
| Size (in) | 97.50% | 87.50% | 50% | 12.50% | 2.50% |
| 10 | 13.03 | 14.24 | **16.21** | 18.44 | 20.21 |
| 11 | 13.91 | 15.22 | 17.32 | 19.69 | 21.56 |
| 12 | 14.76 | 16.14 | **18.37** | 20.90 | 22.90 |
| 13 | 15.58 | 17.06 | 19.42 | 22.08 | 24.18 |
| 14 | 16.41 | 17.98 | **20.44** | 23.26 | 25.46 |

# Appendix B: EPRI (1997) Reported Sample Volumes and Entrainment Densities for Lake Lynn Target Fish Species

| Month | Gizzard Shad - Townsend Dam | | |
|---|---|---|---|
| | Total Catch (#) | Sample Volume ($ft^3$) | Density ($\#/ft^3$) |
| January | 3775 | 290,030,000.00 | 1.30E-05 |
| February | 131 | 266,080,000.00 | 4.91E-07 |
| March | 4323 | 299,800,000.00 | 1.44E-05 |
| April | 37 | 216,770,000.00 | 1.69E-07 |
| May | 18 | 210,410,000.00 | 8.45E-08 |
| June | 2 | 159,160,000.00 | 1.31E-08 |
| July | 5410 | 283,770,000.00 | 1.91E-05 |
| August | 827 | 280,060,000.00 | 2.95E-06 |
| September | 11656 | 170,220,000.00 | 6.85E-05 |
| October | 91950 | 150,860,000.00 | 6.10E-04 |
| November | 24142 | 244,390,000.00 | 9.88E-05 |
| December | 265437 | 241,200,000.00 | 1.10E-03 |

| Month | Gizzard Shad - Minetto | | |
|---|---|---|---|
| | Total Catch (#) | Sample Volume (ft3) | Density ($\#/ft^3$) |
| January | 661 | 934,200,000.00 | 7.07E-07 |
| February | 63 | 479,300,000.00 | 1.31E-07 |
| March | 624 | 2,044,600,000.00 | 3.05E-07 |
| April | 43 | 1,012,600,000.00 | 4.27E-08 |
| May | 2 | 2,381,400,000.00 | 6.72E-10 |
| June | - | - | - |
| July | 2 | 640,000,000.00 | 2.50E-09 |
| August | 8672 | 312,800,000.00 | 2.77E-05 |
| September | 16 | 281,800,000.00 | 5.75E-08 |
| October | 62002 | 1,118,100,000.00 | 5.55E-05 |
| November | 56913 | 1,191,100,000.00 | 4.78E-05 |
| December | 23 | 596,700,000.00 | 3.85E-08 |

| Month | Gizzard Shad - Richard B. Russell | | |
|---|---|---|---|
| | Total Catch (#) | Sample Volume (ft3) | Density (#/ft$^3$) |
| January | - | - | - |
| February | - | - | - |
| March | - | - | - |
| April | 4 | 648,000,000.00 | 6.17E-09 |
| May | - | - | - |
| June | 2 | 760,800,000.00 | 2.63E-09 |
| July | 14 | 701,900,000.00 | 1.99E-08 |
| August | 4 | 464,500,000.00 | 8.61E-09 |
| September | - | - | - |
| October | 3 | 596,200,000.00 | 5.03E-09 |
| November | 12 | 1,709,700,000.00 | 6.77E-09 |
| December | - | - | - |

| Month | Smallmouth bass - Townsend Dam | | |
|---|---|---|---|
| | Total Catch (#) | Sample Volume (ft$^3$) | Density (#/ft$^3$) |
| January | - | - | - |
| February | - | - | - |
| March | 1 | 299,800,000.00 | 3.49E-09 |
| April | 1 | 216,770,000.00 | 4.83E-09 |
| May | 6 | 210,410,000.00 | 2.98E-08 |
| June | 7 | 159,160,000.00 | 4.60E-08 |
| July | 8 | 283,770,000.00 | 2.95E-08 |
| August | 2 | 280,060,000.00 | 7.47E-09 |
| September | 2 | 170,220,000.00 | 1.23E-08 |
| October | - | - | - |
| November | - | - | - |
| December | - | - | - |

| Month | Bluegill - Townsend Dam | | |
|---|---|---|---|
| | Total Catch (#) | Sample Volume (ft$^3$) | Density (#/ft$^3$) |
| January | 5 | 290,030,000.00 | 1.80E-08 |
| February | 5 | 266,080,000.00 | 1.97E-08 |
| March | 16 | 299,800,000.00 | 5.23E-08 |
| April | 6 | 216,770,000.00 | 2.90E-08 |
| May | 15 | 210,410,000.00 | 6.96E-08 |
| June | 9 | 159,160,000.00 | 5.91E-08 |
| July | 13 | 283,770,000.00 | 4.42E-08 |
| August | 7 | 280,060,000.00 | 2.61E-08 |
| September | 4 | 170,220,000.00 | 2.46E-08 |
| October | 30 | 150,860,000.00 | 2.01E-07 |
| November | 55 | 244,390,000.00 | 2.27E-07 |
| December | 13 | 241,200,000.00 | 5.20E-08 |

| Month | Walleye - Townsend Dam | | |
|---|---|---|---|
| | Total Catch (#) | Sample Volume (ft$^3$) | Density (#/ft$^3$) |
| January | 3 | 290,030,000.00 | 1.08E-08 |
| February | 3 | 266,080,000.00 | 1.18E-08 |
| March | 1 | 299,800,000.00 | 3.49E-09 |
| April | 3 | 216,770,000.00 | 1.45E-08 |
| May | 3 | 210,410,000.00 | 1.49E-08 |
| June | - | - | - |
| July | 6 | 283,770,000.00 | 2.21E-08 |
| August | 2 | 280,060,000.00 | 7.47E-09 |
| September | 2 | 170,220,000.00 | 1.23E-08 |
| October | 1 | 150,860,000.00 | 6.93E-09 |
| November | 3 | 244,390,000.00 | 1.28E-08 |
| December | 24 | 241,200,000.00 | 9.97E-08 |

| Month | Emerald shiner - Townsend Dam | | |
|---|---|---|---|
| | Total Catch (#) | Sample Volume ($ft^3$) | Density ($\#/ft^3$) |
| January | 2 | 290,030,000.00 | 7.21E-09 |
| February | - | - | - |
| March | - | - | - |
| April | - | - | - |
| May | - | - | - |
| June | - | - | - |
| July | 3 | 283,770,000.00 | 1.11E-08 |
| August | - | - | - |
| September | - | - | - |
| October | - | - | - |
| November | - | - | - |
| December | - | - | - |

| Month | Channel catfish - Townsend Dam | | |
|---|---|---|---|
| | Total Catch (#) | Sample Volume ($ft^3$) | Density ($\#/ft^3$) |
| January | - | - | - |
| February | 3 | 266,080,000.00 | 1.18E-08 |
| March | 7 | 299,800,000.00 | 2.44E-08 |
| April | 5 | 216,770,000.00 | 2.41E-08 |
| May | 66 | 210,410,000.00 | 3.13E-07 |
| June | 24 | 159,160,000.00 | 1.51E-07 |
| July | 30 | 283,770,000.00 | 1.07E-07 |
| August | 36 | 280,060,000.00 | 1.27E-07 |
| September | 20 | 170,220,000.00 | 1.17E-07 |
| October | 2 | 150,860,000.00 | 1.39E-08 |
| November | - | - | - |
| December | 1 | 241,200,000.00 | 4.34E-09 |

| Month | Shorthead redhorse - Townsend Dam | | |
|---|---|---|---|
| | Total Catch (#) | Sample Volume ($ft^3$) | Density ($\#/ft^3$) |
| January | - | - | - |
| February | - | - | - |
| March | - | - | - |
| April | 2 | 216,770,000.00 | 9.65E-09 |
| May | - | - | - |
| June | - | - | - |
| July | - | - | - |
| August | - | - | - |
| September | - | - | - |
| October | - | - | - |
| November | - | - | - |
| December | - | - | - |

# Appendix C: Estimated Monthly Entrainment Abundance for Lake Lynn Target Fish Species Under Five Inflow Conditions

Calculated estimates of entrained gizzard shad by month under five different flow conditions at the Lake Lynn Project based on density data collected at Townsend Dam

| % Exceeded | JAN | FEB | MAR | APR | MAY | JUN | JUL | AUG | SEP | OCT | NOV | DEC |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **10** | 375,402 | 12,801 | 379,404 | 4,714 | 2,437 | 358 | 393,892 | 20,825 | 1,911,189 | 17,551,971 | 2,440,439 | 31,739,131 |
| **25** | 283,561 | 12,801 | 263,865 | 4,049 | 2,437 | 121 | 157,462 | 13,886 | 363,962 | 6,267,924 | 1,749,282 | 24,156,356 |
| **50** | 143,547 | 12,126 | 144,870 | 2,009 | 1,230 | 58 | 76,477 | 10,083 | 100,225 | 1,907,612 | 795,825 | 11,142,179 |
| **75** | 61,178 | 3,552 | 81,819 | 943 | 572 | 41 | 43,633 | 5,604 | 63,509 | 969,475 | 312,481 | 5,479,523 |
| **90** | 32,341 | 1,692 | 36,156 | 690 | 328 | 23 | 32,186 | 4,116 | 52,919 | 716,190 | 158,237 | 2,964,847 |

Calculated estimates of entrained gizzard shad by month under five different flow conditions at the Lake Lynn Project based on density data collected at Minetto

| % Exceeded | JAN | FEB | MAR | APR | MAY | JUN | JUL | AUG | SEP | OCT | NOV | DEC |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **10** | 20,404 | 3,419 | 8,027 | 1,191 | 19 | - | 52 | 195,429 | 1,605 | 1,596,890 | 1,180,416 | 1,112 |
| **25** | 15,412 | 3,419 | 5,583 | 1,023 | 19 | - | 21 | 130,310 | 306 | 570,260 | 846,110 | 846 |
| **50** | 7,802 | 3,238 | 3,065 | 507 | 10 | - | 10 | 94,618 | 84 | 173,556 | 384,933 | 390 |
| **75** | 3,325 | 949 | 1,731 | 238 | 5 | - | 6 | 52,593 | 53 | 88,203 | 151,144 | 192 |
| **90** | 1,758 | 452 | 765 | 174 | 3 | - | 4 | 38,629 | 44 | 65,159 | 76,538 | 104 |

Calculated estimates of entrained gizzard shad by month under five different flow conditions at the Lake Lynn Project based on density data collected at Richard B. Russell Pump-Storage

| % Exceeded | JAN | FEB | MAR | APR | MAY | JUN | JUL | AUG | SEP | OCT | NOV | DEC |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **10** | - | - | - | 172 | - | 72 | 412 | 61 | - | 145 | 167 | - |
| **25** | - | - | - | 148 | - | 24 | 165 | 40 | - | 52 | 120 | - |
| **50** | - | - | - | 73 | - | 12 | 80 | 29 | - | 16 | 55 | - |
| **75** | - | - | - | 34 | - | 8 | 46 | 16 | - | 8 | 21 | - |
| **90** | - | - | - | 25 | - | 5 | 34 | 12 | - | 6 | 11 | - |

Calculated estimates of entrained smallmouth bass by month under five different flow conditions at the Lake Lynn Project based on density data collected at Townsend Dam

| % Exceeded | JAN | FEB | MAR | APR | MAY | JUN | JUL | AUG | SEP | OCT | NOV | DEC |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **10** | - | - | 92 | 135 | 860 | 1,253 | 609 | 53 | 343 | - | - | - |
| **25** | - | - | 64 | 116 | 860 | 423 | 244 | 35 | 65 | - | - | - |
| **50** | - | - | 35 | 57 | 434 | 202 | 118 | 25 | 18 | - | - | - |
| **75** | - | - | 20 | 27 | 202 | 143 | 67 | 14 | 11 | - | - | - |
| **90** | - | - | 9 | 20 | 116 | 80 | 50 | 10 | 9 | - | - | - |

Calculated estimates of entrained bluegill by month under five different flow conditions at the Lake Lynn Project based on density data collected at Townsend Dam

| % Exceeded | JAN | FEB | MAR | APR | MAY | JUN | JUL | AUG | SEP | OCT | NOV | DEC |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **10** | 520 | 512 | 1,377 | 808 | 2,007 | 1,612 | 914 | 184 | 686 | 5,790 | 5,604 | 1,501 |
| **25** | 393 | 512 | 958 | 694 | 2,007 | 544 | 365 | 123 | 131 | 2,068 | 4,017 | 1,142 |
| **50** | 199 | 485 | 526 | 344 | 1,013 | 260 | 177 | 89 | 36 | 629 | 1,828 | 527 |
| **75** | 85 | 142 | 297 | 162 | 471 | 184 | 101 | 50 | 23 | 320 | 718 | 259 |
| **90** | 45 | 68 | 131 | 118 | 270 | 102 | 75 | 36 | 19 | 236 | 363 | 140 |

Calculated estimates of entrained walleye by month under five different flow conditions at the Lake Lynn Project based on density data collected at Townsend Dam

| % Exceeded | JAN | FEB | MAR | APR | MAY | JUN | JUL | AUG | SEP | OCT | NOV | DEC |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **10** | 312 | 307 | 92 | 404 | 430 | - | 457 | 53 | 343 | 200 | 317 | 2,876 |
| **25** | 236 | 307 | 64 | 347 | 430 | - | 183 | 35 | 65 | 71 | 227 | 2,189 |
| **50** | 119 | 291 | 35 | 172 | 217 | - | 89 | 25 | 18 | 22 | 103 | 1,010 |
| **75** | 51 | 85 | 20 | 81 | 101 | - | 51 | 14 | 11 | 11 | 41 | 497 |
| **90** | 27 | 41 | 9 | 59 | 58 | - | 37 | 10 | 9 | 8 | 21 | 269 |

Calculated estimates of entrained emerald shiner by month under five different flow conditions at the Lake Lynn Project based on density data collected at Townsend Dam

| % Exceeded | JAN | FEB | MAR | APR | MAY | JUN | JUL | AUG | SEP | OCT | NOV | DEC |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **10** | 208 | - | - | - | - | - | 228 | - | - | - | - | - |
| **25** | 157 | - | - | - | - | - | 91 | - | - | - | - | - |
| **50** | 80 | - | - | - | - | - | 44 | - | - | - | - | - |
| **75** | 34 | - | - | - | - | - | 25 | - | - | - | - | - |
| **90** | 18 | - | - | - | - | - | 19 | - | - | - | - | - |

Calculated estimates of entrained channel catfish by month under five different flow conditions at the Lake Lynn Project based on density data collected at Townsend Dam

| % Exceeded | JAN | FEB | MAR | APR | MAY | JUN | JUL | AUG | SEP | OCT | NOV | DEC |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **10** | - | 307 | 643 | 673 | 9,033 | 4,119 | 2,209 | 895 | 3,259 | 399 | - | 125 |
| **25** | - | 307 | 447 | 578 | 9,033 | 1,391 | 883 | 597 | 621 | 143 | - | 95 |
| **50** | - | 291 | 245 | 287 | 4,558 | 665 | 429 | 433 | 171 | 43 | - | 44 |
| **75** | - | 85 | 139 | 135 | 2,121 | 470 | 245 | 241 | 108 | 22 | - | 22 |
| **90** | - | 41 | 61 | 99 | 1,215 | 262 | 180 | 177 | 90 | 16 | - | 12 |

Calculated estimates of entrained shorthead redhorse (surrogate for Golden redhorse) by month under five different flow conditions at the Lake Lynn Project based on density data collected at Townsend Dam

| % Exceeded | JAN | FEB | MAR | APR | MAY | JUN | JUL | AUG | SEP | OCT | NOV | DEC |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **10** | - | - | - | 269 | - | - | - | - | - | - | - | - |
| **25** | - | - | - | 231 | - | - | - | - | - | - | - | - |
| **50** | - | - | - | 115 | - | - | - | - | - | - | - | - |
| **75** | - | - | - | 54 | - | - | - | - | - | - | - | - |
| **90** | - | - | - | 39 | - | - | - | - | - | - | - | - |

# Freshwater Mussel Reconnaissance Scoping Survey Report

Cheat River

November 2020

## Lake Lynn Hydroelectric Project (FERC No. P-2459)

**Prepared For:**

Lake Lynn Generation, LLC
2 Bethesda Metro Center, Suite 1330
Bethesda, Maryland 20814

**Prepared By:**

TRC Companies, Inc.
1382 West Ninth Street, Suite 400
Cleveland, OH 44113

# TABLE OF CONTENTS



## FIGURES



## APPENDICES

## ACRONYM LIST

| | |
|---|---|
| AMD | Acid Mine Drainage |
| °C | Celsius |
| EnviroScience | EnviroScience, Inc. |
| FERC | Federal Energy Regulatory Commission |
| Lake Lynn | Lake Lynn Generation, LLC |
| MW | Megawatt |
| NOI | Notice of Intent |
| PAD | Pre-Application Document |
| PFBC | Pennsylvania Fish and Boat Commission |
| Project | Lake Lynn Hydroelectric Project (FERC No. P-2459) |
| Protocol | 2020 West Virginia Mussel Survey Protocols |
| Study Plan | *Lake Lynn Hydroelectric Project (FERC No. P-2459) Final Study Plan* dated September 2020 |
| TRC | TRC Companies, Inc. |
| USFWS | United States Fish and Wildlife Service |
| WVDNR | West Virginia Division of Natural Resources |

## Acknowledgements

Lake Lynn Generation, LLC (Lake Lynn) has contracted TRC Companies, Inc. (TRC), to conduct a reconnaissance scoping survey for the Lake Lynn Hydroelectric Project (FERC No. P-2459) (Project) near Morgantown, Monongalia County, West Virginia and Fayette County, Pennsylvania near the borough of Point Marion. TRC contracted EnviroScience, Inc. (EnviroScience) for an approved malacologist for the survey. Ms. Joyce Foster (TRC) was the Project Manager, Ms. Sarah Veselka (EnviroScience) was the Pennsylvania and West Virginia Approved Malacologist and Ms. Lindsey Jakovljevic (TRC) was the field team lead for the duration of the survey. Mr. Thomas Radford (TRC) and Mr. Tony Tredway (TRC) assisted with the field effort. Ms. Jakovljevic, Ms. Veselka, and Mr. Radford co-authored this report.

# 1.0 Introduction

Lake Lynn Generation LLC (Lake Lynn), owner and operator of the Lake Lynn Hydroelectric Project (FERC No. P-2459) (Project), is relicensing the Project with the Federal Energy Regulatory Commission (FERC). The current FERC license was issued in December 1994 and will expire on November 30, 2024. The Project is located on the Cheat River near Morgantown, Monongalia County, West Virginia and Fayette County, Pennsylvania near the borough of Point Marion (**Figure 1**). Lake Lynn filed a Notice of Intent (NOI) and Pre-Application Document (PAD) with FERC on August 29, 2019 and held a Joint Meeting and Site Visit in December 2019. Following the Joint Meeting and Site Visit, resource agencies and other stakeholders were afforded the opportunity to comment on the PAD and to request natural resource studies that they deemed were needed to evaluate Project impacts on natural, cultural and recreational resources. The United States Fish and Wildlife Service (USFWS) reviewed the NOI and PAD and requested that a mussel reconnaissance scoping survey be conducted downstream of the dam.

# 2.0 Objectives

The purpose of the reconnaissance scoping survey as outlined in the *Lake Lynn Hydroelectric Project (FERC No. P-2459) Final Study Plan* dated September 2020 (Study Plan) is to identify what freshwater mussel species, if any, may occur within the Cheat River from the Project dam to the confluence with the Monongahela River, approximately 3.5-miles downstream.

# 3.0 Background and Existing Information

By email dated May 18, 2020, Lake Lynn provided a draft Mussel Survey Plan to the USFWS, Pennsylvania Fish and Boat Commission (PFBC), and West Virginia Division of Natural Resources (WVDNR). Lake Lynn convened a meeting via Microsoft Teams and conference call on May 20, 2020 to discuss the draft Mussel Survey Plan. The draft Mussel Survey Plan proposed following 2020 West Virginia Mussel Survey Protocols (Protocol) guidance for effort required for Group 3 streams (WVDNR, 2020) and defining the survey area as the area inside the Project boundary and a downstream buffer (DSB) limit of 25 meters beyond the Project boundary. The Resource Agencies expressed concerns about limiting the survey area and requested that the survey area extend 1 mile downstream of the Project since they considered this project as a scoping project without a full hydraulic study. As an action item, Lake Lynn agreed to share the 1993 Project Instream Flow Study to provide additional information about the Project's operational influence downstream of the dam and the geographic scope of the survey.

Lake Lynn distributed the 1993 Project Instream Flow Study to the resource agencies on June 2, 2020. The 1993 Project Instream Flow Study reported that water level fluctuations due to Project operation are greatest in the segment of river extending 1.02-miles below the Project dam. The 1993 Project Instream Flow Study also reported that the water depth in the Cheat

River segment from the 1.02-mile point below the Project dam to the confluence with the Monongahela is dependent upon and maintained by Pool 7 water elevations during Project shutdown.

By email dated July 9, 2020, Lake Lynn provided a revised draft Mussel Survey Plan to the USFWS, PFBC, and WVDNR. Comments were received from WVDNR and PFBC. WVDNR requested that the first page of the Mussel Survey Plan clarify the intent of the survey and noted that if the intent is to conduct a reconnaissance scoping survey, then the methodology provided is sufficient. WVDNR also requested that the Mussel Survey Plan address the handling of mussels and include a completed summary protocol form. PFBC agreed with the proposed survey methodology outlined in the Mussel Survey Plan dated July 9, 2020 but disagreed with the limits of the survey area being restricted to 1.02-miles downstream of the Project dam (copies of relevant correspondence are included in Attachment 2 of the Mussel Survey Plan in **Appendix A**).

A revised survey plan was submitted to WVDNR and PFBC by EnviroScience, Inc. (EnviroScience) on Monday September 7, 2020. Comments were received on September 8, 2020 from PFBC stating that the one mile was not sufficient and that a survey would need to be performed to the confluence of the Monongahela River, approximately 3.5 miles downstream, of the Project boundary.

The draft Mussel Survey Plan was revised based on comments received on September 8, 2020 from PFBC. The final Mussel Survey Plan was approved by WVDNR on September 9, 2020 and by PFBC on September 11, 2020 and is provided in **Appendix A**.

The Project is a 51.2 megawatt (MW) single development hydroelectric project operated since 1926. It consists of:

- a 125-foot high by 1,000-foot long concrete gravity-type dam with a 624-foot long spillway controlled by 26 Tainter gates, each 17 feet high by 21 feet long;
- a reservoir with a surface area of 1,729 acres and containing about 72,00 acre-feet of water at full pool elevation of 870 feet National Geodetic Vertical Datum;
- a log boom and track racks at the intake facility;
- eight 12-foot by 18-foot gated penstocks of reinforced concrete;
- a 72-foot by 165-foot by 68-foot high brick powerhouse containing four identical Francis generating units with a total rated capacity of 51.2 MW;
- dual 800-foot long 13 8-kilovolt transmission lines; and
  appurtenant facilities.

# 4.0 Study Area

The study area within the Cheat River includes the Project boundary, which extends approximately 200 meters downstream of the Project dam, and approximately 3.5 miles downstream of the Project boundary to the confluence of the Monongahela River. The entirety of the Study Area is within the channel of the Cheat River and excludes its tributaries that exist within the reach. TRC Companies, Inc. (TRC) has preliminarily defined the study area as depicted on the attached **Figure 2**.

# 5.0 Methods

Ms. Lindsey (Moss) Jakovljevic (TRC) was the field team leader for this survey. TRC collaborated with EnviroScience for the duration of the field work and Sarah Veselka (EnviroScience) was the Pennsylvania and West Virginia permitted malacologist (Permit #19-ES0034 and 2020.111) for the survey. The survey was conducted within the study area on September 16 and 17, 2020. Conditions (visibility and flow) at each site were adequate for detecting mussel presence. Visibility was exceptional and clear to the bottom in most cases. The flow conditions were observed to be low and normal. Maximum depth observed was approximately four meters. Weather was clear and air temperatures averaged 21 degrees Celsius (°C) for the duration of the field work. Water temperatures averaged 21.7 °C for the duration of the fieldwork.

## 5.1 Qualitative Survey Design

Reconnaissance scoping survey efforts were coordinated and led by a West Virginia and Pennsylvania approved malacologist. The qualified malacologist provided survey oversight and guidance on execution of the survey and was the lead taxonomist in the field for the duration of the work. The survey followed modified West Virginia Protocol guidance (WVDNR, 2020) with additional guidance from the *American Fisheries Society Monograph 8* (Strayer and Smith, 2003). The survey area included the Project boundary, that extends approximately 200 meters downstream of the Project dam, and approximately 3.5 miles downstream of the Project boundary to the confluence with the Monongahela River.

TRC and EnviroScience biologists performed a reconnaissance scoping survey to determine areas of suitable mussel habitat and evaluate mussel presence/absence within the survey area downstream of the Project dam. The habitat assessment started at the Project dam and continued approximately 3.5 miles downstream to the confluence of the Monongahela River (**Figure 2**). The habitat assessment started at the dam instead of the mouth of the Cheat River, as stated in the Survey Plan, as it was easier to navigate the river with the flow instead of against it. The banks were searched for shell material and the substrate was evaluated to identify suitable mussel habitat (stable burrowable substrates including sand, gravel, cobble, etc.). Once suitable mussel habitat was located, a qualitative timed search was employed for a minimum of 10 minutes to search for live mussels and shell material. In the state of West Virginia, there was one qualitative search every 100 meters in the best possible substrate. Qualitative surveys in the Commonwealth of Pennsylvania were only performed where suitable habitat was identified. If live mussels were observed, the area was searched until the limits of the mussel bed were delineated.

This reconnaissance scoping survey consisted of visually and tactilely searching the area for the presence of mussels and to determine the limits of any mussel concentrations. Snorkeling was used to visually and tactilely search for mussels at the substrate surface; moving cobble and woody debris; hand sweeping away silt, sand and/or small detritus; and disturbing/probing the upper 5 centimeters (2 inches) of substrate to ensure recovery of buried mussels. Data was collected separately for each qualitative search.

Photographs were taken of the survey area. Data recorded included:

- substrate composition of each sample (visual percentage based on Wentworth scale;
- water depth (meters);
- mussel shells (classified as fresh dead, weathered dead, or relic shell);
- where applicable; Global Positioning System (GPS) coordinates of the survey area,
- mussel aggregation limits; and
- other notable features such as land use and general observations about the stream.

## 6.0 Results

In accordance with the approved survey plan, biologists from TRC and EnviroScience completed a reconnaissance scoping survey at 12 discrete sites within the Cheat River, from the Project dam downstream to the confluence with the Monongahela River (approximately 3.5 miles). The survey was conducted on September 16 and 17, 2020. The survey area included the Project boundary, that extends approximately 200 meters downstream of the Project dam, and approximately 3.5 miles downstream of the Project boundary to the confluence with the Monongahela River.

During the survey, no live native mussels were observed. However, eight live native mussels comprised of one species (*Potamilus alatus* [Pink heelsplitter]), were observed from the confluence of the Cheat River and the Monongahela River outside of the downstream limits of the survey area. The live mussels observed were not within one of the recorded sites searched and were assumed to be part of a mussel bed located in the Monongahela River. The mussels were observed while surveyors were heading to the kayak take out location. Live *Corbicula fluminea* (Asian Clam), an invasive freshwater clam, was observed in abundance at Site #11. Additionally, several sub-fossil relic shells of multiple species were collected along the left descending bank of the Cheat River at Site #12. These relic shells appeared to be extremely old and assumed to have been washed up the Cheat River from the Monongahela River during a flood event. Representative photographs of the survey area and mussels ovserved are provided in **Appendix B**.

## 6.1 Mussel Community

The reconnaissance scoping survey effort was concentrated in areas were suitable mussel habitat was present. Zero live mussels were observed within the survey area of the Cheat River. However, a total of eight live mussels, representing one species (*P. alatus* [Pink heelsplitter]) were observed approximately 3.5-miles downstream of the Project dam at the confluence with the Monongahela River. The live mussels observed were not within one of the recorded sites searched and were assumed to be part of a mussel bed located in the Monongahela River. The mussels were found while surveyors were heading to the kayak take out location. All live mussels observed were located along the left descending bank at the confluence of the Cheat River and Monongahela River in an area of sand, silt, and mud, outside of the survey area. No federal or state listed species were observed during the survey.

## 6.2 Mussel Habitat

Beginning in the 1970s, whitewater paddlers on the Cheat River observed water quality becoming increasingly degraded by acid mine drainage (AMD) discharging from abandoned mine lands and active coal mine operations. In the spring of 1994, polluted water from an illegally-sealed major underground coal mine blew out the hillside and poured into Muddy Creek. This massive release of mine water entered the main stem of the Cheat River just upstream of the Cheat Canyon, and turned the river orange for miles. A second blowout in 1995 further accentuated the problem and caused American Rivers, Inc., a national river conservation organization, to name the Cheat as one of the nation’s ten most endangered rivers (Friends of the Cheat, 2020). AMD inputs heavy metals into bodies of water adjacent to coal mining activities, such as the Cheat River. Freshwater mussels are confined to the river bottom, generally immobile, and are therefore very sensitive to poor water quality. The input of AMD may continue to affect the water quality in this reach of the Cheat River and create an environment that is not conducive to mussel colonization.

Starting at approximately 0.4 miles downstream of the Project dam and continuing to the confluence of the Monongahela River, there was evidence of AMD, a yellow-orange coating on the rocks, sediment, and aquatic plants, from Grassy Run, a tributary of the Cheat River (**Attachment 2**; photos 18-20). There was also evidence of AMD coming from unnamed tributaries of the Cheat River, along the left descending bank at 1.8 miles downstream and along the right descending bank at approximately 1.9 miles downstram (**Attachment 2**; photos 44-46).

Substrate within the Cheat River from the Project dam to approximately 1.2-miles downstream was deemed suitable for freshwater mussel presence. Substrate throughout the survey area was mostly a heterogenous mixture of cobble, gravel, and sand. Cobble and gravel were the predominant substrates throughout the reach. Water depths within this reach ranged between 0.2 meters and 1.5 meters. The Cheat River from the Project dam to approximately 1.2-miles downstream was primarily a riffles/run complex. Despite the presence of suitable substrate throughout this section of the Cheat River, no mussel communities or shell material, were observed.

From 1.2-miles downstream of the Project dam to the confluence with the Monongahela River, the Cheat River was majority pool, with depths ranging between 1.5 meters and 4 meters. The substrate in this reach transitioned from cobble, gravel, and sand to mostly sand and silt. Three sites were surveyed in this reach where suitable habitat was found along the banks. Site #11 was the best possible site that was searched within the survey area that could support live mussels. Live *Corbicula fluminea* (Asian Clam), an invasive freshwater clam, was observed in abundance at Site #11 (**Figure 3**). Despite the presence of suitable mussel habitat throughout this section of the Cheat River, no native freshwater mussel communities, were observed within the study area. However, eight live native mussels were found outside the study area, within the Monongahela river while kayaking to the takeout location. Relic shell material was also observed at Site #12. A summary of substrate characteristics of each site is provided in **Table 1**. Table 1. Summary of Substrate characteristics in the Cheat River, 2020.

**Table 1. Summary of Substrate characteristics in the Cheat River, 2020.**

| Site | State | % Substrate Composition | | | | | | | | **Total** |
|---|---|---|---|---|---|---|---|---|---|---|
| | | Br | Bo | Co | Gr | Sd | St | LWD | Vegetation | |
| 1 | WV | *10* | *30* | *45* | *10* | *5* | – | – | – | **100** |
| 2 | WV | *5* | *25* | *40* | *20* | *10* | – | – | – | **100** |
| 3 | PA | – | – | *70* | – | – | – | – | *30* | **100** |
| 4 | PA | – | – | *45* | *30* | *25* | – | – | – | **100** |
| 5 | PA | – | – | *60* | *30* | – | – | – | *10* | **100** |
| 6 | PA | – | *5* | *55* | *25* | – | – | – | *15* | **100** |
| 7 | PA | – | – | *60* | *40* | – | – | – | – | **100** |
| 8 | PA | – | – | *40* | *35* | – | – | *5* | *20* | **100** |
| 9 | PA | – | – | *65* | *15* | – | – | – | *20* | **100** |
| 10 | PA | – | – | *75* | *15* | – | – | – | *10* | **100** |
| 11 | PA | – | – | *60* | *15* | *25* | – | – | – | **100** |
| 12 | PA | – | – | – | – | *55* | *35* | *10* | – | **100** |
| Br= Bedrock, Bo= Boulder, Cb= Cobble, Gr= Gravel, Sd= Sand, St= Silt, LWD= Large Woody Debris | | | | | | | | | | |

## 7.0 Variances from the Study Plan

The habitat assessment was conducted from the dam to the confluence instead of from the confluence to the dam. This was done as it was more efficient to conduct the survey with the flow of the river.

# 8.0 Summary

In accordance with the approved survey plan, biologists from TRC and EnviroScience completed a reconnaissance scoping survey at 12 discrete sites within the Cheat River, from the Project dam downstream to the confluence with the Monongahela River (approximately 3.5 miles). The survey was conducted on September 16 and 17, 2020. The survey area included the Project boundary, that extends approximately 200 meters downstream of the Project dam, and approximately 3.5 miles downstream of the Project boundary to the confluence with the Monongahela River.

Suitable mussel habitat exists within the surveyed reach of the Cheat River. From the dam to approximately 1.2 miles downstream, the substrate was a heterogenous mixture of cobble, gravel, and sand and was predominately a riffle/run complex. From 1.2 miles downstream to the confluence of the Monongahela River the substrate was mostly sand and silt with intermittent cobble bars along the shore, at the confluence of tributaries, and island margins. This section of the Cheat River was predominately a pool. No native freshwater mussels were observed within the study area during the survey. Live *Corbicula fluminea* (Asian Clam), an invasive freshwater clam, was observed at Site #11 and several sub-fossil relic shells of multiple species were observed along the left descending bank of the Cheat River at Site #12 (approximately 3.4 miles downstream at the confluence to the Monongahela River). Additionally, there were eight live mussels of one species (*P. alatus*) found outside of the survey area at the confluence of the Monongahela River. The lack of established mussel communities within this reach of the Cheat River is possibly due to water quality influenced by AMD.

# 9.0 References

Friends of the Cheat. “History.” Friends of the Cheat, 2020, www.cheat.org/about/history/.

Strayer, D.L., and D.R. Smith. 2003. A guide to sampling freshwater mussel populations. American Fisheries Society, Monograph 8, Bethesda, Maryland.

West Virginia Division of Natural Resources (WVDNR). 2020. West Virginia Mussel Survey Protocols. West Virginia Division of Natural Resources. unpublished. 25pp + app.

TRC - GIS

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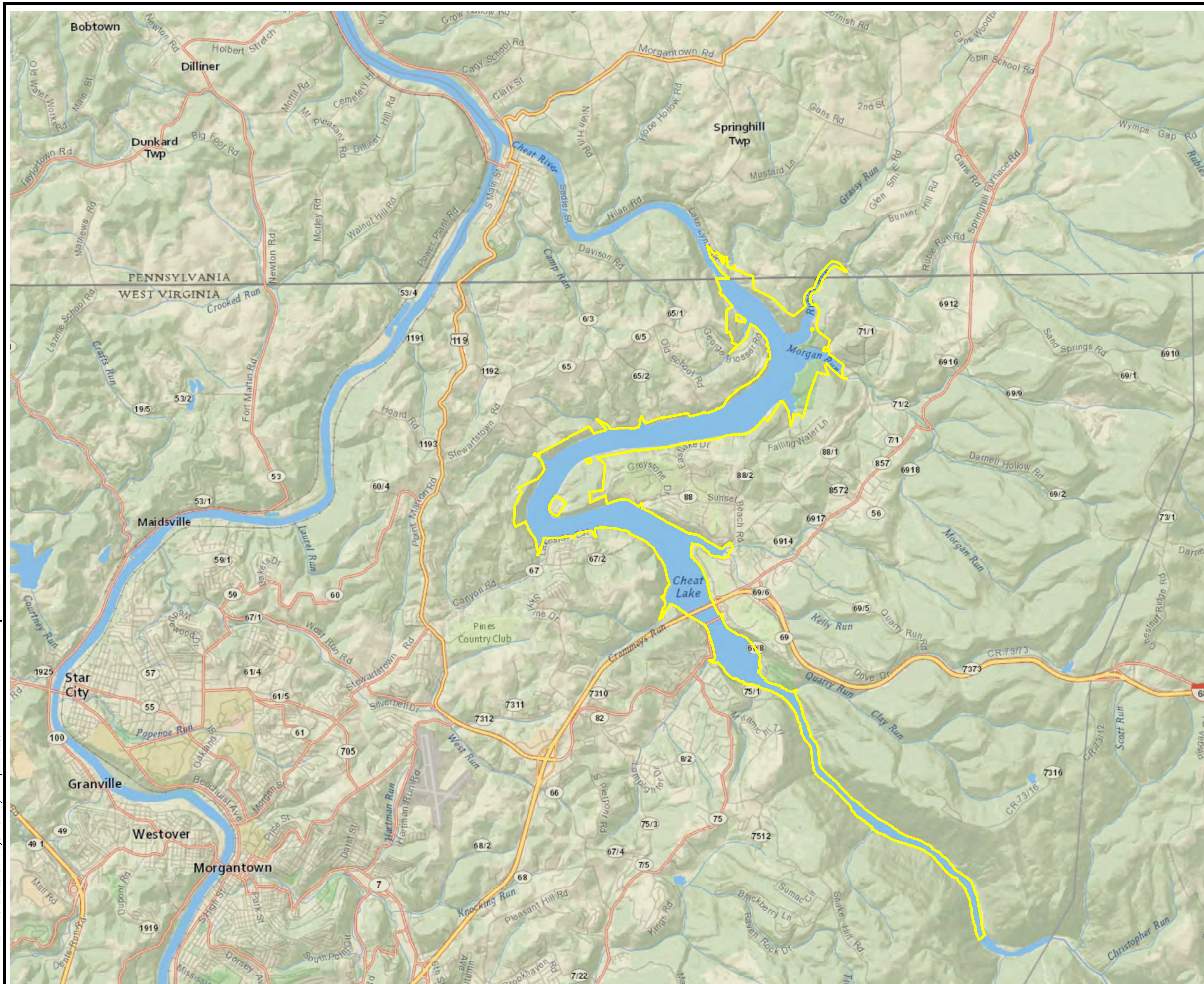
Map Rotation: 0





## LEGEND

FERC Project Boundary

0 0.5 1 2 Miles

PROJECT:

**LAKE LYNN GENERATION, LLC**

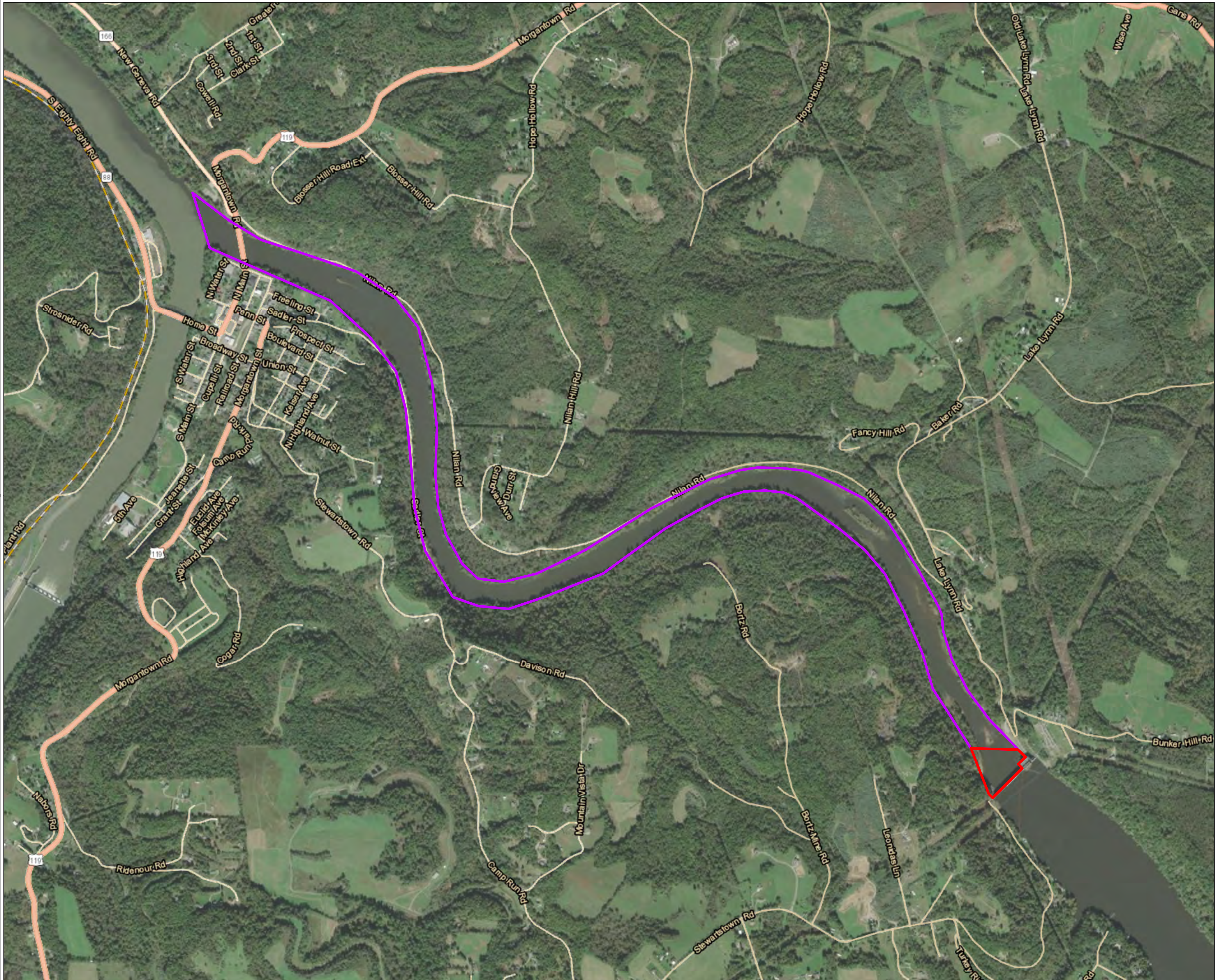
TITLE:

Project Location Map

| | | | |
|---|---|---|---|
| DRAWN BY: | K. BABCOCK | PROJ. NO.: | 232345.0000.0000 |
| CHECKED BY: | | | |
| APPROVED BY: | | **FIGURE 1** | |
| DATE: | JULY 2019 | | |

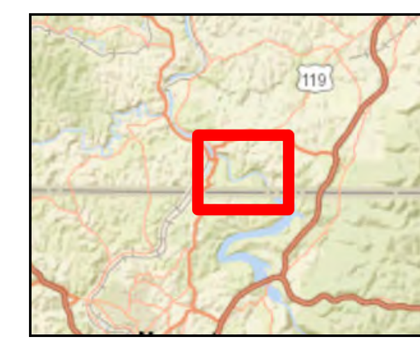
TRC
14 Gabriel Drive
Augusta, ME 04330

FILE NO.: Lake_Lynn_Project_Location.mxd




Project Boundary

Downstream Survey Buffer




0 1,500 3,000 Feet

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N

**LAKE LYNN HYDROELECTRIC PROJECT**
**MONONGALIA COUNTY, WEST VIRGINIA**

**FIGURE 2**
**SURVEY AREA LIMITS**

TRC

1382 West Ninth Street
Suite 400
Cleveland, OH 44113
Phone: 216-344-3072

SEPTEMBER 2020

Fig02_SurveyArea.mxd

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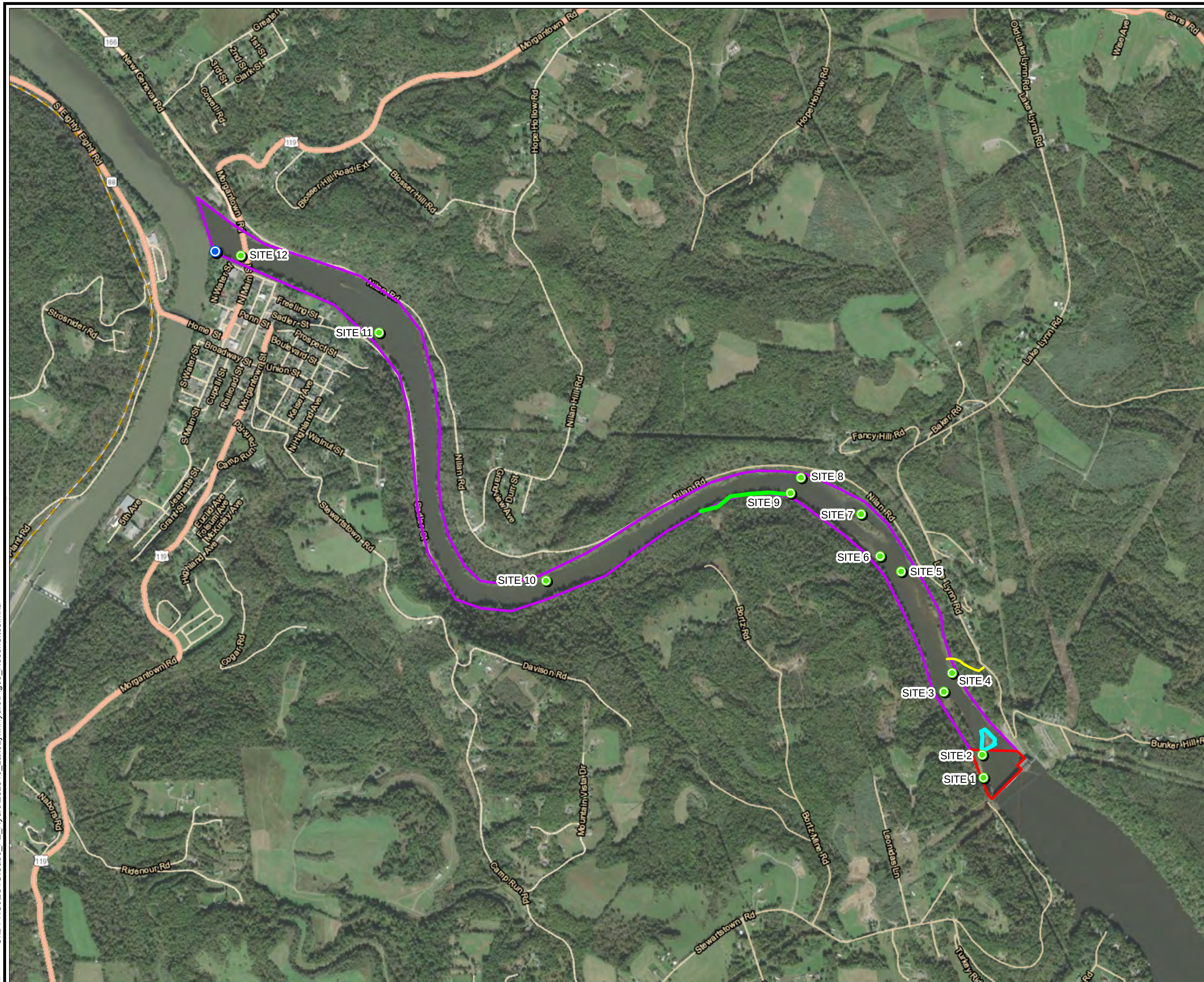



Project Boundary

Downstream Survey Buffer

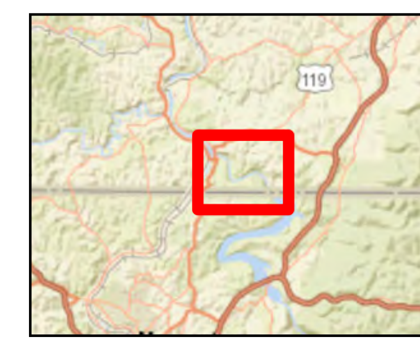
Live Mussel Observation

Suitable Mussel Habitat (Survey Site Location)

Island/Out of Water

Acid Mine Drainage Stream

Suitable Mussel Habitat



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**LAKE LYNN HYDROELECTRIC PROJECT**
**Monongalia County, West Virginia and Fayette County, Pennsylvania**

**FIGURE 3**
**RECONNAISSANCE MUSSEL SURVEY AREA SITE LOCATIONS**

TRC

1382 West Ninth Street
Suite 400
Cleveland, OH 44113
Phone: 216-344-3072

OCTOBER 2020

Fig03_ReconSites.mxd

TRC - GIS

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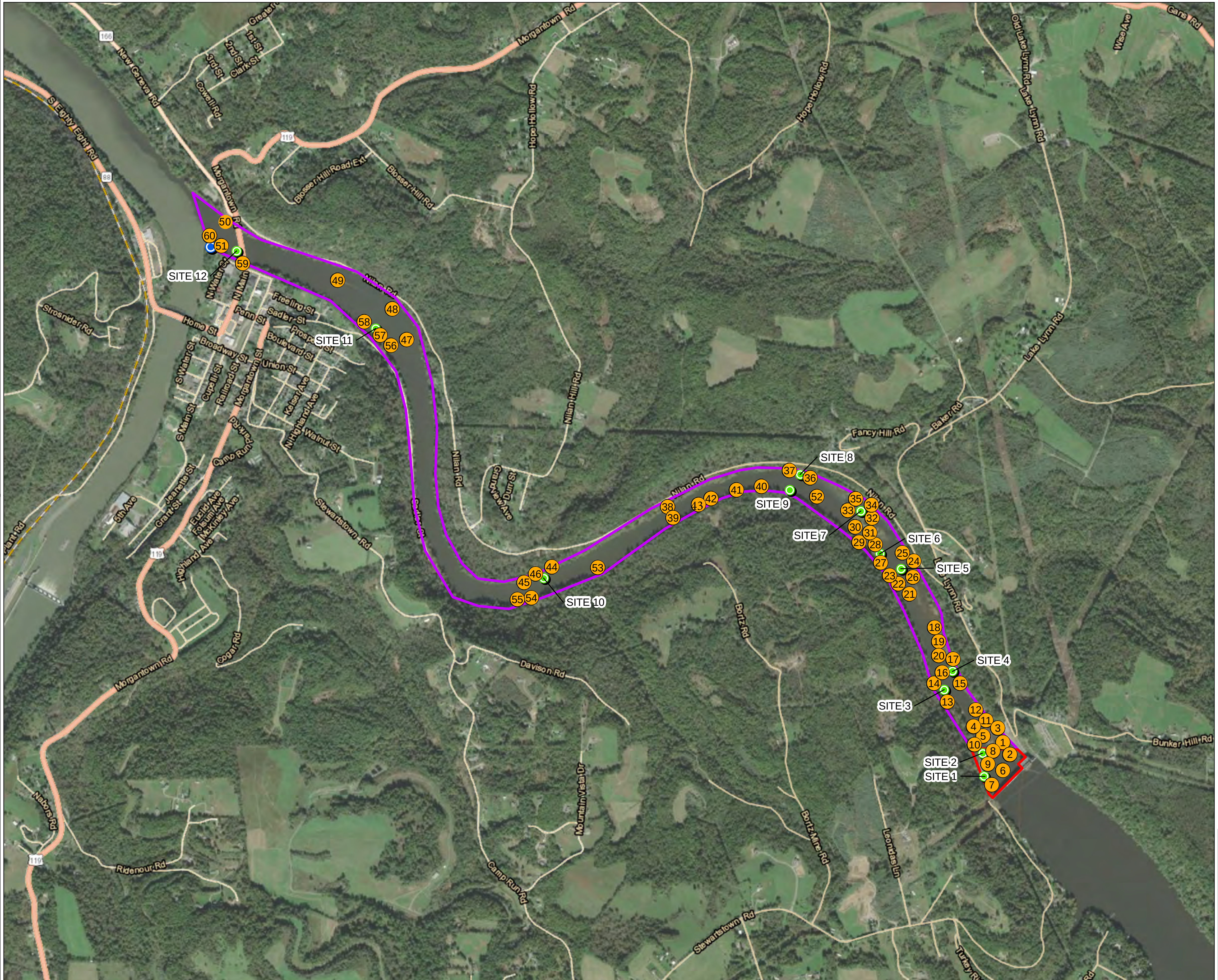


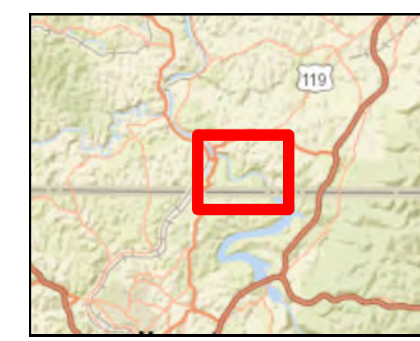

Project Boundary

Downstream Survey Buffer

Live Mussel Observation

Suitable Mussel Habitat (Survey Site Location)

Photo Location




0 1,500 3,000 Feet

1 " = 1,500 ' 1:18,000

**LAKE LYNN HYDROELECTRIC PROJECT**
**Monongalia County, West Virginia and Fayette County, Pennsylvania**

**FIGURE 4**
**PHOTO LOCATION MAP**

TRC
1382 West Ninth Street
Suite 400
Cleveland, OH 44113
Phone: 216-344-3072

OCTOBER 2020 Fig04_Photos.mxd

TRC - GIS

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# Appendix A
# Approved Mussel Survey Plan, Agency Correspondence, Permits

REVISED 2020 MUSSEL SURVEY PLAN (SEPTEMBER 2020)
CHEAT RIVER – LAKE LYNN HYDROELECTRIC PROJECT
MONONGALIA COUNTY, WEST VIRGINIA AND FAYETTE COUNTY, PENNSYLVANIA

Survey Background and Justification

Lake Lynn Generation LLC (Lake Lynn) is relicensing the Lake Lynn Hydroelectric Project (FERC No. P-2459) (Project) with the Federal Energy Regulatory Commission (FERC). The current FERC license was issued in December 1994 and will expire on November 30, 2024. The Project is located on the Cheat River near Morgantown, West Virginia in Monongalia County, West Virginia and Fayette County, Pennsylvania (**Figure 1**). Lake Lynn filed a Notice of Intent (NOI) and Pre-Application Document (PAD) with FERC on August 29, 2019 and held a Joint Meeting and Site Visit in December 2019. Following the Joint Meeting and Site Visit, resource agencies and other stakeholders were afforded the opportunity to comment on the PAD and to request resource studies that they deemed were needed to evaluate Project impacts on natural, cultural and recreational resources. The U.S. Fish and Wildlife Service (USFWS) reviewed the NOI and PAD and requested that a mussel survey be conducted downstream of the dam.

By email dated May 18, 2020, Lake Lynn provided a draft Mussel Survey Plan to the USFWS, Pennsylvania Fish and Boat Commission (PBFC), and West Virginia Division of Natural Resources (WVDNR). Lake Lynn convened a meeting via MS Teams and conference call on May 20, 2020 to discuss the draft Mussel Survey Plan. The draft Mussel Survey Plan proposed following West Virginia Protocol guidance for effort required for Group 3 streams (WVDNR, 2020) and defining the survey area as the area inside the Project boundary and a downstream buffer (DSB) limit of 25 meters beyond the Project boundary. The Resource Agencies expressed concerns about limiting the survey area and requested that the survey area extend 1 mile downstream of the Project since they considered this project as a scoping project without a full hydraulic study. As an action item, Lake Lynn agreed to share the 1993 Project Instream Flow Study to provide additional information about the Project's operational influence downstream of the dam and the geographic scope of the survey.

Lake Lynn distributed the 1993 Project Instream Flow Study to the Resource Agencies on June 2, 2020. The 1993 Project Instream Flow Study reported that water level fluctuations due to Project operation are greatest in the segment of river extending 1.02 mile below the Project dam. The 1993 Project Instream Flow Study also reported that the water depth in the Cheat River segment from the 1.02-mile point below the Project dam to the confluence with the Monongahela is dependent upon and maintained by Pool 7 water elevations during Project shutdown.

By email dated July 9, 2020, Lake Lynn provided a revised draft Mussel Survey Plan to the USFWS, PBFC, and WVDNR. Comments were received from WVDNR and PFBC. WVDNR requested that the first page of the Mussel Survey Plan clarify the intent of the survey and noted that if the intent is to conduct a reconnaissance scoping survey, then the methodology provided is sufficient. WVDNR also requested that the Mussel Survey Plan address the handing of mussels and include a completed summary protocol form. PFBC agreed with the proposed survey methodology outlined in the Mussel Survey Plan dated July 9, 2020 but disagreed with the limits of the survey area being restricted to 1.02 miles downstream of the Project dam (copies of relevant correspondence is included in **Attachment 2**).

A revised Survey Plan was submitted to WVDNR and PFBC by EnviroScience on Monday, September 7, 2020. Comments were received on September 8, 2020 from PFBC stating that the one mile was not sufficient and that a survey would need to be performed to the confluence of the Monongahela River, approximately 3.5 miles downstream, of the Project boundary.

REVISED 2020 MUSSEL SURVEY PLAN (SEPTEMBER 2020)
CHEAT RIVER – LAKE LYNN HYDROELECTRIC PROJECT
MONONGALIA COUNTY, WEST VIRGINIA AND FAYETTE COUNTY, PENNSYLVANIA

The draft Mussel Survey Plan has been revised based on comments received on September 8, 2020 from PFBC and follow-up discussion with PFBC. The objective of this mussel survey is to conduct a reconnaissance scoping survey to identify what mussels, if any, may be within the Cheat River from the Project dam to approximately 3.5 miles downstream to the confluence of the Monongahela River. Mussel habitat (location, depth, and substrate) and the occurrence density, distribution, and relative abundance of any mussel species present will be recorded.

The Project is a 51.2 megawatt (MW) single development project operated since 1926. It consists of:

- a 125-foot high by 1,000-foot long concrete gravity-type dam with a 624-foot long spillway controlled by 26 Tainter gates, each 17 feet high by 21 feet long;
- a reservoir with a surface area of 1,729 acres and containing about 72,00 acre-feet of water at full pool elevation of 870 feet National Geodetic Vertical Datum;
- a log boom and track racks at the intake facility;
- eight 12-foot by 18-foot gated penstocks of reinforced concrete;
- a 72-foot by 165-foot by 68-foot high brick powerhouse containing four identical Francis generating units with a total rated capacity of 51.2 MW;
- dual 800-foot long 13 8-kilovolt transmission lines; and
- appurtenant facilities.

Survey Plan

Reconnaissance scoping survey efforts will be coordinated and led by a West Virginia and Pennsylvania approved malacologist. The qualified malacologist will provide survey oversight and guidance on execution of the survey and will be the lead taxonomist in the field for the duration of the work. The survey will follow modified West Virginia Protocol guidance (WVDNR, 2020) with additional guidance from the American Fisheries Society Monograph 8 (Strayer and Smith, 2003). The survey area includes the Project boundary that extends approximately 200 meters downstream of the Project dam and will continue approximately 3.5 miles downstream to the confluence with the Monongahela River. TRC has preliminarily defined the survey area as depicted on the attached **Figure 2**. A summary protocol form (Mussel Survey Scope of Work Summary Sheet) is attached (**Attachment 1**).

TRC will perform a reconnaissance scoping survey to determine areas of suitable mussel habitat and evaluate for mussel presence/absence within the survey area downstream of the dam. The habitat assessment will start at the mouth of the Cheat River, approximately 3.5 miles downstream of the Project boundary and move upstream to the Project dam (**Figure 2**). The banks will be searched for shell material and the substrate will be evaluated to identify suitable mussel habitat (stable burrowable substrates including sand, gravel, cobble, etc.). Once suitable mussel habitat is located, a qualitative timed search will be employed for a minimum of 10-minutes to search for live mussels and shell material. In the state of West Virginia, there will be at least one qualitative dive every 100 meters in the best possible substrate, if no suitable habitat is located. Qualitative surveys in the Commonwealth of Pennsylvania will only be performed where suitable habitat is identified. If live mussels are collected, the area will be searched until the limits of the mussel bed are delineated.

This survey will consist of visually and tactilely searching the survey area for presence of mussels and to determine limits of any mussel concentrations. Snorkeling and surface supplied air diving will be used to visually and tactilely search for mussels at the substrate surface; moving cobble and woody debris; hand sweeping away silt, sand and/or small detritus; and disturbing/probing the upper 5cm (2in) of substrate in order to ensure recovery of buried mussels. Data will be collected separately for each qualitative search.

**If any federally listed species are observed during survey or efforts, efforts will stop and PBFC, WVDNR, and USFWS will be immediately contacted.**

Data Collection

Photographs will be taken of the survey area and a minimum of one representative photo of each mussel species will be taken for verification purposes. Live mussels will be kept in stream water in mesh collection bags and out of water time will be kept to one (1) minute or less during processing. Mussels that are bagged and held for identification will be hand placed back into their respective habitats where they were collected. At a minimum, data to be recorded includes: substrate composition of each sample (visual percentage based on Wentworth scale; water depth (meters); mussel species, individual size (length, height, and width to the nearest millimeter), sex (where applicable), and age (external annuli count); mussel shells (classified as fresh dead, weathered dead, or relic shell); where applicable; Global Positioning System (GPS) coordinates of the survey area, mussel aggregation limits; and other notable features such as land use and general observations about the stream.

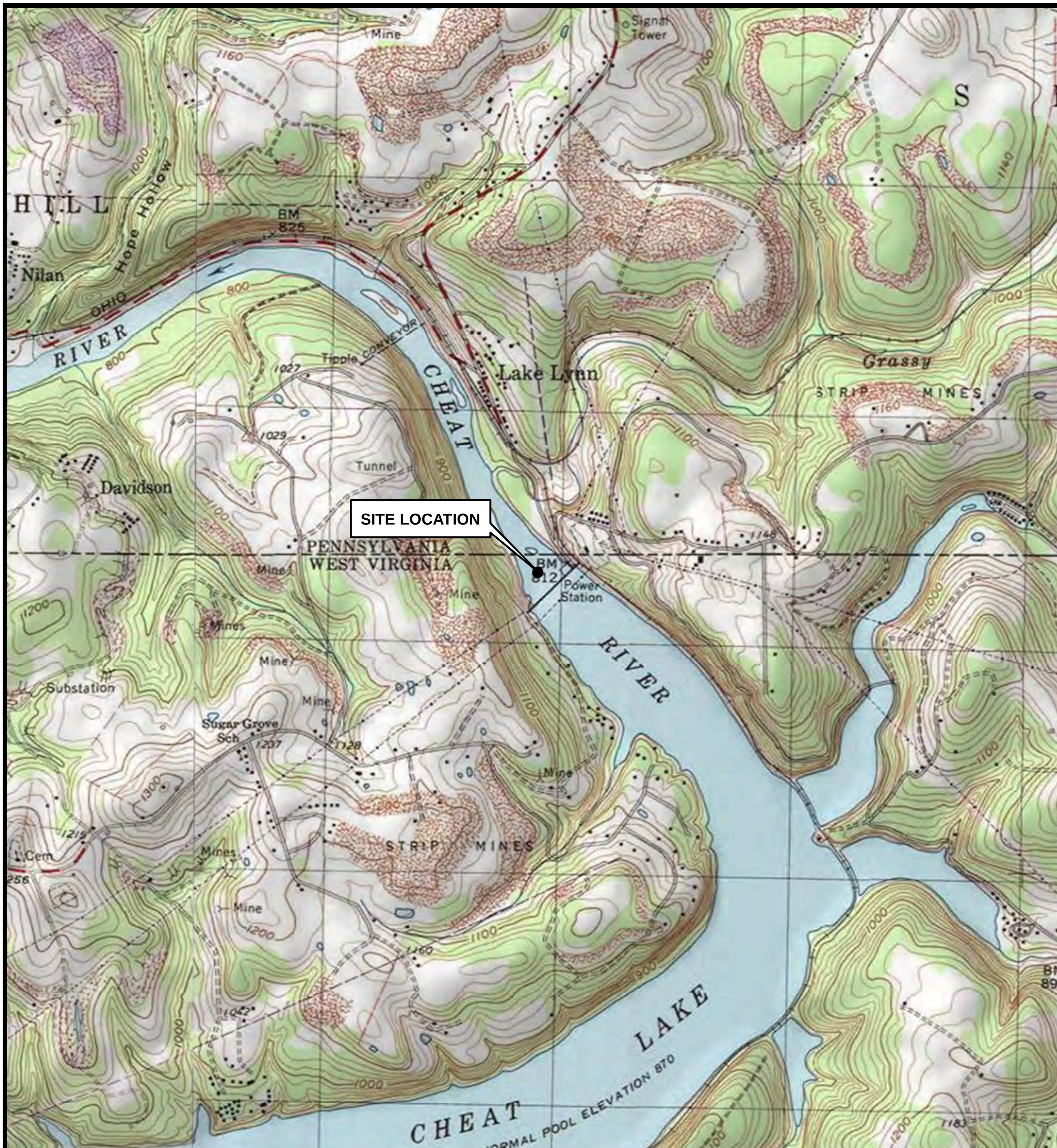
Reporting

A report documenting the results of the habitat assessment survey will be prepared upon completion of field work. Reports will follow technical reporting guidelines and will include an introduction, methods, results, and discussion with associated tables, figures, and appendices. Maps showing the survey area, mussel distribution, and habitat conditions will also be included, along with photo documentation of the survey area and mussel species encountered. Reporting will follow Protocol recommendations.

References

Strayer, D.L., and D.R. Smith. 2003. A guide to sampling freshwater mussel populations. American Fisheries Society, Monograph 8, Bethesda, Maryland.

West Virginia Division of Natural Resources (WVDNR). 2020. West Virginia Mussel Survey Protocols. West Virginia Division of Natural Resources. unpublished. 25pp + app.




BASE MAP FROM USGS TOPOGRAPHIC MAP WEB SERVICE, QUAD: LAKE LYNN

NORTH

1 " = 2,000 '
1:24,000

0 1,000 2,000 FEET


**FIGURE 1**

1382 West Ninth Street
Suite 400
Cleveland, OH 44113
Phone: 216-344-3072

TRC - GIS

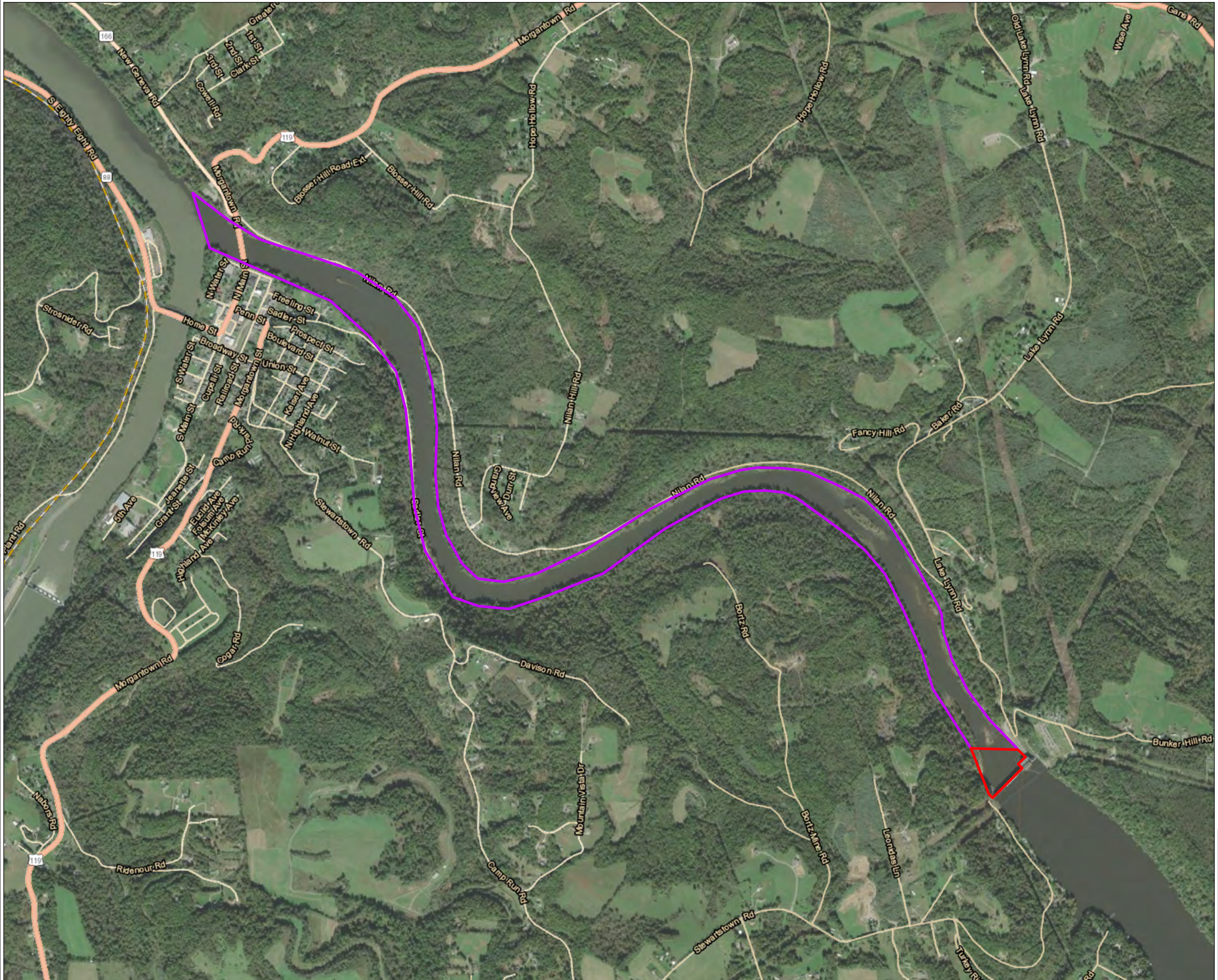
PROJECT:

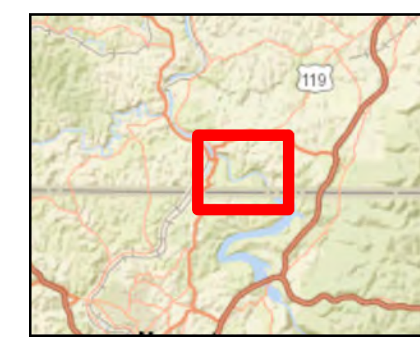
**LAKE LYNN HYDROELECTRIC PROJECT**
**MONONGALIA COUNTY, WEST VIRGINIA**

TITLE:

**SITE LOCATION MAP**

TRC - GIS




0 1,500 3,000 Feet

1 " = 1,500 ' 1:18,000

**LAKE LYNN HYDROELECTRIC PROJECT**
**MONONGALIA COUNTY, WEST VIRGINIA**

**FIGURE 2**
**SURVEY AREA LIMITS**

TRC

1382 West Ninth Street
Suite 400
Cleveland, OH 44113
Phone: 216-344-3072

SEPTEMBER 2020

Fig02_SurveyArea.mxd

**Plot Date:**9/9/2020, 11:03:27 AM by MOPEL -- LAYOUT: ANSI B(11"x17")
**Path:** S:\1-PROJECTS\Cube_PE_Hydro\282346_LakeLynnHydro\Fig02_SurveyArea.mxd

# Mussel Survey Scope of Work Summary Sheet

Form Date **3/16/2020**

## Project Title:

Reconnaissance Scoping Survey for the Lake Lynn Hydroelectric Relicensing Project (FERC No. P-2459) on the Cheat River, Monongalia County, West Virginia and Fayette County, Pennsylvania

Project Company: Lake Lynn Generation LLC
Date Submitted: 9/7/2020
Mussel Contractor: EnviroScience, Inc.
Date Revised: 9/9/2020
Lead Malacologist: Sarah Veselka
Project Contractor: TRC Environmental Corporation
Collectors: if applicable Lindsey Jakovljevic, Tom Radford, Tony Tredway
County: Monongalia, WV and Fayette, PA
Group (Circle One): 1 2 (3) 4
Stream: Cheat River
Location Description: The Project is located on the Cheat River near Morgantown, West Virginia in Monongalia County, West Virginia and Fayette County, Pennsylvania
Navigational Pool if Applicable: ____
If Group 1 or 2, Receiving Stream: ____

Project Type: Hydropower (corresponds to Table 3, WV Mussel Survey Protocol)

| | | | | | |
|---|---|---|---|---|---|
| ADI Length: | 100 m | ADI Width: | 195 m | Salvage area ($m^2$): | |
| US Buffer Length: | NA | US Buffer Width: | NA | USS Buffer Length: | |
| DS Buffer Length: | 3.5 Miles | DS Buffer Width: | 60 m | DSS Buffer Length: | |
| Lateral Buffer Length: | NA | Lateral Buffer Width: | BB | Lateral S Buffer Width: | |

Phase 1 Survey Method: Transect ☐ Cells ☐ Other ☒ qualitative spot dives

# Transects/Length (m): ____ Cell Size (mxm): ____ Cell Search Effort (Min/$m^2$)

| | | | |
|---|---|---|---|
| ____ | ADI: | ____ | 10-minute spot dive in suitable habitat or every 100 m (WV ONLY) |
| ____ | USB: | ____ | NA |
| ____ | DSB: | ____ | 10-minute spot dive in suitable habitat or every 100 m (WV ONLY) |

____ Spacing Between Transects (M)

Coordinates (Decimal Degrees, NAD83)

| | Long. | Lat. |
|---|---|---|
| Upstream End US Buffer: | NA | NA |
| Upstream End ADI: | -79.857352 | 39.719387 |
| ADI Center: | -79.857683 | 39.720052 |
| Downstream End ADI: | -79.858185 | 39.720662 |
| Downstream End DS Buffer: | -79.901564 | 39.742802 |
| RELOCATION AREA: | NA | NA |

Map: Show ADI, USB, DSB and survey layout with outline of proposed impact.

Did you provide? Justification must be provided in scope of work
- Addressed Alternative Methods ☐ Yes — FERC relicense no alternate methods
- Addressed Alternative Sites ☐ Yes — FERC relicense no alternate sites

Phase 2 requested?: ☐ Yes ☒ No

Request for Relocation: ☐ Yes ☒ No

Method:
(check one)
- ☐ Cell Size (mxm): ____
- ☐ Moving Transect:
- ☐ Other:____

Multiple passes are to be made through the area until less than 5 % of the number collected on the first two passes combined are recovered on the

# Foster, Joyce

| | |
|---|---|
| **Subject:** | FW: [EXTERNAL] Lake Lynn Relicensing - Draft Mussel Survey Plan |
| **Location:** | Microsoft Teams Meeting |
| **Start:** | Wed 5/20/2020 11:00 AM |
| **End:** | Wed 5/20/2020 12:00 PM |
| **Show Time As:** | Tentative |
| **Recurrence:** | (none) |
| **Meeting Status:** | Not yet responded |
| **Organizer:** | Jody Smet |

-----Original Appointment-----
**From:** Jody Smet <Jody.Smet@eaglecreekre.com>
**Sent:** Monday, May 18, 2020 11:04 PM
**To:** Jody Smet; Janet_Norman@fws.gov; Jacob Harrell; Heather Smiles; Foster, Joyce
**Cc:** Robert Flickner; Dale Short
**Subject:** [EXTERNAL] Lake Lynn Relicensing - Draft Mussel Survey Plan
**When:** Wednesday, May 20, 2020 11:00 AM-12:00 PM (UTC-05:00) Eastern Time (US & Canada).
**Where:** Microsoft Teams Meeting



All,

Based on the responses received to the Doodle poll, I would also like to schedule a conference call at 11 a.m. on Wednesday, May 20, to discuss the attached draft survey plan for the proposed Lake Lynn Project mussel survey. We anticipate that this call will last no more than an hour. Please join by phone, or MS Teams link, below. Please forward this invitation to others, as appropriate.

Thank you.

________________________________________________________________________________

## Join Microsoft Teams Meeting

+1 920-393-6252 United States, Green Bay (Toll)

Conference ID: 578 406 16#

Local numbers | Reset PIN | Learn more about Teams | Meeting options

________________________________________________________________________________

| | |
|---|---|
| **From:** | Jody Smet |
| **To:** | Smiles, Heather A |
| **Subject:** | [EXTERNAL] RE: Lake Lynn Relicensing - Draft Mussel Survey Plan |
| **Date:** | Tuesday, May 19, 2020 8:16:18 AM |



Great, thanks Heather.

Jody J. Smet, AICP
Vice President Regulatory Affairs
Eagle Creek Renewable Energy

Please note my new email address – jody.smet@eaglecreekre.com

-----Original Appointment-----
**From:** Smiles, Heather A <hsmiles@pa.gov>
**Sent:** Tuesday, May 19, 2020 8:15 AM
**To:** Jody Smet
**Subject:** Accepted: Lake Lynn Relicensing - Draft Mussel Survey Plan
**When:** Wednesday, May 20, 2020 11:00 AM-12:00 PM (UTC-05:00) Eastern Time (US & Canada).
**Where:** Microsoft Teams Meeting

Jody,

Our Malacologist, Nevin Welte, will join the meeting. For your records, below is his information.

Thanks,

**Heather A. Smiles** | Chief, Division of Environmental Services
PA Fish and Boat Commission
595 East Rolling Ridge Drive | Bellefonte, PA 16823
Phone: 814.359.5194
Email: hsmiles@pa.gov
www.fishandboat.com

Nevin Welte
Malacologist/Nongame Biologist, Natural Diversity Section
Pennsylvania Fish & Boat Commission
Centre Region Office
595 E. Rolling Ridge Dr.
Bellefonte, PA 16823
c-nwelte@pa.gov

412-586-2334

| | |
|---|---|
| **From:** | Jody Smet |
| **To:** | Norman, Janet; Harrell, Jacob D; Heather Smiles; c-nwelte@pa.gov |
| **Cc:** | Dale Short; Robert Flickner; Michael Scarzello; Matthew Nini; Foster, Joyce |
| **Subject:** | [EXTERNAL] Lake Lynn Relicensing – Revised Draft Mussel Survey Plan |
| **Date:** | Thursday, July 9, 2020 11:11:10 AM |
| **Attachments:** | image001.png<br>Lake Lynn Mussel Survey Plan_REV 1.pdf |



All,

As follow-up to our call on May 20 discussing the draft Lake Lynn Mussel Survey Plan and review of the 1993 Lake Lynn Instream Flow Study Report, we have attached a revised draft Lake Lynn Mussel Survey Plan for your review. Please provide your comments on the revised Survey Plan by July 17.

Thank you,

**Jody J. Smet, AICP | Vice President Regulatory Affairs**
**Eagle Creek Renewable Energy**
Desk: 804 739 0654
Mobile: 804 382 1764
Email: jody.smet@eaglecreekre.com

| | |
|---|---|
| **From:** | Jody Smet |
| **To:** | Foster, Joyce |
| **Subject:** | FW: [EXTERNAL] Lake Lynn Relicensing – Revised Draft Mussel Survey Plan |
| **Date:** | Tuesday, July 14, 2020 10:42:38 AM |
| **Attachments:** | image001.png |

This is an **EXTERNAL** email. Do not click links or open attachments unless you validate the sender and know the content is safe.

Jody J. Smet, AICP
Vice President Regulatory Affairs
Eagle Creek Renewable Energy

Please note my new email address – jody.smet@eaglecreekre.com

**From:** Norman, Janet <janet_norman@fws.gov>
**Sent:** Tuesday, July 14, 2020 10:37 AM
**To:** Jody Smet <Jody.Smet@eaglecreekre.com>
**Subject:** Re: [EXTERNAL] Lake Lynn Relicensing – Revised Draft Mussel Survey Plan

Received, thank you.
Will look over this week.

Janet

Janet Norman
Fish and Wildlife Biologist
USFWS Chesapeake Bay Field Office
177 Admiral Cochrane Dr.
Annapolis, MD 21401
(O) 410-573-4533
(Fax) 410-269-0832
(cell) 410-320-5519

---

**From:** Jody Smet <Jody.Smet@eaglecreekre.com>
**Sent:** Thursday, July 9, 2020 11:10 AM
**To:** Norman, Janet <janet_norman@fws.gov>; Harrell, Jacob D <Jacob.D.Harrell@wv.gov>; Heather Smiles <hsmiles@pa.gov>; c-nwelte@pa.gov <c-nwelte@pa.gov>
**Cc:** Dale Short <Dale.Short@eaglecreekre.com>; Robert Flickner <Robert.Flickner@eaglecreekre.com>; Michael Scarzello <Michael.Scarzello@eaglecreekre.com>; Matthew Nini <Matthew.Nini@eaglecreekre.com>; Foster, Joyce <JFoster@trccompanies.com>
**Subject:** [EXTERNAL] Lake Lynn Relicensing – Revised Draft Mussel Survey Plan

All,

As follow-up to our call on May 20 discussing the draft Lake Lynn Mussel Survey Plan and review of the 1993 Lake Lynn Instream Flow Study Report, we have attached a revised draft Lake Lynn Mussel Survey Plan for your review. Please provide your comments on the revised Survey Plan by July 17.

Thank you,

**Jody J. Smet, AICP | Vice President Regulatory Affairs**
**Eagle Creek Renewable Energy**
Desk: 804 739 0654
Mobile: 804 382 1764
Email: jody.smet@eaglecreekre.com

| | |
|---|---|
| **From:** | Jody Smet |
| **To:** | Foster, Joyce |
| **Subject:** | [EXTERNAL] FW: Lake Lynn Mussel Survey Plan Comments |
| **Date:** | Thursday, July 30, 2020 9:39:25 AM |
| **Attachments:** | Lake Lynn Mussel Survey Plan Revision Comments.pdf |



FYI, I haven't seen any others.

Jody J. Smet, AICP
Vice President Regulatory Affairs
Eagle Creek Renewable Energy

Please note my new email address – jody.smet@eaglecreekre.com

---

**From:** Harrell, Jacob D <Jacob.D.Harrell@wv.gov>
**Sent:** Tuesday, July 21, 2020 2:37 PM
**To:** Jody Smet <Jody.Smet@eaglecreekre.com>
**Subject:** Lake Lynn Mussel Survey Plan Comments

Jody,

Please see the attached comments concerning the Lake Lynn Mussel Survey Plan. Comments by our Diversity section are included within.

Thanks,

Jacob Harrell

Coordination Unit
WVDNR – Wildlife Resources Section
1110 Railroad Street
Farmington, WV 26571
(304)704-9328
Jacob.D.Harrell@wv.gov

**Sarah Veselka**

---

**From:** Welte, Nevin <c-nwelte@pa.gov>
**Sent:** Friday, September 11, 2020 9:30 AM
**To:** Sarah Veselka
**Cc:** Jacob.D.Harrell@wv.gov; Smiles, Heather A; Jody.Smet@eaglecreekre.com; Foster, Joyce; Jakovljevic, Lindsey; Urban, Chris; Anderson, Robert M
**Subject:** RE: [External] FW: Lake Lynn Survey Plan

Hi Sarah,

Thanks for sharing with us a revised study plan. PFBC concurs with the proposed survey methodology and extent of the study area. Please keep us posted on anticipated survey dates and we may join you in the field.

Thanks again and good luck with the survey,

Nevin

Nevin Welte
Malacologist/Nongame Biologist, Natural Diversity Section
Pennsylvania Fish & Boat Commission
Centre Region Office
595 E. Rolling Ridge Dr.
Bellefonte, PA 16823
c-nwelte@pa.gov

---

**From:** Sarah Veselka <sveselka@enviroscienceinc.com>
**Sent:** Thursday, September 10, 2020 5:10 PM
**To:** Welte, Nevin <c-nwelte@pa.gov>
**Cc:** Jacob.D.Harrell@wv.gov; Smiles, Heather A <hsmiles@pa.gov>; Jody.Smet@eaglecreekre.com; Foster, Joyce <JFoster@trccompanies.com>; Jakovljevic, Lindsey <LJakovljevic@trccompanies.com>; Urban, Chris <curban@pa.gov>; Anderson, Robert M <Robert_M_Anderson@fws.gov>
**Subject:** RE: [External] FW: Lake Lynn Survey Plan

Hi Nevin,

Thank you for your comments. Please find the requested revised survey plan attached here for your review.

Thank you,

Sarah

**Sarah Veselka**
**EnviroScienceInc.com**
**"Excellence in Any Environment"**

---

**From:** Welte, Nevin <c-nwelte@pa.gov>
**Sent:** Tuesday, September 8, 2020 8:51 AM

**To:** Sarah Veselka <sveselka@enviroscienceinc.com>; Sargent, Barbara D <Barbara.D.Sargent@wv.gov>
**Cc:** Jacob.D.Harrell@wv.gov; Smiles, Heather A <hsmiles@pa.gov>; Jody.Smet@eaglecreekre.com; Foster, Joyce <JFoster@trccompanies.com>; Jakovljevic, Lindsey <LJakovljevic@trccompanies.com>; Urban, Chris <curban@pa.gov>; Anderson, Robert M <Robert_M_Anderson@fws.gov>
**Subject:** RE: [External] FW: Lake Lynn Survey Plan

Hi Sarah,

Thanks for the email and the attached survey plan. While PFBC agrees with the proposed survey methods (i.e., "how to look for mussels") we continue to disagree with the extent of the study area (1.0 mile downstream of the project). The extent of the study area was not revised based upon recent PFBC comments submitted by Heather Smiles (email dated August 3, 2020) and no biological rationale was given for maintaining a limited study area. Any data collected from this limited study area will be continue to be insufficient data to answer the question of whether or not this dam or its operations have an effect on Pennsylvania's freshwater mussels. We continue to advise that the study scope be revised and extended to include the length of the Cheat River in Pennsylvania using the approach described in Heather's email (in quotes below).

"Although the Cheat River has not been examined recently to detect freshwater mussels it is possible that species have recolonized the Cheat in areas that contain suitable mussel habitat. A survey of the Pennsylvania stretch of the Cheat would entail a scouting trip to determine areas of potentially suitable habitat followed by a qualitative survey of these areas (similar to the Large Scoping Projects in the WV mussel protocol). Such an effort would be necessary to determine whether mussels are present and to determine, to some extent, what the effects of the existing management of Lake Lynn are having on the Cheat River downstream of the dam."

We look forward to reviewing a revised study plan.

Thanks,

Nevin

Nevin Welte
Malacologist/Nongame Biologist, Natural Diversity Section
Pennsylvania Fish & Boat Commission
Centre Region Office
595 E. Rolling Ridge Dr.
Bellefonte, PA 16823
c-nwelte@pa.gov

---

**From:** Sarah Veselka <sveselka@enviroscienceinc.com>
**Sent:** Monday, September 7, 2020 4:19 PM
**To:** Welte, Nevin <c-nwelte@pa.gov>; Sargent, Barbara D <Barbara.D.Sargent@wv.gov>
**Cc:** Jacob.D.Harrell@wv.gov; Smiles, Heather A <hsmiles@pa.gov>; Jody.Smet@eaglecreekre.com; Foster, Joyce <JFoster@trccompanies.com>; Jakovljevic, Lindsey <LJakovljevic@trccompanies.com>
**Subject:** [External] FW: Lake Lynn Survey Plan

Hello Nevin and Barb,

On behalf of Lake Lynn Generation and TRC, please find the attached mussel survey plan for the Lake Lynn Hydroelectric Project for your review and approval. I will be acting as the WV/PA qualified malacologist for the Project.

Thank you,

Sarah

**Sarah Veselka**
**EnviroScienceInc.com**
**"Excellence in Any Environment"**

## Sarah Veselka

**From:** Sargent, Barbara D <Barbara.D.Sargent@wv.gov>
**Sent:** Wednesday, September 9, 2020 10:20 AM
**To:** Sarah Veselka
**Cc:** Harrell, Jacob D
**Subject:** RE: [External] FW: Lake Lynn Survey Plan
**Attachments:** carlson_bAdd10.pdf; veselka_sAdd08.pdf; dunford_dAdd04.pdf; schwegman_rAdd04.pdf; mathias_pAdd04.pdf; winterringer_rAdd04.pdf

Hi Sarah—

I have attached your addenda for the Lake Lynn project. The Scope is approved only for the WV portion; we defer to PA for their portion.

b.

---

**From:** Sarah Veselka [mailto:sveselka@enviroscienceinc.com]
**Sent:** Monday, September 07, 2020 4:19 PM
**To:** Welte, Nevin; Sargent, Barbara D
**Cc:** Harrell, Jacob D; hsmiles@pa.gov; Jody.Smet@eaglecreekre.com; Foster, Joyce; Jakovljevic, Lindsey
**Subject:** [External] FW: Lake Lynn Survey Plan

CAUTION: External email. Do not click links or open attachments unless you verify sender.

Hello Nevin and Barb,

On behalf of Lake Lynn Generation and TRC, please find the attached mussel survey plan for the Lake Lynn Hydroelectric Project for your review and approval. I will be acting as the WV/PA qualified malacologist for the Project.

Thank you,

Sarah

**Sarah Veselka**
EnviroScienceInc.com
**"Excellence in Any Environment"**

| | |
|---|---|
| **From:** | Jody Smet |
| **To:** | Norman, Janet; Harrell, Jacob D; Heather Smiles; c-nwelte@pa.gov |
| **Cc:** | Dale Short; Robert Flickner; Michael Scarzello; Matthew Nini; Foster, Joyce |
| **Subject:** | [EXTERNAL] RE: Lake Lynn Relicensing – Revised Draft Mussel Survey Plan |
| **Date:** | Thursday, July 30, 2020 9:41:00 AM |
| **Attachments:** | image001.png |



All,

Comments were due on the revised mussel survey plan on 7/17. We received comments from WVDNR. We are working to finalize this study plan so that we are prepared to be in the field in late August / early September.

Thank you,

Jody J. Smet, AICP
Vice President Regulatory Affairs
Eagle Creek Renewable Energy

Please note my new email address – jody.smet@eaglecreekre.com

---

**From:** Jody Smet
**Sent:** Thursday, July 9, 2020 11:10 AM
**To:** Norman, Janet <janet_norman@fws.gov>; Harrell, Jacob D <Jacob.D.Harrell@wv.gov>; Heather Smiles <hsmiles@pa.gov>; c-nwelte@pa.gov
**Cc:** Dale Short <Dale.Short@eaglecreekre.com>; Robert Flickner <Robert.Flickner@eaglecreekre.com>; Michael Scarzello <Michael.Scarzello@eaglecreekre.com>; Matthew Nini <Matthew.Nini@eaglecreekre.com>; Foster, Joyce <JFoster@trccompanies.com>
**Subject:** Lake Lynn Relicensing – Revised Draft Mussel Survey Plan

All,

As follow-up to our call on May 20 discussing the draft Lake Lynn Mussel Survey Plan and review of the 1993 Lake Lynn Instream Flow Study Report, we have attached a revised draft Lake Lynn Mussel Survey Plan for your review. Please provide your comments on the revised Survey Plan by July 17.

Thank you,

**Jody J. Smet, AICP | Vice President Regulatory Affairs**
**Eagle Creek Renewable Energy**
Desk: 804 739 0654
Mobile: 804 382 1764
Email: jody.smet@eaglecreekre.com

EAGLE CREEK
RENEWABLE ENERGY
— EXCELLENCE IN HYDRO —

| | |
|---|---|
| **From:** | Jody Smet |
| **To:** | Foster, Joyce |
| **Subject:** | FW: [External] RE: Lake Lynn Relicensing – Revised Draft Mussel Survey Plan - PFBC Comments |
| **Date:** | Monday, August 3, 2020 12:29:10 PM |
| **Attachments:** | image001.png |



Jody J. Smet, AICP
Vice President Regulatory Affairs
Eagle Creek Renewable Energy

Please note my new email address – jody.smet@eaglecreekre.com

**From:** Smiles, Heather A <hsmiles@pa.gov>
**Sent:** Monday, August 3, 2020 11:35 AM
**To:** Jody Smet <Jody.Smet@eaglecreekre.com>
**Subject:** RE: [External] RE: Lake Lynn Relicensing – Revised Draft Mussel Survey Plan - PFBC Comments

Dear Jody,

Thanks for the opportunity to review the proposed study plan. While PFBC agrees with the proposed survey methodologies, we disagree with the limits of the study area being restricted to 1.02 miles downstream of the dam.

Per the study plan, the study area was restricted based upon the area of fluctuating water elevations, but wetted width of a river is but one component of regulated rivers that may have an adverse effect on freshwater mussel communities. Discharge water temperature is another critical component to the survival and persistence of a viable mussel community. Discharge temperatures are controlled by where water is being released from within the impoundment, and coldwater releases have a well-documented effect on freshwater mussel communities including limiting gametogenesis, growth, as well as altering the host fish community which affects mussel community composition. The Lake Lynn study limit should, at minimum, consider the entire length of the Cheat that has temperature affected by the discharge of the dam.

In lieu of a temperature study delimits the downstream thermal effects of the dam, a mussel study that focuses on potential mussel habitat from the dam downstream to its confluence with the Monongahela River would be appropriate to ascertain what species if any, occur in the Cheat River.

If such a survey effort results in the detection of no mussels or a limited community in the Cheat River then it would be a worthy biological objective of relicensing to try and mimic, to the extent practicable, the natural flow  and/or thermal regime as much as possible to maintain the river's restoration potential.

The proximity of the project to recent/known populations of state listed species (e.g., Snuffbox, Salamander Mussel, and Pistolgrip) approximately ~ 2.4 miles from the confluence of the Cheat and Monongahela River confluence suggests that it is a possibility that these species could occur in the Cheat, could disperse there in the future, and thus may be affected by Lake Lynn dam operations.

As you may know, the Cheat contained a diverse mussel fauna including the state and federal listed Clubshell (*Pleurobema clava*), a species undergoing a federal status assessment (SSA) (Longsolid, *Fusconaia subrotunda*), as well as two species that haven't been seen in Pennsylvania in over 100 years (Pimpleback, *Cyclonaias pustulosa* and Purple Wartyback, *C. tuberculata*). This Cheat River population was likely an extension of the Monongahela River population which was also quite diverse (e.g., Fanshell, *Cyprogenia stegaria*) until the effects of the steel and associated industries became too severe, before 1900. The Monongahela River, like the Ohio River (21 mussel species in PA), is a river in recovery since water quality improvements began in the 1970s.

Despite the effects of that industry, Dunkard Creek – a tributary to the Monongahela River just 2.4 miles downstream of the Cheat – was considered the crown jewel of the Monongahela River system until 2009, when a toxic event wiped that fauna out. Dunkard Creek harbored – as of 2009 – the state and federally endangered Snuffbox (*Epioblasma triquetra*), the state endangered Salamander Mussel (*Simpsonaias ambigua*, also undergoing a federal SSA), and the state endangered Pistolgrip (*Tritogonia verrucosa*). Numerous other species also occurred in Dunkard and PFBC and WVDNR are actively working to restore Dunkard with common mussels and via propagation and augmentation efforts. It's not unreasonable to suspect that glochidia-inoculated host fishes from Dunkard Creek were able to traverse the short distance to the Cheat River.
Although the Cheat River has not been examined recently to detect freshwater mussels it is possible that species have recolonized the Cheat in areas that contain suitable mussel habitat. A survey of the Pennsylvania stretch of the Cheat would entail a scouting trip to determine areas of potentially suitable habitat followed by a qualitative survey of these areas (similar to the Large Scoping Projects in the WV mussel protocol). Such an effort would be necessary to determine whether mussels are present and to determine, to some extent, what the effects of the existing management of Lake Lynn are having on the Cheat River downstream of the dam.

We look forward to reviewing a modified mussel survey plan.

**Heather A. Smiles** | Chief, Division of Environmental Services
PA Fish and Boat Commission
595 East Rolling Ridge Drive | Bellefonte, PA 16823
Phone: 814.359.5194
Email: hsmiles@pa.gov
www.fishandboat.com

---

**From:** Jody Smet <Jody.Smet@eaglecreekre.com>
**Sent:** Thursday, July 30, 2020 9:41 AM

**To:** Norman, Janet <janet_norman@fws.gov>; Harrell, Jacob D <Jacob.D.Harrell@wv.gov>; Smiles, Heather A <hsmiles@pa.gov>; Welte, Nevin <c-nwelte@pa.gov>
**Cc:** Dale Short <Dale.Short@eaglecreekre.com>; Robert Flickner <Robert.Flickner@eaglecreekre.com>; Michael Scarzello <Michael.Scarzello@eaglecreekre.com>; Matthew Nini <Matthew.Nini@eaglecreekre.com>; Foster, Joyce <JFoster@trccompanies.com>
**Subject:** [External] RE: Lake Lynn Relicensing – Revised Draft Mussel Survey Plan



All,

Comments were due on the revised mussel survey plan on 7/17. We received comments from WVDNR. We are working to finalize this study plan so that we are prepared to be in the field in late August / early September.

Thank you,

Jody J. Smet, AICP
Vice President Regulatory Affairs
Eagle Creek Renewable Energy

Please note my new email address – jody.smet@eaglecreekre.com

---

**From:** Jody Smet
**Sent:** Thursday, July 9, 2020 11:10 AM
**To:** Norman, Janet <janet_norman@fws.gov>; Harrell, Jacob D <Jacob.D.Harrell@wv.gov>; Heather Smiles <hsmiles@pa.gov>; c-nwelte@pa.gov
**Cc:** Dale Short <Dale.Short@eaglecreekre.com>; Robert Flickner <Robert.Flickner@eaglecreekre.com>; Michael Scarzello <Michael.Scarzello@eaglecreekre.com>; Matthew Nini <Matthew.Nini@eaglecreekre.com>; Foster, Joyce <JFoster@trccompanies.com>
**Subject:** Lake Lynn Relicensing – Revised Draft Mussel Survey Plan

All,

As follow-up to our call on May 20 discussing the draft Lake Lynn Mussel Survey Plan and review of the 1993 Lake Lynn Instream Flow Study Report, we have attached a revised draft Lake Lynn Mussel Survey Plan for your review. Please provide your comments on the revised Survey Plan by July 17.

Thank you,

---

**Jody J. Smet, AICP | Vice President Regulatory Affairs**
**Eagle Creek Renewable Energy**
Desk: 804 739 0654
Mobile: 804 382 1764
Email: jody.smet@eaglecreekre.com

**DIVISION OF NATURAL RESOURCES**
**Wildlife Resources Section**
**District I**
**PO Box 99, 1110 Railroad Street**
**Farmington, West Virginia 26571-0099**
**Telephone 304 825-6787**
**Fax 304 825-6270**
**TDD 800-354-6087**

**Stephen S. McDaniel**
**Director**

July 20, 2020

Jody Smet, AICP
Vice President Regulatory Affairs
Eagle Creek Renewable Energy
2 Bethesda Metro Center, Suite 1330
Bethesda, MD 20814

**RE: Lake Lynn Hydroelectric Project, FERC no. 2459; Lake Lynn Mussel Survey Plan Revision**

Dear Ms. Smet:

Thank you for allowing the West Virginia Division of Natural Resources, Wildlife Resources Section (WRS) the opportunity to review the Mussel Survey Plan as part of the relicensing process for the Lake Lynn Hydroelectric Project, FERC no. 2459. The WRS has reviewed the plan and offers the following comments for your consideration.

As provided, it is unclear if the intent of the surveys is for scoping or to identify potential impacts related to the project. Such intent should be made clear on the first page of the mussel survey plan. If the intent is to conduct a reconnaissance scoping survey to identify what mussels, if any, may be within the project impact area, then the methodology as provided would be sufficient. However, if the intent of the survey is to identify potential impacts that may occur due to project operation, then the methodology provided is insufficient and would fail to meet the standards of the 2020 West Virginia Mussel Survey Protocols which would require additional work (i.e. transect surveys).

Within West Virginia, the Cheat River is a Group 3 stream (large river not expected to have federally threatened and endangered mussel species). Transect surveys on Group 3 streams must include a minimum of 500 linear meters of surveyed area and contain a minimum of 5 transects (up to a maximum of 10 transectes).

With further regard to the methodology, the handling of mussels should be addressed within the survey plan. Mussels that are bagged and held for identification need to be hand placed back into their respective habitat where they were collected.

A summary protocol form, see attached, must also be completed and attached to the mussel survey plan. The mussel survey plan must also be approved by the Diversity Section of the West Virginia Division of Natural Resources and a scientific collection permit would need to be obtained to survey the sections of the survey within West Virginia.

Thank you again for the opportunity to provide comments regarding the mussel survey plan. If you have any questions or comments concerning the mussel survey plan please contact me at (304)989-0208 or by email at jacob.d.harrell@wv.gov.

Sincerely Yours,

Jacob Harrell
Hydropower Coordination Biologist

# Mussel Survey Scope of Work Summary Sheet

Form Date: 3/16/2020

## Project Title:

Project Company: ______________________ Date Submitted: ______________________
Mussel Contractor: ______________________ Date Revised: ______________________
Lead Malacologist: ______________________
Project Contractor: ______________________
Collectors: if applicable ______________________
County: ______________________ Group (Circle One): 1 2 3 4
Stream: ______________________ Location Description:
Navigational Pool if Applicable: ______________________
If Group 1 or 2, Receiving Stream: ______________________

Project Type: ______________________ (corresponds to Table 3, WV Mussel Survey Protocol)

| | | | | | |
|---|---|---|---|---|---|
| ADI Length: | ________ | ADI Width: | ________ | Salvage area ($m^2$): | ________ |
| US Buffer Length: | ________ | US Buffer Width: | ________ | USS Buffer Length: | ________ |
| DS Buffer Length: | ________ | DS Buffer Width: | ________ | DSS Buffer Length: | ________ |
| Lateral Buffer Length: | ________ | Lateral Buffer Width: | ________ | Lateral S Buffer Width: | ________ |

Phase 1 Survey Method: Transect ☐ Cells ☐ Other ☐ ______________________

| # Transects/Length (m): | | Cell Size (mxm): | Cell Search Effort (Min/$m^2$) |
|---|---|---|---|
| ________ | ADI: | ________ | ________ |
| ________ | USB: | ________ | ________ |
| ________ | DSB: | ________ | ________ |

________ Spacing Between Transects (M)

Coordinates (Decimal Degrees, NAD83)

| | | |
|---|---|---|
| Upstream End US Buffer: | Long. ________ | Lat. ________ |
| Upstream End ADI: | Long. ________ | Lat. ________ |
| ADI Center: | Long. ________ | Lat. ________ |
| Downstream End ADI: | Long. ________ | Lat. ________ |
| Downstream End DS Buffer: | Long. ________ | Lat. ________ |
| RELOCATION AREA: | Long. ________ | Lat. ________ |

Map: Show ADI, USB, DSB and survey layout with outine of proposed impact.

Did you provide? Justification must be provided in scope of work

Addressed Alternative Methods ☐ Yes Provide Description in Scope
Addressed Alternative Sites ☐ Yes Provide Description in Scope

Phase 2 requested?: ☐ Yes ☐ No

Request for Relocation: ☐ Yes ☐ No

Method:
(check one)
☐ Cell Size (mxm): ________
☐ Moving Transect:
☐ Other: ______________________

Multiple passes are to be made through the area until less than 5 % of the number collected on the first two passes combined are recovered on the

**COMMONWEALTH OF PENNSYLVANIA**
PENNSYLVANIA FISH AND BOAT COMMISSION
Bureau of Fisheries - Environmental Services Division - Natural Diversity Section
595 E. Rolling Ridge Drive
Bellefonte, PA 16823

Permit Issue Date:May 21, 2020 Permit Print Date:May 27, 2020 PERMIT NO. 2020-03-0241 Type 3

THIS IS TO CERTIFY THAT ACTING UNDER THE PROVISIONS OF THE FISH AND BOAT CODE, ACT 1980-175 AMENDED:

| Name and Town of Permit Owner | Age | Height | Weight | Eyes | Hair | PA Fishing License # |
|---|---|---|---|---|---|---|
| SARAH VESELKA, EnviroScience, Inc.-Malacologist<br>Morgantown, WV | 41 | 5ft. 7In. | 1 | Hazel | Brown | 071-887-806 |

AND ASSISTANTS LISTED, ARE HEREBY AUTHORIZED TO COLLECT FISH OR OTHER AQUATIC LIFE FOR SCIENTIFIC PURPOSES AND IS LIMITED TO THOSE ACTIVITIES AS DESCRIBED IN RESPONSE TO THE APPLICATION PROJECT DETAILS SECTION. THIS PERMIT IS VALID FOR COLLECTION PROJECTS: (SEE ATTACHED SHEET)

UNLESS OTHERWISE PERMITTED, ALL SPECIES MUST BE RELEASED UNHARMED AT SITE OF CAPTURE. A SCIENTIFIC COLLECTOR'S PERMIT DOES NOT GRANT THE PERSONS THE AUTHORITY TO TRESPASS ON PRIVATE PROPERTY.

THIS PERMIT IS GOOD FOR THE CALENDAR YEAR **2020** OR DATE SPECIFIED IN PERMIT CONDITIONS, WHICHEVER COMES FIRST.

THE OWNER OF THIS PERMIT AND LISTED ASSISTANTS MUST BE THE HOLDERS OF A RESIDENT OR NONRESIDENT FISHING LICENSE WHICH MUST BE CARRIED WITH THEM AT ALL TIMES, ALONG WITH THIS PERMIT, OR A COPY THEREOF. PROPER NOTIFICATION MUST BE GIVEN TO THE REGIONAL LAW ENFORCEMENT OFFICE COVERING THE COUNTY IN WHICH COLLECTIONS ARE BEING CONDUCTED. OFFICES ARE OPEN MONDAY THRU FRIDAY BETWEEN 8:00AM AND 4:00PM

IN WITNESS THEREOF, I HAVE HEREUNTO SET MY HAND AND AFFIXED THE OFFICAL SEAL OF THE COMMISSION THE DAY AND DATE FIRST ABOVE WRITTEN

EXECUTIVE DIRECTOR OR DESIGNEE

Pennsylvania Fish & Boat Commission

PENNSYLVANIA FISH & BOAT COMMISSION
established 1866

**Natural Diversity Section**
595 E. Rolling Ridge Drive
Bellefonte, PA 16823-9620
*(814) 359-5237 Fax: (814) 359-5175*

May 27, 2020

SARAH E VESELKA
EnviroScience, Inc.
129 Greenbag Road,
Morgantown, WV 26501

**RE: Chapter 75.4 Special Permit for Collection of Threatened and Endangered Species**
**Scientific Collectors' Permits No. 2020-03-0241 Type 3**

Dear SARAH E VESELKA:

THIS IS TO CERTIFY THAT, pursuant to PA 58 Code §75.4,

**SARAH E VESELKA**

and approved Scientific Collectors' Permit (SCP) assistants, are hereby granted written permission to search for, trap, measure, and mark threatened and endangered species under Pennsylvania Fish and Boat Commission jurisdiction in exception of the prohibition of possession. Specifically, this permit grants permission for SARAH E VESELKA to survey for the following species:

| **Common Name** | ***Scientific Name*** |
|---|---|
| Northern Riffleshell | *Epioblasma torulosa rangiana* |
| Snuffbox | *Epioblasma triquetra* |
| Sheepnose Mussel | *Plethobasus cyphyus* |
| Clubshell | *Pleurobema clava* |
| Salamander Mussel | *Simpsonaias ambigua* |
| Pistolgrip Mussel | *Quadrula verrucosa* |
| Rayed Bean Mussel | *Villosa fabalis* |

Upon capture, these specimens will be measured, marked, photo-documented, and immediately released to the point of capture and reported to the Commission within 48 hours via the Scientific Collectors' Permit online reporting system. This Special Permit **DOES NOT AUTHORIZE** any individual to kill or take from the wild endangered or threatened species. However, this permit authorizes valid Scientific Collector Permit holders (Types I, II and III) and their approved SCP assistants to engage in scientific collecting for endangered or threatened species at the locations approved on their 2020 Scientific Collectors' Permit. **Any endangered or threatened species captured during these permitted activities shall be released as authorized by the conditions outlined in your Scientific Collector's permit.** Deceased specimens, in whole or parts, shall be reported immediately to the Pennsylvania Fish & Boat Commission to determine disposition. This permit, unless sooner revoked, is effective immediately and expires with the 2020 Scientific Collectors' Permit.

FOR THE PENNSYLVANIA FISH AND BOAT COMMISSION

Christopher A. Urban, Chief
Natural Diversity Section

**DIVISION OF NATURAL RESOURCES**
Wildlife Resources Section
Elkins Operations Center
738 Ward Rd., PO Box 67
Elkins, WV 26241
Telephone 304-637-0245
Fax 304-637-0250

Stephen S. McDaniel
Director

# ADDENDUM TO SCIENTIFIC COLLECTING PERMIT NO. 2020.111

Permittee: Sarah Veselka
Address: EnviroScience, Inc.
West Virginia – Appalachia Operations
129 Greenbag Road
Morgantown, WV 26501

Expiration Date: October 1, 2020

THE FOLLOWING PROVISIONS ARE ADDED TO THIS PERMIT: The Scope of Work is approved for the West Virginia portion of the project only. The WVDNR defers to the Pennsylvania Fish and Boat Commission for surveys conducted in their waters.

Mussel surveys are permitted in the Cheat River in Monongalia at the West Virginia – Pennsylvania state line (Lake Lynn Hydroelectric Relicensing)

**THIS ADDENDUM MUST BE ATTACHED TO ORIGINAL PERMIT.**

Must be signed before valid.

Sarah Veselka

Signature of permittee

Scientific Collecting Permit Coordinator

9/9/2020

Date of Issue

# Appendix B
# Photolog

# PHOTOGRAPHIC RECORD

## Mussel Reconnaissance Scoping Survey

Lake Lynn Hydroelectric Project (FERC No. P-2459)

| Client Name: | Site Location: | Project No. |
|---|---|---|
| Lake Lynn Generation LLC | Cheat River, Monongalia County, West Virginia and Fayette County, Pennsylvania | 282346.2020.000 |

| | |
|---|---|
| **Photo No. 1.** |  |
| **Date:** September 16, 2020 | |
| **Description:** View of the Lake Lynn Generation, LLC development looking upstream, facing east. | |

| | |
|---|---|
| **Photo No. 2.** |  |
| **Date:** September 16, 2020 | |
| **Description:** View of the Lake Lynn Generation, LLC dam development looking upstream, facing southeast. | |

| **Client Name:** | **Site Location:** | **Project No.** |
|---|---|---|
| Lake Lynn Generation LLC | Cheat River, Monongalia County, West Virginia and Fayette County, Pennsylvania | 282346.2020.000 |

**Photo No. 3.**

**Date:**
September 16, 2020

**Description:**

View of the right descending bank of the island just downstream of the Project dam, facing south west.

**Photo No. 4.**

**Date:**
September 16, 2020

**Description:**

Cross stream view looking towards the left descending bank of the Cheat River, facing west.

# PHOTOGRAPHIC RECORD

## Mussel Reconnaissance Scoping Survey

Lake Lynn Hydroelectric Project (FERC No. P-2459)

| Client Name: | Site Location: | Project No. |
|---|---|---|
| Lake Lynn Generation LLC | Cheat River, Monongalia County, West Virginia and Fayette County, Pennsylvania | 282346.2020.000 |

**Photo No. 5.**

**Date:** September 16, 2020

**Description:**

View of the left descending bank of the Cheat River from the island just downstream of the dam, facing southwest.

**Photo No. 6.**

**Date:** September 16, 2020

**Description:**

View of Site 1 from the island directly downstream of the Project dam.

# PHOTOGRAPHIC RECORD

**Mussel Reconnaissance Scoping Survey**

Lake Lynn Hydroelectric Project (FERC No. P-2459)

| Client Name: | Site Location: | Project No. |
|---|---|---|
| Lake Lynn Generation LLC | Cheat River, Monongalia County, West Virginia and Fayette County, Pennsylvania | 282346.2020.000 |

**Photo No. 7.**

**Date:**
September 16, 2020

**Description:**

Substrate within Site 1, directly downstream of the dam.

**Photo No. 8.**

**Date:**
September 16, 2020

**Description:**

View of the substrate at the point of Site 2.

| | |
|---|---|
| **Photo No. 9.** |  |
| **Date:**<br>September 16, 2020 | |
| **Description:**<br><br>View of the left descending bank from Site 2. | |

| | |
|---|---|
| **Photo No. 10.** |  |
| **Date:**<br>September 16, 2020 | |
| **Description:**<br><br>View of Site 2 on the island directly downstream of the Project dam, facing northeast. | |

| Client Name: | Site Location: | Project No. |
|---|---|---|
| Lake Lynn Generation LLC | Cheat River, Monongalia County, West Virginia and Fayette County, Pennsylvania | 282346.2020.000 |

| | |
|---|---|
| **Photo No. 11.** |  |
| **Date:** September 16, 2020 | |
| **Description:** View of the Cheat River looking downstream along the right descending bank downstream of the island, facing northwest. | |

| | |
|---|---|
| **Photo No. 12.** |  |
| **Date:** September 16, 2020 | |
| **Description:** View of the Cheat River looking across at the left descending bank downstream of the island, facing southwest. | |

# PHOTOGRAPHIC RECORD

**Mussel Reconnaissance Scoping Survey**

Lake Lynn Hydroelectric Project (FERC No. P-2459)

| Client Name: | Site Location: | Project No. |
|---|---|---|
| Lake Lynn Generation LLC | Cheat River, Monongalia County, West Virginia and Fayette County, Pennsylvania | 282346.2020.000 |

| **Photo No. 13.** |  |
|---|---|
| **Date:** September 17, 2020 | |
| **Description:** Representative view of Site 3, facing west. | |

| **Photo No. 14.** |  |
|---|---|
| **Date:** September 17, 2020 | |
| **Description:** Representative view of Site 3 looking downstream, facing north. | |

| | |
|---|---|
| **Photo No. 15.** |  |
| **Date:** September 16, 2020 | |
| **Description:** Representative view of Site 4, facing northwest. | |

| | |
|---|---|
| **Photo No. 16.** |  |
| **Date:** September 16, 2020 | |
| **Description:** Representative view of Site 4, facing northwest. | |

# PHOTOGRAPHIC RECORD

## Mussel Reconnaissance Scoping Survey

Lake Lynn Hydroelectric Project (FERC No. P-2459)

| Client Name: | Site Location: | Project No. |
|---|---|---|
| Lake Lynn Generation LLC | Cheat River, Monongalia County, West Virginia and Fayette County, Pennsylvania | 282346.2020.000 |

| Photo No. 17. | |
|---|---|
| **Date:** September 16, 2020 |  |
| **Description:** Substrate within Site 4. | |

| Photo No. 18. | |
|---|---|
| **Date:** September 16, 2020 |  |
| **Description:** Representative photo of acid mine drainage, downstream of Site 4, facing east. | |

**Photo No. 19.**

**Date:**
September 16, 2020

**Description:**

Evidence of acid mine drainage, downstream of Site 4.

**Photo No. 20.**

**Date:**
September 16, 2020

**Description:**

View of milky colored water with iron covered rocks, downstream of Site 4.

| Client Name: | Site Location: | Project No. |
|---|---|---|
| Lake Lynn Generation LLC | Cheat River, Monongalia County, West Virginia and Fayette County, Pennsylvania | 282346.2020.000 |

**Photo No. 21.**

**Date:**
September 16, 2020

**Description:**

Representative view of Site 5 looking downstream, facing north.

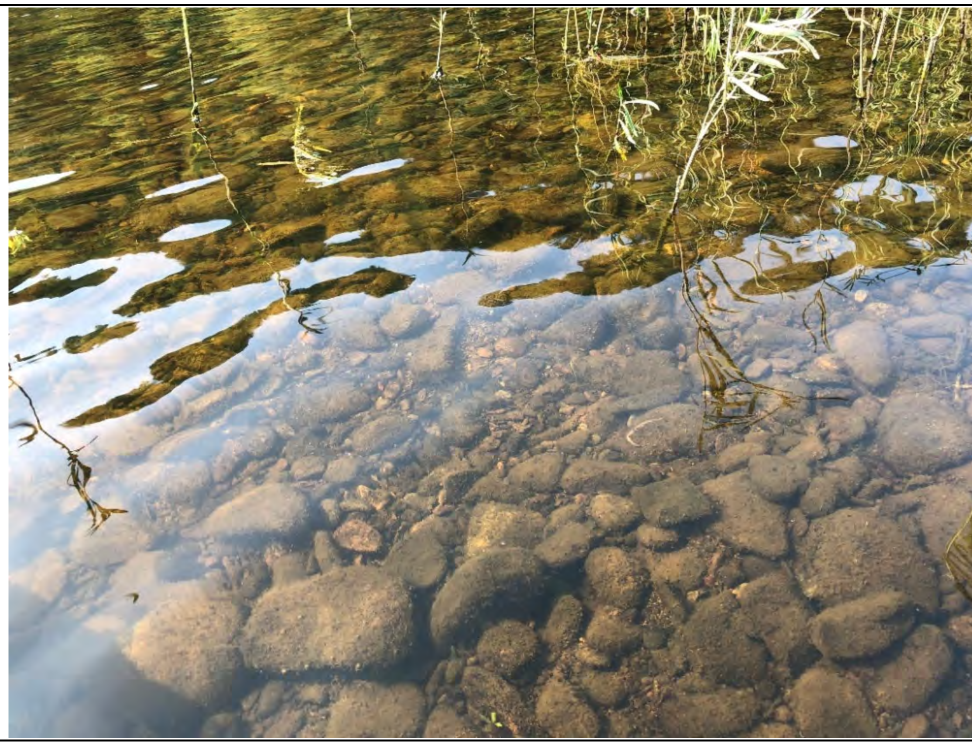
**Photo No. 22.**

**Date:**
September 16, 2020

**Description:**

Representative view of Site 5, looking at the left descending bank, facing southwest.

| **Client Name:** Lake Lynn Generation LLC | **Site Location:** Cheat River, Monongalia County, West Virginia and Fayette County, Pennsylvania | **Project No.** 380830.0000.0000 |
| --- | --- | --- |

| | |
| --- | --- |
| **Photo No. 23.** |  |
| **Date:** September 16, 2020 | |
| **Description:** View of substrate within Site 5. | |

| | |
| --- | --- |
| **Photo No. 24.** |  |
| **Date:** September 16, 2020 | |
| **Description:** Representative view of Site 5 looking downstream at right descending bank, facing northeast. | |

| Client Name: | Site Location: | Project No. |
|---|---|---|
| Lake Lynn Generation LLC | Cheat River, Monongalia County, West Virginia and Fayette County, Pennsylvania | 380830.0000.0000 |

| | |
|---|---|
| **Photo No. 25.** |  |
| **Date:** September 16, 2020 | |
| **Description:** Representative view of Site 5 looking downstream at left descending bank, facing northwest. | |

| | |
|---|---|
| **Photo No. 26.** |  |
| **Date:** September 16, 2020 | |
| **Description:** Representative view of a riffle within Site 5 looking upstream, facing southeast. | |

**Photo No. 27.**

**Date:**
September 17, 2020

**Description:**

View of the right descending bank at Site 6, facing west.

**Photo No. 28.**

**Date:**
September 17, 2020

**Description:**

Representative view of Site 6, facing west.

| Client Name: | Site Location: | Project No. |
|---|---|---|
| Lake Lynn Generation LLC | Cheat River, Monongalia County, West Virginia and Fayette County, Pennsylvania | 380830.0000.0000 |

| Photo No. 29. | |
|---|---|
| **Date:** September 17, 2020 |  |
| **Description:** Representative view of Site 6 looking downstream at the left descending bank, facing northwest. | |

| Photo No. 30. | |
|---|---|
| **Date:** September 17, 2020 |  |
| **Description:** Representative view of Site 6 looking upstream, facing east. | |

| **Client Name:** Lake Lynn Generation LLC | **Site Location:** Cheat River, Monongalia County, West Virginia and Fayette County, Pennsylvania | **Project No.** 380830.0000.0000 |
|---|---|---|

**Photo No. 31.**

**Date:**
September 17, 2020

**Description:**

View of substrate within Site 6.

**Photo No. 32.**

**Date:**
September 16, 2020

**Description:**

Representative view of the island adjacent to Site 7, facing southwest.

# PHOTOGRAPHIC RECORD

**Mussel Reconnaissance Scoping Survey**

Lake Lynn Hydroelectric Project (FERC No. P-2459)

| Client Name: | Site Location: | Project No. |
|---|---|---|
| Lake Lynn Generation LLC | Cheat River, Monongalia County, West Virginia and Fayette County, Pennsylvania | 380830.0000.0000 |

**Photo No. 33.**

**Date:** September 16, 2020

**Description:**

Representative view of Site 7 looking downstream, facing northwest.

**Photo No. 34.**

**Date:** September 16, 2020

**Description:**

Representative view of Site 7 looking upstream at the right descending bank, facing northeast.

| | |
|---|---|
| **Photo No. 35.** |  |
| **Date:** September 16, 2020 | |
| **Description:** View of substrate within Site 7. | |

| | |
|---|---|
| **Photo No. 36.** |  |
| **Date:** September 16, 2020 | |
| **Description:** View of Site 8 looking upstream at a riffle, facing southeast. | |

| **Photo No. 37.** |  |
| --- | --- |
| **Date:**<br>September 16, 2020 | |
| **Description:**<br><br>View of Site 8 looking across at the right descending bank, facing north. | |

| **Photo No. 38.** |  |
| --- | --- |
| **Date:**<br>September 16, 2020 | |
| **Description:**<br><br>Representative view of the Cheat River approximately 1.5 miles downstream, looking downstream, facing west. | |

| Client Name: | Site Location: | Project No. |
|---|---|---|
| Lake Lynn Generation LLC | Cheat River, Monongalia County, West Virginia and Fayette County, Pennsylvania | 380830.0000.0000 |

**Photo No. 39.**

**Date:**
September 16, 2020

**Description:**

Representative view of the Cheat River approximately 1.5 miles downstream, looking at the left descending bank, facing southwest.

**Photo No. 40.**

**Date:**
September 17, 2020

**Description:**

View of Site 9 looking downstream at the left descending bank, facing northwest.

# PHOTOGRAPHIC RECORD
## Mussel Reconnaissance Scoping Survey
Lake Lynn Hydroelectric Project (FERC No. P-2459)

| Client Name: | Site Location: | Project No. |
|---|---|---|
| Lake Lynn Generation LLC | Cheat River, Monongalia County, West Virginia and Fayette County, Pennsylvania | 380830.0000.0000 |

**Photo No. 41.**

**Date:**
September 17, 2020

**Description:**

Representative view of Site 9 looking upstream, facing east.

**Photo No. 42.**

**Date:**
September 17, 2020

**Description:**

View of Site 9 looking upstream along the left descending bank, facing southeast.

| | |
|---|---|
| **Photo No. 43.** |  |
| **Date:** September 17, 2020 | |
| **Description:** View from the downstream end of Site 9 looking downstream, facing northwest. | |

| | |
|---|---|
| **Photo No. 44.** |  |
| **Date:** September 16, 2020 | |
| **Description:** Representative view of Site 10, facing northwest. | |

| | |
|---|---|
| **Photo No. 45.** |  |
| **Date:** September 16, 2020 | |
| **Description:** Representative view of Site 10 looking downstream, facing west. | |

| | |
|---|---|
| **Photo No. 46.** |  |
| **Date:** September 16, 2020 | |
| **Description:** View of Site 10, facing north. | |

| | **PHOTOGRAPHIC RECORD**<br>**Mussel Reconnaissance Scoping Survey**<br>Lake Lynn Hydroelectric Project (FERC No. P-2459) | |
|---|---|---|
| **Client Name:**<br>Lake Lynn Generation LLC | **Site Location:**<br>Cheat River, Monongalia County, West Virginia and Fayette County, Pennsylvania | **Project No.**<br>380830.0000.0000 |

| | |
|---|---|
| **Photo No. 47.** |  |
| **Date:**<br>September 16, 2020 | |
| **Description:**<br><br>Representative view of the Cheat River approximately 2.9 miles downstream of the Project dam, looking downstream, facing west. | |

| | |
|---|---|
| **Photo No. 48.** |  |
| **Date:**<br>September 16, 2020 | |
| **Description:**<br><br>Representative view of the Cheat River approximately 2.9 miles downstream of the Project dam, looking downstream, facing west. | |

| Client Name: | Site Location: | Project No. |
|---|---|---|
| Lake Lynn Generation LLC | Cheat River, Monongalia County, West Virginia and Fayette County, Pennsylvania | 380830.0000.0000 |

| | |
|---|---|
| **Photo No. 49.** |  |
| **Date:** September 16, 2020 | |
| **Description:** Representative view of the Cheat River approximately 3.1 miles downstream of the Project dam, looking downstream, facing west. | |

| | |
|---|---|
| **Photo No. 50.** |  |
| **Date:** September 16, 2020 | |
| **Description:** Representative view of the Cheat River approximately 3.1 miles downstream of the Project dam, looking upstream, facing east. | |

**Photo No. 51.**

**Date:**
September 16, 2020

**Description:**

Representative view of the Cheat River approximately 3.5 miles downstream, at the mouth of the Monongahela River, facing south.

**Photo No. 52.**

**Date:**
September 17, 2020

**Description:**

Representative view of the Cheat River approximately 1 mile downstream, facing northwest.

| Client Name: | Site Location: | Project No. |
|---|---|---|
| Lake Lynn Generation LLC | Cheat River, Monongalia County, West Virginia and Fayette County, Pennsylvania | 380830.0000.0000 |

**Photo No. 53.**

**Date:**
September 17, 2020

**Description:**

Representative view of the Cheat River approximately 1.75 miles downstream, facing west.

**Photo No. 54.**

**Date:**
September 17, 2020

**Description:**

View of the left descending bank of the Cheat River approximately 2 miles downstream, facing south.

**Photo No. 55.**

**Date:**
September 17, 2020

**Description:**

Representative view of Cheat River approximately 2 miles downstream, facing west.

**Photo No. 56.**

**Date:**
September 17, 2020

**Description:**

View of the left descending bank at Site 11, facing south.

| | | |
|---|---|---|
| TRC | | **PHOTOGRAPHIC RECORD**<br>**Mussel Reconnaissance Scoping Survey**<br>Lake Lynn Hydroelectric Project (FERC No. P-2459) |
| **Client Name:**<br>Lake Lynn Generation LLC | **Site Location:**<br>Cheat River, Monongalia County, West Virginia and Fayette County, Pennsylvania | **Project No.**<br>380830.0000.0000 |

| | |
|---|---|
| **Photo No. 57.** |  |
| **Date:**<br>September 17, 2020 | |
| **Description:**<br><br>View of Site 11 looking upstream along the left descending bank, facing west. | |

| | |
|---|---|
| **Photo No. 58.** |  |
| **Date:**<br>September 17, 2020 | |
| **Description:**<br><br>View of Site 11 looking downstream along the left descending bank, facing southwest. | |

| Client Name: | Site Location: | Project No. |
|---|---|---|
| Lake Lynn Generation LLC | Cheat River, Monongalia County, West Virginia and Fayette County, Pennsylvania | 380830.0000.0000 |

| | |
|---|---|
| **Photo No. 59.**<br>**Date:**<br>September 17, 2020<br>**Description:**<br>Relic shells found under the SR 119 bridge along the left descending bank approximately 1,000 feet from the mouth of the Monongahela River. |  |

| | |
|---|---|
| **Photo No. 60.**<br>**Date:**<br>September 17, 2020<br>**Description:**<br>Representative photo of *Potamilus alatus* (Pink heelsplitter) found downstream of Site 12, near the mouth of the Monongahela River. |  |

# Recreation Site Enhancement Feasibility and Assessment

July 2021

## Lake Lynn Hydroelectric Project (FERC No. 2459)

**Prepared For:**

Lake Lynn Generation, LLC
2 Bethesda Metro Center, Suite 1330
Bethesda, Maryland 20814

**Prepared By:**

TRC

## TABLE OF CONTENTS

## TABLES



## FIGURES

## ACRONYM LIST

| | |
|---|---|
| Commission | Federal Energy Regulatory Commission |
| FERC | Federal Energy Regulatory Commission |
| Lake Lynn | Lake Lynn Generation, LLC or Licensee |
| Licensee | Lake Lynn Generation, LLC or Lake Lynn |
| Project | Lake Lynn Hydroelectric Project (FERC No. 2459) |
| Study Plan | *Lake Lynn Hydroelectric Project (FERC No. P-2459) Final Study Plan* dated September 2020 |
| WMA | Snake Hill Wildlife Management Area |
| WVDCTR | West Virginia Department of Commerce Travel and Recreation |

## Introduction

A recreation site enhancement feasibility and assessment was conducted in August and September 2020 to support the relicensing of the Lake Lynn Hydroelectric Project, FERC No. 2459 (Project). Lake Lynn Generation, LLC (Licensee) is licensed by the Federal Energy Regulatory Commission (FERC or Commission) to operate the Project. Results of the recreation site enhancement feasibility and assessment are included herein.

## Objectives

In accordance with Section 5.1 of the *Lake Lynn Hydroelectric Project (FERC No. P-2459) Final Study Plan* dated September 2020 (Study Plan), the objectives of the Recreation Site Enhancement Feasibility and Assessment were to:

- Evaluate the feasibility of making certain recreation site/facility enhancements at the Project. Specific enhancements to be evaluated included:
    1. Connection from the Cheat Lake Trail to the Sheepskin Trail at the northern end of the Cheat Lake Trail;
    2. Extension of the Cheat Lake Trail toward the south to Sunset Beach Marina;
    3. Extension of the swimming beach area to create a dog beach; and
    4. Public access to the upper reaches of Cheat Lake by improving an existing road in Snake Hill Wildlife Management Area (WMA) along Buzzard Run.
- Conduct both desktop and in-field assessments.

## Background and Existing Information

The Project is located on the Cheat River, in Monongalia County, West Virginia near the City of Morgantown, and in Fayette County, Pennsylvania near the Borough of Point Marion, Pennsylvania (Figure 3.0-1). Cheat Lake and the Cheat River are popular destinations for boating, fishing, and other water sport activities. Cheat Lake is quickly becoming one of the best bass fisheries in the state. Cheat Lake is known for largemouth bass, smallmouth bass, crappie, yellow perch, white bass, and channel catfish. Known for excellent fishing of sauger, walleye, and smallmouth bass. The Project tailwater attracts hundreds of anglers each year (West Virginia Department of Commerce Travel and Recreation [WVDCTR], 2017).

Project recreation sites provide fishing, boating, nature viewing, picnicking, and hiking/biking opportunities. Existing Project recreation sites are summarized in Table 3-1 and shown in Figure 3.0-2.

**Table 3-1: Commission Approved Recreation Facilities at the Lake Lynn Project**

| Recreation Site Name | Recreation Facilities |
|---|---|
| Cheat Lake Park | Hilltop and shoreline picnic areas, parking areas, playground area, car-top/winter boat launch, 3 restroom facilities, security/maintenance station, day-use boat docks, swimming beach, fish cleaning station, fishing platforms, access to the Cheat Lake Trail, 80 vehicle parking spaces (50 paved; 30 gravel), 5 Americans with Disabilities Act (ADA) parking spaces |
| Cheat Lake Trail | 4.5-mile hiking/biking trail (ADA accessible), 15 vehicle parking spaces, additional parking at Cheat Lake Park, interpretive signs |
| Tailrace Recreation Area | Fishing platform, bank fishing opportunities, 20 vehicle parking spaces (including 2 ADA accessible spaces), portable ADA toilet |
| Sunset Beach Marina Public Boat Launch | Boat launch, approximately 60 boat trailer parking spaces |
| Cheat Haven Peninsula Nature Viewing Area | Nature trail, bike rack, picnic table |
| Cheat Lake Park Nature Viewing Area | Nature viewing area |
| Nature Viewing Area Across from Cheat Haven | Nature viewing area (Accessible by boat only) |
| Tower Run Nature Viewing Area | Pull-off parking, nature trail |

## Study Area

The study area for this assessment includes enhancements of several existing Project recreation sites and a new recreation site. The potential recreation enhancements assessed for this study include:

1. Connection from Cheat Lake Trail (northern trailhead) to proposed route for the Sheepskin Trail);
2. Extension of the Cheat Lake Trail (southern terminus) to Sunset Beach Marina;
3. Extension of the swimming beach area at Cheat Lake Park to create a dog beach; and
4. Public access to the upper reaches of Cheat Lake by improving an existing road in Snake Hill Wildlife Management Area (WMA) along Buzzard Run.

Figure 4.0-1 depicts the locations of the enhancements assessed for this study.

## Methods

The desktop phase examined existing tax and property records to determine property ownership and access limitations associated with each site or enhancement. Safety and security concerns and considerations associated with Project operations, were also assessed including a review of any history of past safety or security concerns at the Project.

Subsequent to the initial desktop phase, an in-field assessment of each of the listed enhancements was conducted to assess the requested enhancements.

Figure 3.0-1: Overview Map of the Lake Lynn Project

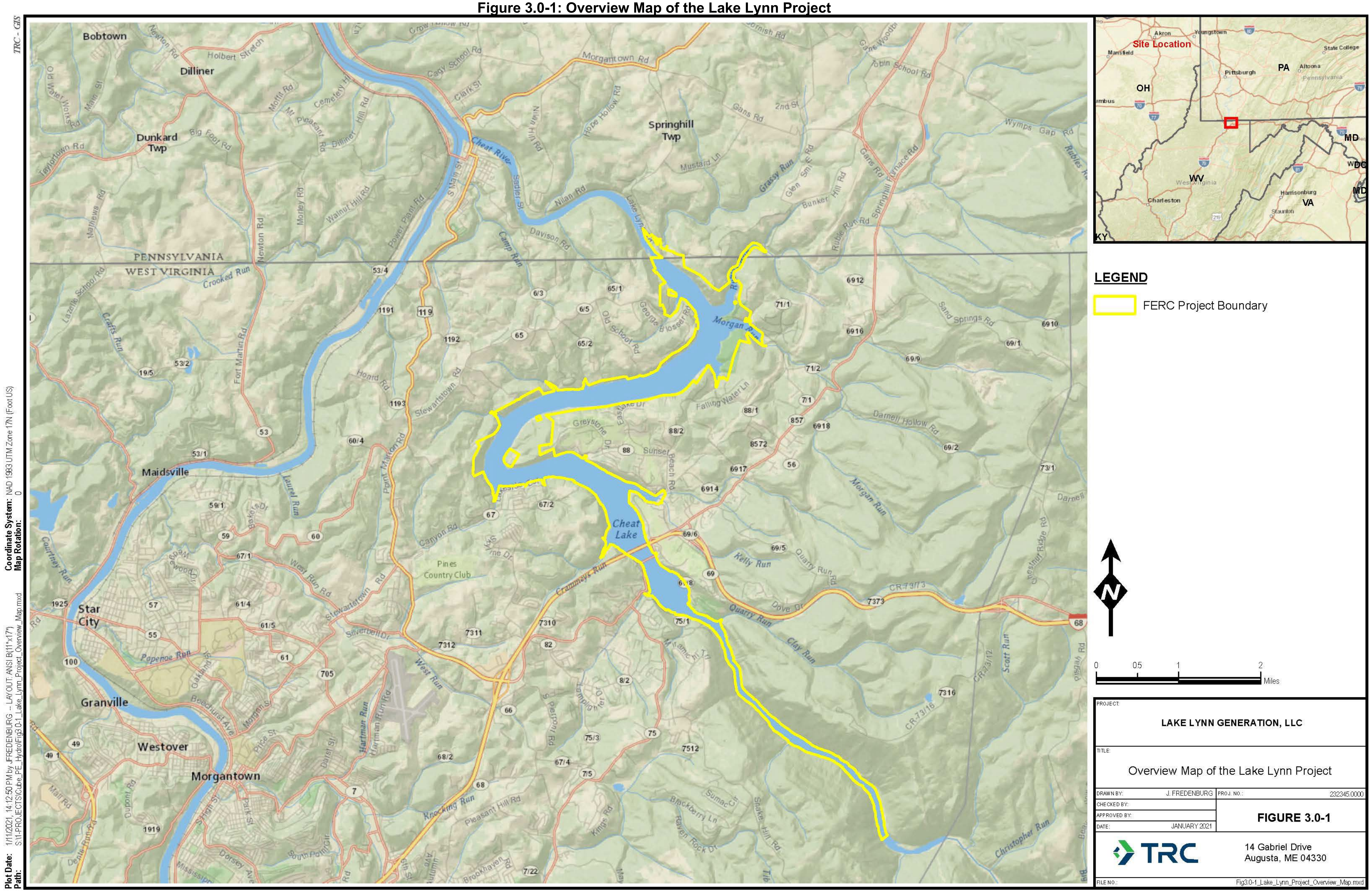


**Figure 3.0-2: Lake Lynn Project Recreation Sites**

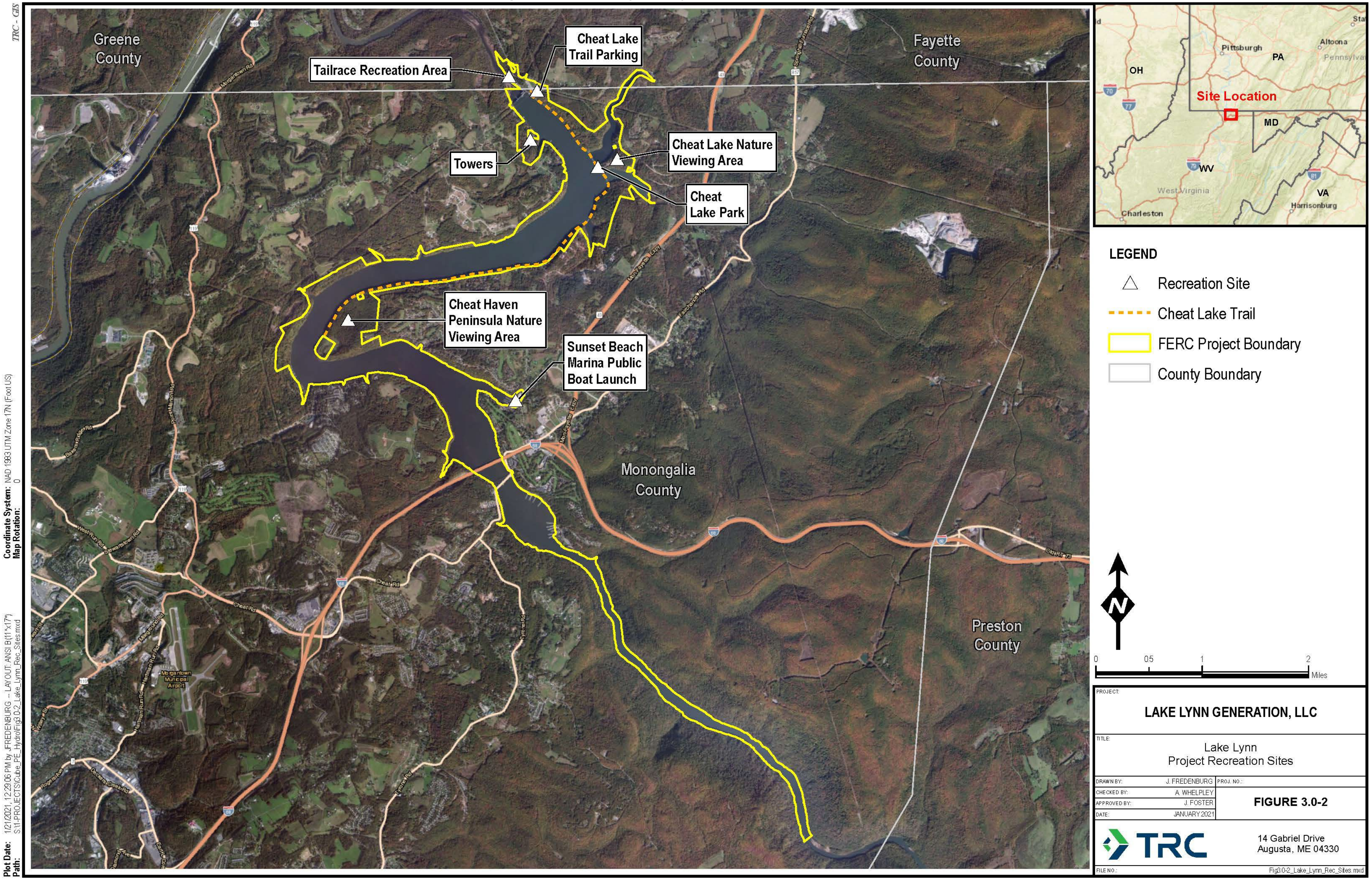
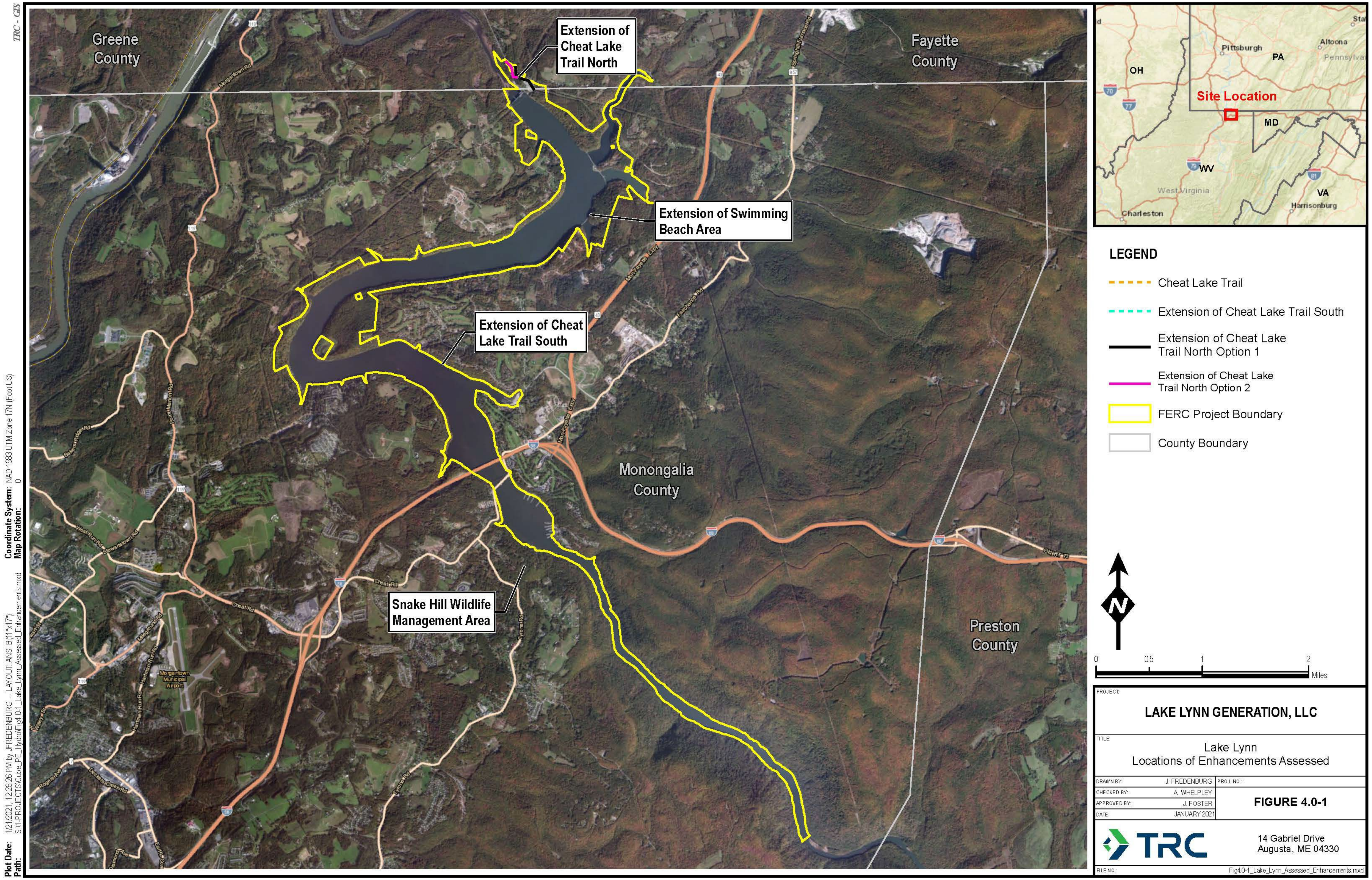


**Figure 4.0-1-Locations of Enhancements Assessed**



# Results

A recreation site enhancement feasibility and assessment was conducted in August and September 2020 for the enhancements identified in Section 4.0 and the Study Plan. Results of the recreation site enhancement feasibility and assessment are summarized below.

## 1.1 Connection from the Cheat Lake Trail to the Sheepskin Trail (North)

Monongahela River Trails Conservancy (MRTC), Cheat Lake Environmental and Recreation Association (CLEAR), Friends of the Cheat (FOC), and several individuals requested that the Licensee work with stakeholders on planning and building a connection from the Cheat Lake Trail to the Sheepskin Trail, including opening the gate at the northern end of the trail to create a passageway from the northern end of the Cheat Lake Trail through the dam facility. CLEAR also requested a continued commitment for a connection to other regional trails. Options for connecting the Cheat Lake Trail to the Sheepskin Trail were examined. The first option is along an existing maintenance road that runs by the powerhouse. There is currently a locked gate prohibiting public access through this area. The second option is creating a trail from the Substation Parking Area located at the northern terminus of Cheat Lake Trail to connect to the proposed Sheepskin Trail segment.

**Continue Trail North Through Gate Beside the Powerhouse**

One option is to extend the Cheat Lake Trail approximately 0.24 miles from the current Cheat Lake Trail terminus to Bunker Hill Road along an existing maintenance road that runs by the powerhouse. After crossing the road, the extension would connect to the existing transmission line corridor and run along the transmission line corridor for approximately 0.1 mile to connect to the proposed Sheepskin Trail.

**Property Ownership**

Most of the property that would be needed for the extension of the Cheat Lake Trail through the existing gate would be on Licensee owned land with the exception or Bunker Hill Road and the WVDOT ROW.

**Security**

While this is likely the easiest option, this trail extension option would be in close proximity to the powerhouse and at a higher elevation than the existing powerhouse parking area creating a potential security and safety issue. The gate is in place to keep the public away from the powerhouse. This option would require additional security measures at the powerhouse to ensure objects cannot be thrown at the powerhouse or into the powerhouse parking area.

### Safety

There are also safety concerns with this trail option. Bunker Hill Road is steep, narrow, and winding in this area which poses a public safety concern for creating a trail extension that crosses the road or runs along the road in this area. The area to access the existing transmission line corridor is steep and heavily vegetated and would require improvements to create safe access (see photo 1).

Photo 1: View of transmission line corridor assessed for trail extension.

## Extend Trail from Substation Parking Area

A new Sheepskin Trail segment would be approximately 0.34 miles from the Substation Parking area. The second option for connecting Cheat Lake Trail to the Sheepskin would be to create a bike route from the northern terminus of Cheat Lake Trail that could be used instead of the current steps to the Substation Parking Area. There is a significant slope from the parking area to the Cheat Lake Trail and limited space that would be challenging to create a bike route that could be used by bikers of all skill levels. The trail extension would follow the road into the Substation Parking area, cross Bunker Hill Road, and then follow the existing transmission corridor for about 0.1 mile to the proposed Sheepskin Trail.

### Property Ownership

Most of the property that would be needed for the extension of the Cheat Lake Trail from the Substation Parking area would be on Licensee owned land except for the WV ROW and Bunker Hill Road.

### Access Limitations

There are access limitations associated with this trail option. The first would be the proximity to the substation. This trail would pass outside of the substation fence that could potentially create a public safety issue. The second access limitation would be the Bunker Hill Road crossing. This road is steep, narrow and winding in the area of the crossing. Finally, the access to the existing transmission line corridor is steep and heavily vegetated.

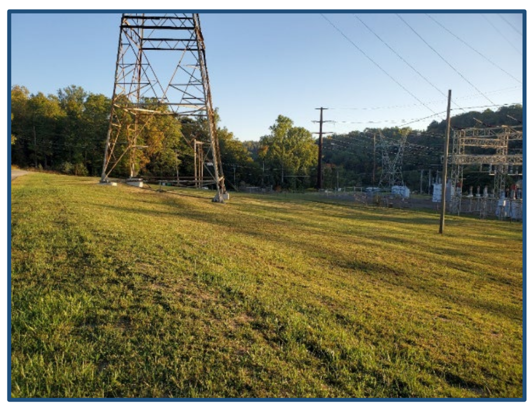


Photo 2: View of assessed trail extension area within the proximity of the substation.

### Safety

There are several safety concerns with this trail option. In order for bikers to traverse the steep hill from the Cheat Lake Trail to the Substation Parking area, a bike route with a ramp would need to be installed. Installing a route suitable for bikers of all skill levels would be challenging given the slope and space limitations in this area. This ramp could cause potential hazards for trail users during inclement weather. Bunker Hill Road is steep, narrow, and winding in this area which poses a public safety concern for creating a trail extension that crosses the road or runs along the road in this area. The area to access the existing transmission line corridor is also steep and heavily vegetated and would require improvements to create safe access (see photo 1).

## 1.2 Extension of the Cheat Lake Trail (South)

MRTC and FOC requested the Licensee extend the Cheat Lake Trail toward the south that would begin in the Cheat Haven Nature Viewing Area and follow the shoreline of Cheat Lake and end at Sunset Beach Marina. The extension would be approximately 3.1 miles long and end at the Sunset Beach Marina Parking Area.

**Property Ownership**

Access across approximately 47 properties would be needed for the extension of the Cheat Lake Trail from the Cheat Haven Nature Viewing Area south to Sunset Beach Marina. Of these properties, the Licensee has ownership of only one (1). The remaining 46 properties are privately owned.

**Access Limitations**

Due to the steep topography along the Cheat Lake shoreline south from Cheat Haven, there is very limited land located within the Project boundary or owned by the Licensee. Given the steep topography along the shoreline, sections of the existing trail that have washed out or been damaged due to runoff from the upland subdivision. This subdivision is also located above a large section of the potential south trail extension that could potentially be washed out as well. The proximity of nearby residential homes is another limitation to extending this trail to the south. The Cheat Haven Nature Viewing Area preserves land to reduce habitat destruction thereby creating a limitation for extending the Cheat Lake Trail to the south. Finally, the Sunset Beach Marina parking area would be the terminus of the extended Cheat Lake Trail to the south. This parking area is frequently crowded in its existing condition and would not be able to accommodate additional parking associated with the requested Cheat Lake Trail extension to the south.

Photo 3: View of steep shoreline in close proximity to local homeowners taken from Sunset Beach Marina.

**Security**

The local Homeowners Association and homeowners adjacent to the Cheat Lake Trail have historically raised concerns about the Cheat Lake Trail (southern portion) and extending the Cheat Lake Trail. They feel an extension would bring additional people too close to their homes creating safety issues to their properties. The Licensee currently contracts with a security company to patrol/maintain the existing Cheat Lake Trail from Memorial Day through Labor Day. The security company is responsible for locking and unlocking a gate across the southern portion of the Cheat Lake Trail to address the concerns of homeowners adjacent to the trail. Extending the Cheat Lake Trail to the south with another trailhead would likely create additional security burden to open and close a gate at both entrances to the southern portion of the Cheat Lake Trail.

## 1.3 Extension of Swimming Beach Area to Create Dog Beach/Swim Area

CLEAR requested the Licensee extend the swimming beach area toward the day-use boat docks to create a dog beach or swimming area.

**Property Ownership**

All of the property that would be needed for the extension of the swimming beach area toward the day-use boat docks would be on Licensee owned land.

**Maintenance**

Access to the requested dog beach area would be along the existing Cheat Lake Trail. Parking for the proposed dog beach would be at the existing Cheat Lake Park. Extending the beach would require additional maintenance along with hauling in sand to the area. Due to the nature of this area, sand would need to be replenished periodically as erosion occurs and washes out the beach sand. The area suggested for the expansion has an abundance of wetland vegetation present. This area also collects an abundance of woody debris that needs to be removed frequently.

Photo 4: View of potential dog park area showing woody debris, wetland vegetation and the proximity of the boat docks in the background.

**Safety**

There are safety concerns related to the requested location of the dog beach/swim area. First, this area is close to the eight day use boat docks that are in place during the recreation season. Since boats may come and go to the docks throughout the day during the recreation season this would pose a safety risk to the dogs in the water as well as the boats as boat operators may have to navigate around a dog in the water. Another safety concern is the water quality at the swimming beach. The Monongalia County Health Department and FOC conduct bacteria monitoring at the beach. Dogs in the water in close proximity to the swimming beach could potentially increase bacteria levels at the swimming beach. Another safety concern is related to unleashed dogs. Cheat Lake Park rules currently require that all dogs be leashed for the safety of all visitors. Creating a swimming area for dogs would encourage the unleashing of dogs that could potentially pose a safety risk to swimmers at the swimming beach or to other recreationists in the area.

## 1.4 Public Access to Upper Reaches of Cheat Lake through Snake Hill WMA

FOC requested the Licensee create public access to the upper reaches of Cheat Lake by improving an existing gated road in the Snake Hill Wildlife Management Area (WMA) along Buzzard Run to provide a trailhead for hikers, angler access to upper Cheat Lake, and egress for whitewater paddlers running the Lower Cheat Canyon. West Virginia Department of Natural

Resources (WVDNR) commented that it is unequivocally opposed to creating public access to the upper reaches of Cheat Lake by opening a gated road that passes through Snake Hill WMA property because continued maintenance of the access road would be problematic and an undue burden for the State of West Virginia and the Licensee with very little benefit to the WVDNR's prime constituents. This requested enhancement was assessed at a cursory level in this report since the property owner is the  and it is managed by WVDNR, which is opposed to the request. The American Whitewater website[1] describes the stretch of the Cheat River that runs along the WMA as . There is an existing put-in at Jenkins burg Bridge which is 7.4 miles upstream of the take-out located at Cheat Lake.

**Property Ownership**

This property is located outside of the Project boundary and owned by the  and managed by WVDNR. WVDNR is opposed to creating a public access to the upper reaches of Cheat Lake by improving an existing gated road in the WMA (see figure 6.4-1 for a map of the WMA). The WMA is managed to provide visitors with undisturbed hunting, fishing, and other outdoor recreation and providing a road for vehicular traffic is inconsistent with the management of the WMA.

**Maintenance**

The WMA access road along Buzzard Hill Road is currently gated and unmanned. If the State were to open the gate to provide an access road, significant improvements would be needed that would require continued maintenance. This would create an undue burden on the State and the Licensee. Given the steep topography to the river, road construction would be needed to safely access the river.

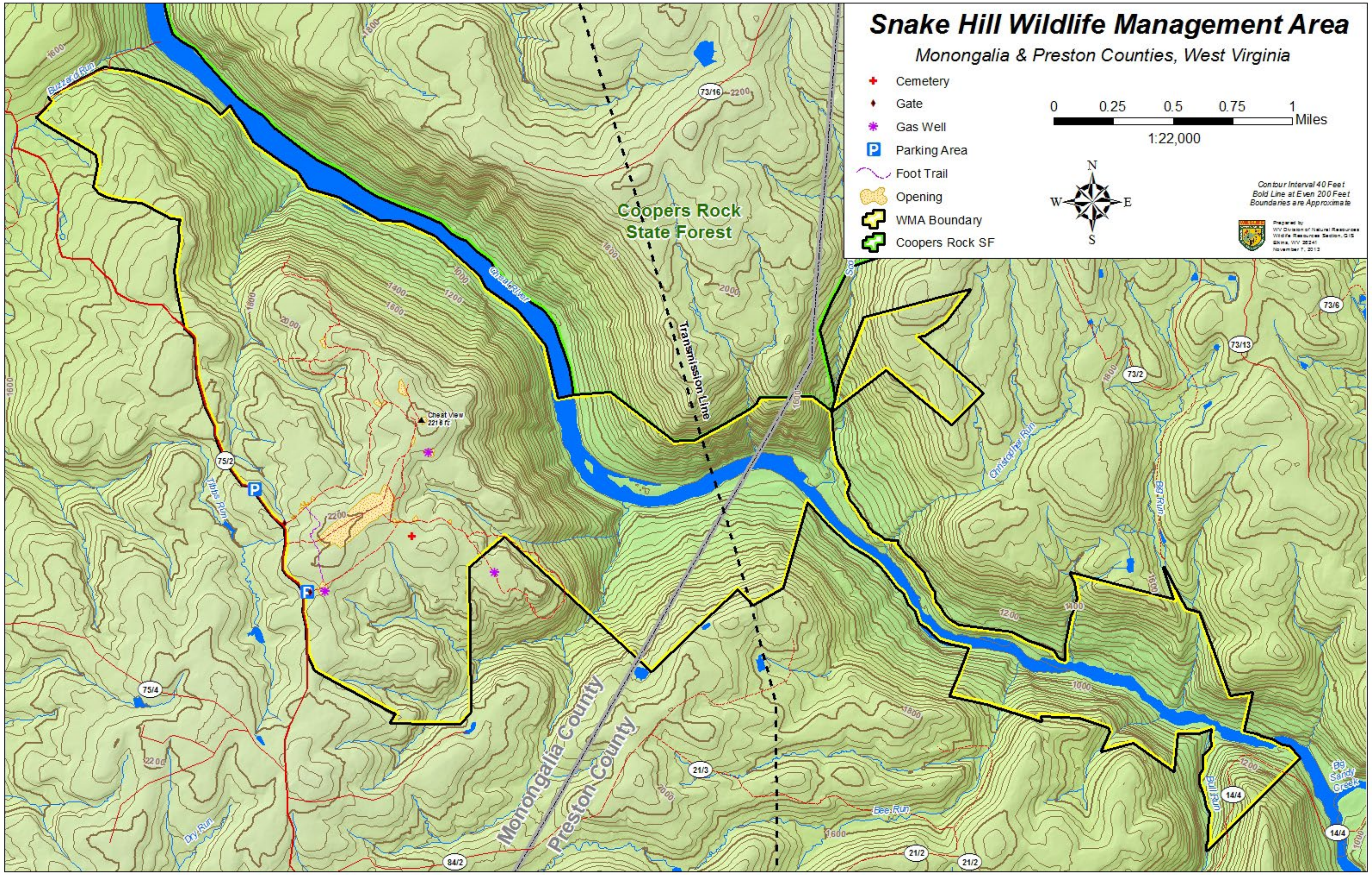
**Safety**

The WMA is managed to provide visitors with undisturbed hunting, fishing, and other outdoor recreation. Due to the large number of hunters in West Virginia, the safety of both hunters and other recreationists is one of the greatest safety concerns at the Snakehill WMA. There are numerous hunting seasons in West Virginia which extend from September 5 through December 31 and then again from April 17 through May 23. Given the wide variety of game in the Snakehill WMA, hunters could be prevalent. If a road were constructed for angler access or egress for whitewater paddlers, this could pose a significant public safety risk.

---

1

**Figure 6.4-1 Snakehill Wildlife Management Area**




Source: http://www.wvdnr.gov/wmamapproj/images/SnakeHillFinal11x17.jpg

## 7.0 Variances from the Study Plan

There were no variances from the Study Plan.

## 8.0 Summary

The feasibility of certain recreation site/facility enhancements at the Project, as requested by the agencies and stakeholders, was examined. Specific improvements examined include:

1. Connection from Cheat Lake Trail (northern trailhead) to the proposed route for the Sheepskin Trail;
2. Extension of the Cheat Lake Trail (southern terminus) to Sunset Beach Marina;
3. Extension of the swimming beach area at Cheat Lake Park to create a dog beach; and
4. Public access to the upper reaches of Cheat Lake by improving an existing road in Snake Hill WMA along Buzzard Run.

The feasibility of connecting the northern terminus of the Cheat Lake Trail to the proposed route for the Sheepskin Trail was examined. Based on a review of tax maps, aerial photography, and a site visit to Lake Lynn, a trail extension north toward the proposed route for the Sheepskin Trail could feasibly use one of two proposed options. The first option that was assessed would be the easiest option to construct and would entail the Licensee opening a gate near the powerhouse. This option involves security risks for on-site staff and the powerhouse. The second option would be to create a bike route (ramp) from the northern terminus of the Cheat Lake Trail up a steep slope (next to the existing steps) to the Substation Parking area and then create a trail from the parking area to the Sheepskin Trail.. Both options would also include safety risks to the general public including a road crossing and steep terrain on the existing transmission line corridor.

The feasibility of providing an extension of the Cheat Lake Trail toward the Sunset Beach Marina was examined and determined to not be feasible. Based on a review of tax maps, aerial photography, and a site visit to Lake Lynn, a trail extension south toward the Sunset Beach Marina would require many easement agreements with local landowners. Steep topography along the trail would also make constructing this extension costly.

The feasibility of providing an extension of the swimming beach area to create a dog beach was examined. Given the proximity to the existing swimming area and the day use boat docks, there are safety risks associated with the requested enhancement..

Providing public access to the upper reaches of Cheat Lake by improving an existing road in the Snake Hill WMA was determined to not be feasible. The land is owned by the State of West Virginia and WVDNR is opposed to opening a gated road that passes through Snake Hill WMA property because continued maintenance of the access road would be problematic and an undue burden.

# Lake Lynn Hydroelectric Project

# FERC No. 2459

## Exhibit F

## General Design Drawings

This Material is Critical Energy/Electric Infrastructure Information (CEII).
Members of the Public may Obtain Nonpublic or Privileged Information
by Submitting a Freedom of Information Act (FOIA) Request.

# Lake Lynn Hydroelectric Project

# FERC No. 2459

## Exhibit G

## Project Maps

# TABLE OF CONTENTS



# LIST OF TABLES



# LIST OF APPENDICES

# 1.0 PROJECT MAP

The attached (Appendix A) Exhibit G map denotes the Lake Lynn Hydroelectric Project (Lake Lynn Project) boundary. Table 1 provides a summary of the drawing number and title for the Exhibit G map. The Lake Lynn Project boundary map shows the Lake Lynn Project vicinity, location, and boundary in sufficient detail to provide a full understanding of the Lake Lynn Project. The Exhibit G maps were prepared in accordance with the requirements of 18 C.F.R. § 4.41(h).

**Table 1 Lake Lynn Project Boundary Maps**

| Drawing Number | Title |
|---|---|
| Exhibit G - Sheet 1 of 3 | Project Boundary Map |
| Exhibit G - Sheet 2 of 3 | Project Boundary Map |
| Exhibit G - Sheet 3 of 3 | Project Boundary Map |

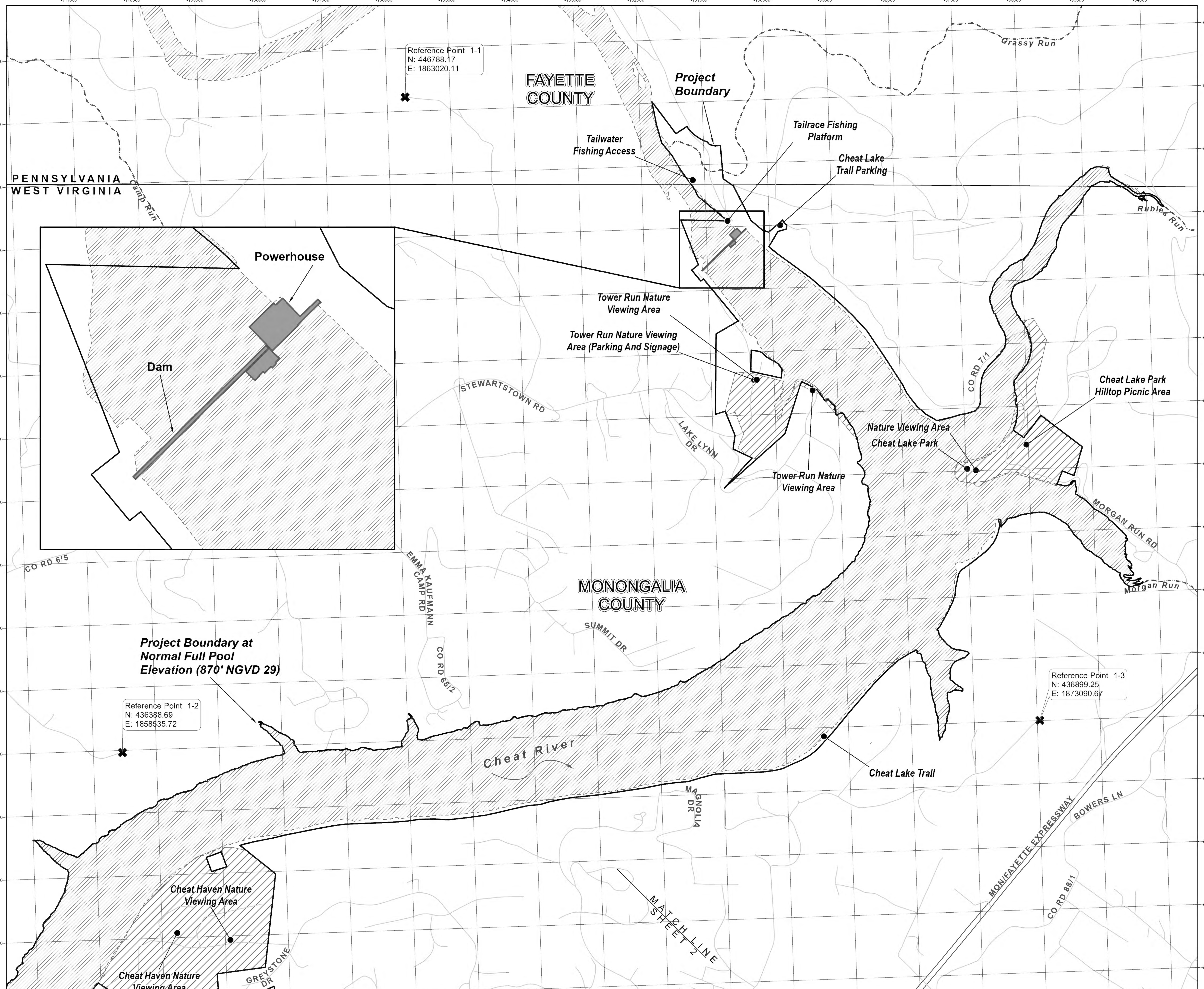
Lake Lynn Generation, LLC (Lake Lynn or Licensee) is proposing to modify the Lake Lynn Project boundary to remove 310.89 acres of land to more closely align with the Lake Lynn Project footprint and maintenance needs. As part of the Lake Lynn Project boundary modification, Lake Lynn is proposing to remove the 12-acre water accessible only Nature Viewing Area (NVA). The Exhibit G drawings incorporate these proposed Lake Lynn Project boundary modifications and corrections. Lake Lynn possesses property or easement rights to all areas within the defined Lake Lynn Project boundary.

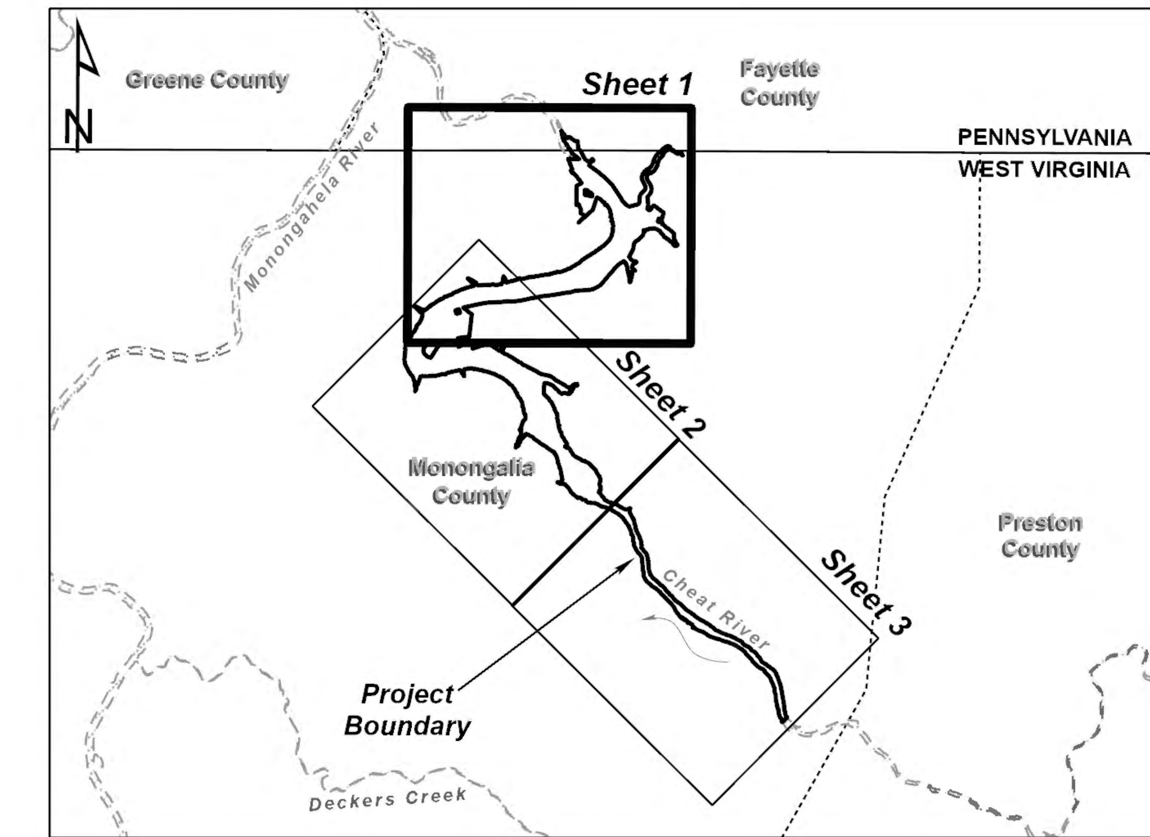
# 2.0 FEDERAL LANDS

There are no public lands or reservations of the United States within the Lake Lynn Project boundary.

# Appendix A

# Exhibit G Drawings




9.19°W
4/9/2021

- Project Boundary
- ✖ Reference Point
- ● Recreation
- Nature Viewing Recreation Area
- Features
- Hydrography
- Waterbody
- Interstate
- Road
- Match Line
- Protected Land
- County
- State

**Map notes**:
1. The Lake Lynn Project is located in the States of West Virginia and Pennsylvania in Monongalia and Fayette Counties, respectfully.
2. Reference Point coordinates are shown in NAD 1983 StatePlane West Virginia North FIPS 4701 Ft US.
3. Elevations shown are referenced to NGVD 29, where NAVD 88 = NGVD 29 + 0.378 ft. Conversion factor was determined from The NGS Coordinate Conversion and Transformation Tool (NCAT).
4. Licensee has acquired all flowage rights and title in fee or the right to use in perpetuity all lands necessary or appropriate for the construction, maintenance, and operation of the Project. All property records are kept on file with the licensee.
5. There are no federal lands within the Project boundary.
6. The Project boundary description, as required by 18 CFR 4.41, is represented here by a grid of Northings and Eastings around, and graticules within, the map frame. Any position in Northings and Eastings along the Project boundary can be determined using these references.
7. The Project boundary, in part, was digitized from contour elevations derived from USGS WV Southcentral LiDAR data (USGS 2018).

SURVEYORS STATEMENT

I HEREBY CERTIFY TO THE FEDERAL ENERGY REGULATORY COMMISSION (FERC) THAT THIS PLAN MEETS THE CONDITIONS SET FORTH BY FERC FOR ITS EXPRESSED PURPOSE. THE PURPOSE OF THIS MAP IS TO PROVIDE A GEOREFERENCED VISUAL DEPICTION OF THE LOCATION OF PROJECT FEATURES AND BOUNDARIES BASED ON THE BEST AVAILABLE HISTORICAL DRAWINGS AND DIGITAL REFERENCE SOURCES INCORPORATED INTO THE GEOGRAPHIC INFORMATION SYSTEM (GIS). LOCATIONS HAVE NOT BEEN VERIFIED BY PHYSICAL FIELD SURVEYS AND THIS DRAWING SHOULD NOT BE USED FOR PURPOSES OF DEVELOPING PROPERTY BOUNDARY DESCRIPTIONS.

STATE OF MAINE STEPHEN M. EVERETT 2161 PROFESSIONAL LAND SURVEYOR

LAKE LYNN GENERATION, LLC

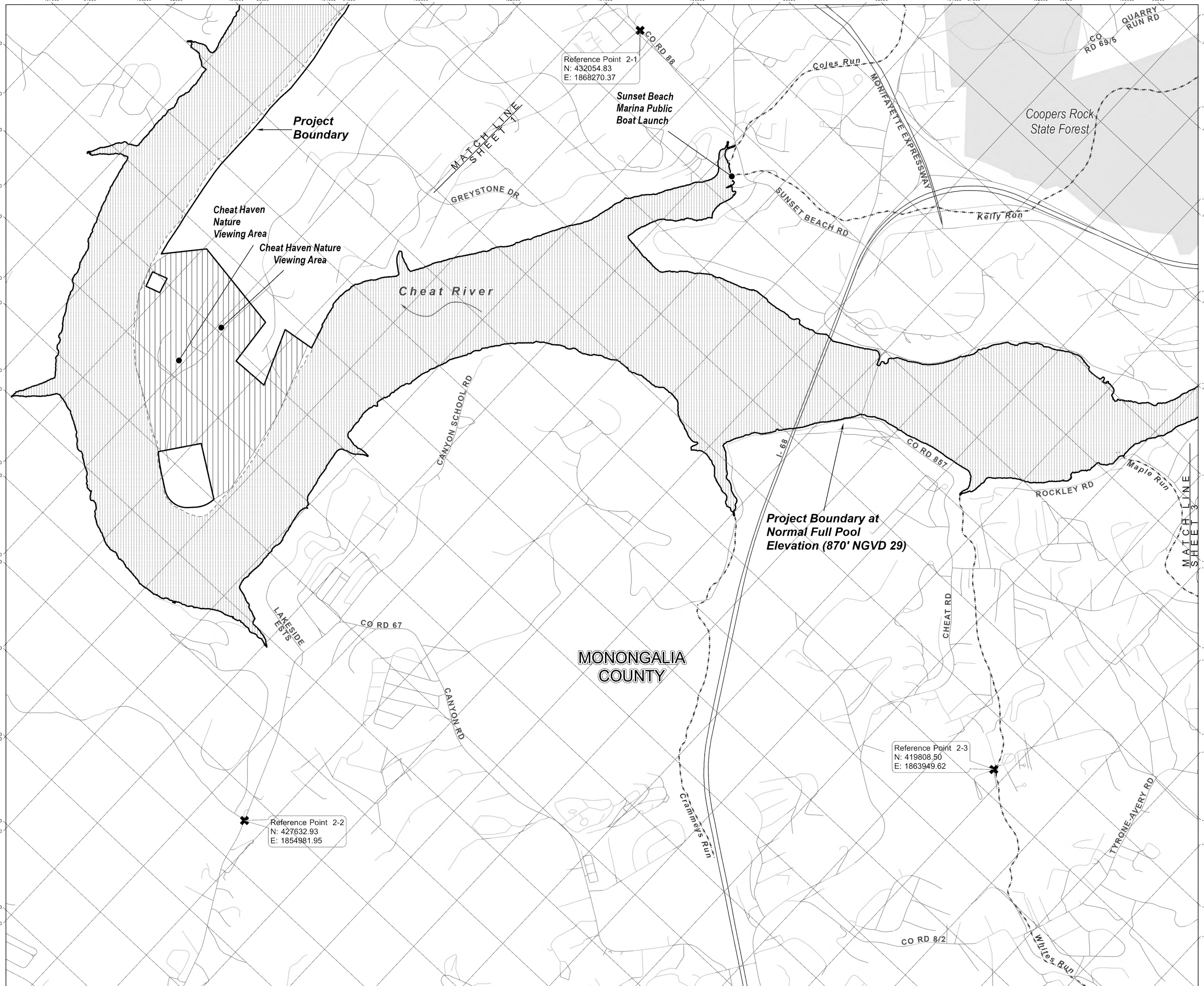
LAKE LYNN HYDROELECTRIC PROJECT
FERC NO. 2459

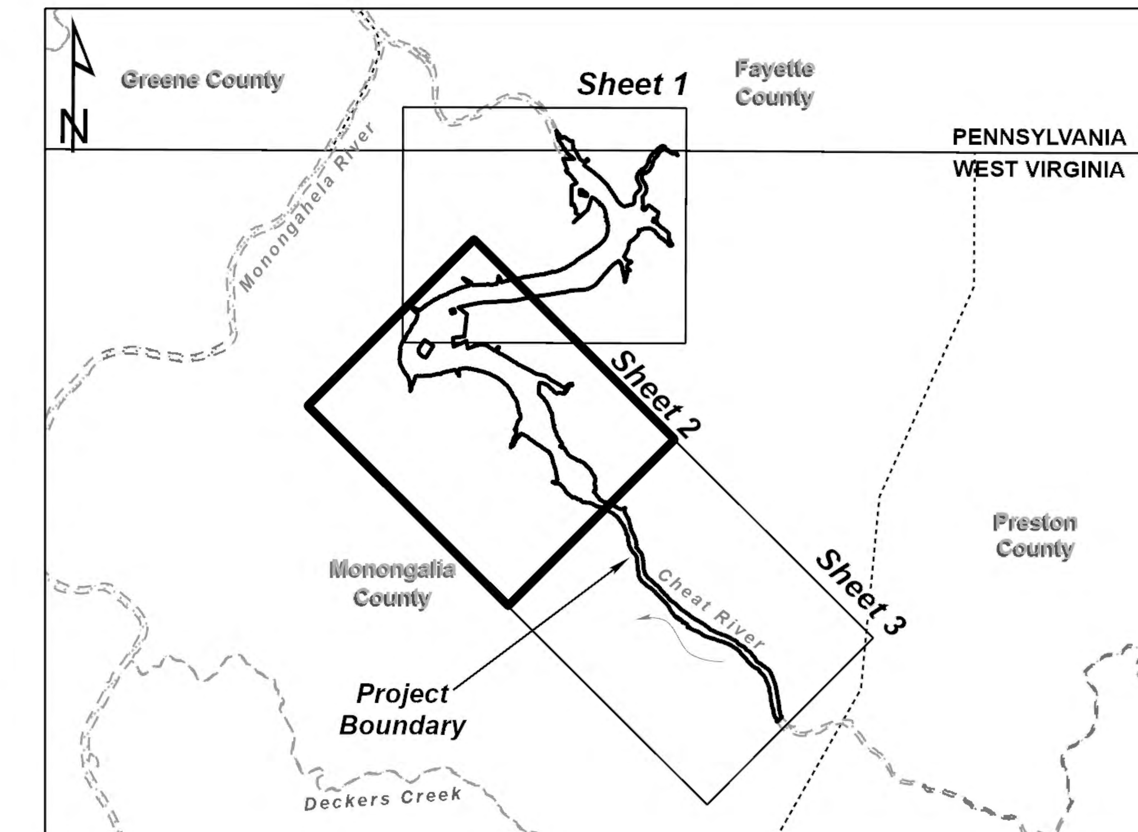
PROJECT BOUNDARY MAP

EXHIBIT G | SCALE: 1" = 750' | SHEET NO. 1 OF 3

0 500 1,000 2,000 3,000 4,000 Feet

FERC DWG. NO. 2459-




9.19°W
4/9/2021

- Project Boundary
- Reference Point
- Recreation
- Nature Viewing Recreation Area
- Features
- Hydrography
- Waterbody
- Interstate
- Road
- Match Line
- Protected Land
- County
- State

**Map notes**:
1. The Lake Lynn Project is located in the States of West Virginia and Pennsylvania in Monongalia and Fayette Counties, respectfully.
2. Reference Point coordinates are shown in NAD 1983 StatePlane West Virginia North FIPS 4701 Ft US.
3. Elevations shown are referenced to NGVD 29, where NAVD 88 = NGVD 29 + 0.378 ft. Conversion factor was determined from The NGS Coordinate Conversion and Transformation Tool (NCAT).
4. Licensee has acquired all flowage rights and title in fee or the right to use in perpetuity all lands necessary or appropriate for the construction, maintenance, and operation of the Project. All property records are kept on file with the licensee.
5. There are no federal lands within the Project boundary.
6. The Project boundary description, as required by 18 CFR 4.41, is represented here by a grid of Northings and Eastings around, and graticules within, the map frame. Any position in Northings and Eastings along the Project boundary can be determined using these references.
7. The Project boundary, in part, was digitized from contour elevations derived from USGS WV Southcentral LiDAR data (USGS 2018).

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STATE OF MAINE
STEPHEN R. EVERETT
2161
PROFESSIONAL LAND SURVEYOR

**LAKE LYNN GENERATION, LLC**

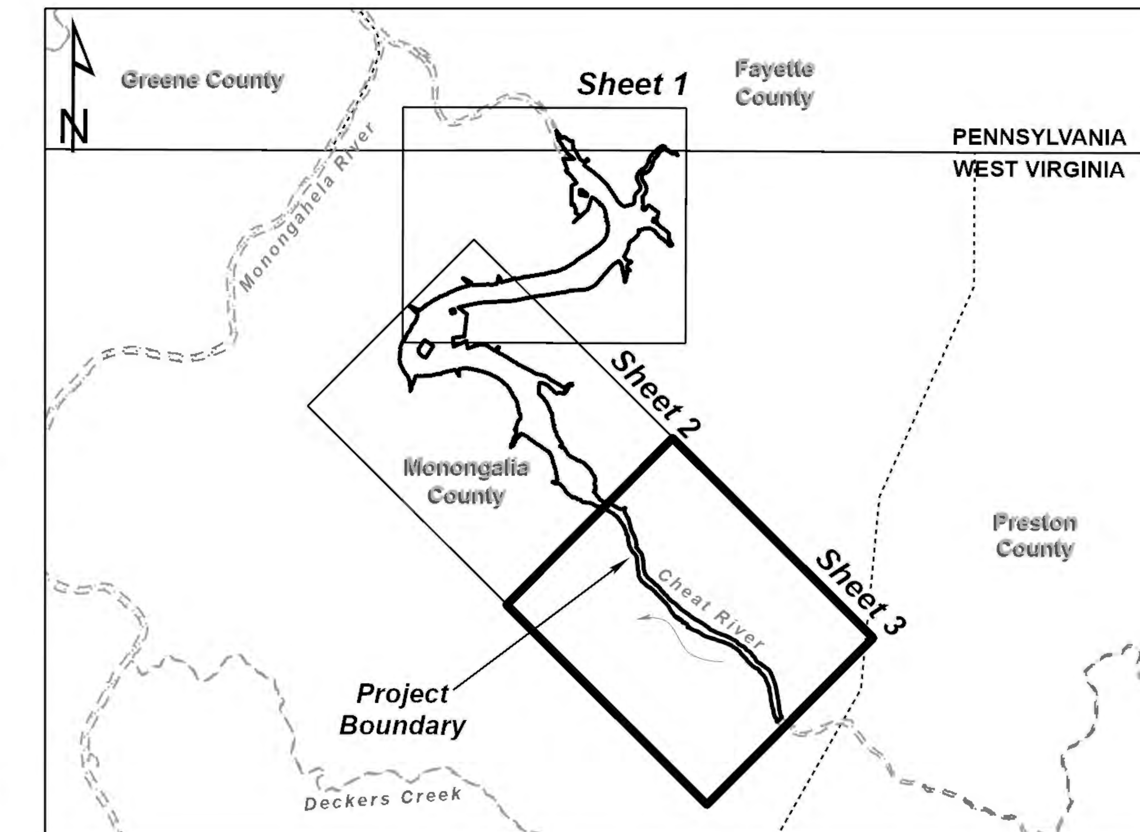
LAKE LYNN HYDROELECTRIC PROJECT
FERC NO. 2459

PROJECT BOUNDARY MAP

EXHIBIT G | SCALE: 1" = 750' | SHEET NO. 2 OF 3

0 500 1,000 2,000 3,000 4,000 Feet

FERC DWG. NO. 2459-


9.19°W
4/9/2021

| | | |
|---|---|---|
| Project Boundary | Features | Match Line |
| Reference Point | Hydrography | Protected Land |
| Recreation | Waterbody | County |
| Nature Viewing Recreation Area | Interstate | State |
| | Road | |

**Map notes**:
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STATE OF MAINE STEPHEN R. EVERETT 2161 PROFESSIONAL LAND SURVEYOR

LAKE LYNN GENERATION, LLC

LAKE LYNN HYDROELECTRIC PROJECT
FERC NO. 2459

PROJECT BOUNDARY MAP

EXHIBIT G | SCALE: 1" = 750' | SHEET NO. 3 OF 3

0 500 1,000 2,000 3,000 4,000 Feet

FERC DWG. NO. 2459-

# Lake Lynn Hydroelectric Project

# FERC No. 2459

# Exhibit H

# Description of Project Management and Need for Project Power

## TABLE OF CONTENTS

## LIST OF APPENDICES

# 1.0 INTRODUCTION

Lake Lynn Generation, LLC (Lake Lynn or Licensee), a subsidiary of Eagle Creek Renewable Energy, LLC (Eagle Creek), is the licensee, owner, and operator of the existing 51.2-megawatt (MW) Lake Lynn Hydroelectric Project (Lake Lynn Project). The Lake Lynn Project is located on the Cheat River in Monongalia County, West Virginia, near the city of Morgantown and in Fayette County, Pennsylvania, near the borough of Point Marion. The Federal Energy Regulatory Commission (FERC or Commission) issued the current license for the Lake Lynn Project (FERC No. 2459) on December 27, 1994.

# 2.0 INFORMATION TO BE SUPPLIED BY ALL APPLICANTS

## 2.1 Plans and Ability of the Applicant to Operate and Maintain the Project (18 CFR Section 5.18(c)(1)(i)(A))

### 2.1.1 Plans to Increase Capacity or Generation

The Licensee has no current plans to increase the capacity or generation of the Lake Lynn Project.

### 2.1.2 Plans to Coordinate the Operation of the Project with Other Water Resource Projects

The Licensee does not own other hydroelectric facilities in the river system. The Lake Lynn Project operates as a dispatchable peaking hydroelectric facility with storage capability, and therefore the Lake Lynn Project is operated independently of other facilities.

### 2.1.3 Plans to Coordinate the Operation of the Project with Other Electrical Systems

There is no coordination of generation with other electrical systems because the Licensee is not a utility. The Licensee is an independent power producer and currently delivers all power generation directly to PJM Interconnection, LLC (PJM), a regional transmission organization (RTO), that coordinates the movement of wholesale electricity. PJM is a voluntary association whose members include not only traditional electric utilities, but independent power producers that are participating in the competitive wholesale electricity marketplace. As an RTO, PJM operates a wholesale electricity market that spans all or part of Delaware, Illinois, Kentucky, Maryland, Michigan, New Jersey, North Carolina, Ohio, Pennsylvania, Tennessee, Virginia, West Virginia, and the District of Columbia.

Acting as a neutral, independent party, PJM operates electricity “spot markets” in which generators sell and utilities or electricity providers buy energy for immediate delivery.

## 2.2 Need for the Electricity Generated By the Project (18 CFR Section 5.18(c)(1)(i)(B))

### 2.2.1 The Reasonable Costs and Availability of Alternative Sources of Power

The Lake Lynn Project generates emission-free, renewable power and the electrical output from the Lake Lynn Project is sold to PJM. The replacement of energy and capacity provided by the Lake Lynn Project (144,741 megawatt-hour (MWh) annually; based on a period from 2012-2021) would be met through other sources (see also Exhibit A). Alternative sources of power could be obtained by purchasing power from electricity markets operated in the region. Power could also be supplied through the construction of new power plants. Services to the grid would need to be provided by other existing projects, or in some other means by the system operator, if a new license for the Lake Lynn Project is not granted. This would likely be the equivalent amount of power from PJM with costs based on market pricing. Therefore, it is difficult for Lake Lynn to speculate the cost and availability of such alternative sources of power since the price and source can vary hourly.

### 2.2.2 Increase in Costs if the Licensee is not Granted a License

If the Licensee is not granted a license, the Lake Lynn Project would cease to provide affordable, clean electricity to PJM. An unquantified increase in costs may occur to the electric customer in the region if a license for continued operation of the Lake Lynn Project were not granted.

## 2.3 Effects of Alternative Sources of Power

### 2.3.1 Effects on Licensee’s Customers

This section is not applicable to the Licensee since the Licensee sells its electricity to PJM.

### 2.3.2 Effects on Licensee’s Operating and Load Characteristics

The Licensee is an independent power producer and, as such, does not maintain a separate transmission system which could be affected by replacement or alternative power sources.

### 2.3.3 Effects on Communities Served by the Project

See the discussion above in Section 2.2*, Need for Electricity Generated by the Project*, regarding the loss of generation from the Lake Lynn Project. Because the Licensee cannot predict with any certainty the actual type or location of a potential alternative facility providing replacement power, it cannot specifically discuss potential effects of an alternative source of power on any particular community.

## 2.4 Need, Reasonable Cost, and Availability of Alternative Sources of Power (18 CFR Section 5.18(c)(1)(i)(C))

The Licensee is an independent power producer and, as such, does not have an obligation or need to prepare load and capability forecasts in reference to any particular group or class of customers. For the region, those obligations and tasks remain within the scope of services provided by PJM. If Lake Lynn is not granted a license, the Lake Lynn Project would cease to provide affordable, clean electricity to the PJM market. The annual cost of replacing the power produced by the Lake Lynn Project is estimated to be $62.73/MWh (energy only for 2023) based on expected generation of 127,047 MWh.

## 2.5 Effect of Power on Applicant’s Industrial Facility (18 CFR Section 5.18(c)(1)(i)(D))

This section is not applicable as Lake Lynn does not use the power generated for its own industrial operations.

## 2.6 Need of the Tribe for Electricity Generated by the Project (18 CFR Section 5.18(c)(1)(i)(E))

Lake Lynn is not a Native American Tribe; therefore, this section is not applicable.

## 2.7 Impacts on the Operations and Planning of the Licensee’s Transmission System of Receiving or Not Receiving the License (18 CFR Section 5.18(c)(1)(i)(F))

The Licensee does not own the local transmission system other than the dual 800-foot-long, 138 kV transmission lines which connect to grid at the substation owned and operated by FirstEnergy; therefore, this section is not applicable. However, power generated by the Lake Lynn Project is currently transmitted to the PJM transmission/distribution system as shown in the Single Line Diagram for the Lake Lynn Project (see Appendix H-1).

## 2.8 Statement of Need for Modifications to Existing Project Facilities or Operations (18 CFR Section 5.18(c)(1)(i)(G))

Lake Lynn has no plans to construct new facilities or to alter operations of the Lake Lynn Project. Lake Lynn is seeking authorization to continue operating the Lake Lynn Project in its current configuration and as it is currently licensed to operate.

## 2.9 Consistency with Comprehensive Plans (18 CFR Section 5.18(c)(1)(i)(H))

Section 10(a)(2)(A) of the Federal Power Act (FPA), 16 U.S.C. section 803 (a)(2)(A), requires FERC to consider the extent to which a project is consistent with Federal or state comprehensive plans for improving, developing, or conserving a waterway or waterways affected by a hydropower project. On April 27, 1988, the Commission issued Order No. 481-A, revising Order No. 481, issued October 26, 1987, establishing that the Commission will accord FPA section 10(a)(2)(A) comprehensive plan status to any Federal or state plan that: (1) is a comprehensive study of one or more of the beneficial uses of a waterway or waterways; (2) specifies the standards, the data, and the methodology used; and (3) is filed with the Secretary of the Commission.

FERC currently lists 66 comprehensive plans for the state of West Virginia and the Commonwealth of Pennsylvania combined. Of those the following 8 comprehensive plans are identified as pertaining to waters in the vicinity of the Lake Lynn Project:

- National Park Service. The Nationwide Rivers Inventory. Department of the Interior, Washington, D.C. 1993.
- Pennsylvania Department of Environmental Resources. 1983. Pennsylvania State water plan. Harrisburg, Pennsylvania. January 1983. 20 volumes.
- Pennsylvania Department of Environmental Resources. 1986. Pennsylvania's recreation plan, 1986-1990. Harrisburg, Pennsylvania.
- Pennsylvania Department of Environmental Resources. 1988. Pennsylvania 1988 water quality assessment. Harrisburg, Pennsylvania. April 1988.
- West Virginia Division of Natural Resources. 1982. Monongahela River Basin plan. Charleston, West Virginia.
- West Virginia Division of Natural Resources. 2015 West Virginia State Wildlife Action Plan. Charleston, West Virginia. September 1, 2015.

- West Virginia Governor's Office of Community and Industrial Development. West Virginia State Comprehensive Outdoor Recreation Plan: 1988-1992. Charleston, West Virginia.
- U.S. Fish and Wildlife Service. n.d. Fisheries USA: the recreational fisheries policy of the U.S. Fish and Wildlife Service. Washington, D.C.

Based on a review of these plans, Lake Lynn has determined that current and proposed operations of the Lake Lynn Project facilities are consistent with these plans.

## 2.10 Financial and Personnel Resources (18 CFR Section 5.18(c)(1)(i)(I))

The Licensee has considerable experience operating not only the Lake Lynn Project but other hydroelectric and water storage projects within the region. The Licensee employs 2 full time operators and 4 full time staff cross trained in maintenance and operations dedicated to the Lake Lynn Project. In addition to the operators, staff engineers and managers who are familiar with Lake Lynn Project maintenance and operations are available if needed. Information regarding the Lake Lynn Project’s expected annual costs and value are provided in Exhibit D of this Final License Application.

## 2.11 Notification of Affected Landowners (18 CFR Section 5.18(c)(1)(i)(J))

Lake Lynn is proposing to modify the Lake Lynn Project boundary by removing lands in order to encompass only lands necessary for Lake Lynn Project maintenance and operations. Notification of adjacent landowners is not applicable.

## 2.12 Applicant’s Electricity Consumption Efficiency Improvement Program (18 CFR Section 5.18(c)(1)(i)(K))

Because the Licensee is an independent power producer, this section is not applicable to the Lake Lynn Project.

## 2.13 Tribes Affected by the Project (18 CFR Section 5.18(c)(1)(i)(L))

There are no Native American lands, known Native American traditional cultural properties or religious properties, or National Register-eligible or -listed sites associated with Native American Nations within the Lake Lynn Project boundary or which would likely be affected by the relicensing. The following is a listing of Native American tribes that have been consulted by the Licensee (letters dated May 20, 2019 and emails dated August 5, 2022 and September 12, 2022) and by FERC (letters dated June 27, 2019):

**Licensee:**
Absentee-Shawnee Tribe of Oklahoma
Catawba Indian Nation
Cayuga Nation
Cherokee Nation
Delaware Nation, Oklahoma
Delaware Tribe of Indians
Eastern Band of Cherokee Indians
Eastern Shawnee Tribe of Oklahoma
Oneida Indian Nation
Oneida Indian Nation of Wisconsin
Onondaga Nation
Osage Nation
Seneca Nation of Indians
Seneca-Cayuga Tribe of Oklahoma
Shawnee Tribe
St. Regis Mohawk Tribe
Stockbridge-Munsee Band of the Mohican Nation of Wisconsin
Tonawanda Band of Seneca
Tuscarora Nation
United Keetoowah Band of Cherokee Indians in Oklahoma

**FERC:**
Delaware Nation
Delaware Tribe of Indians
Osage Nation

The Cherokee Nation indicated via email dated June 19, 2019 that the Lake Lynn Project was outside of its Area of Interest. The Delaware Nation indicated via letter dated July 10, 2019 that the Lake Lynn Project as proposed does not endanger cultural or religious sites of interest to it. The Stockbridge-Munsee Band of the Mohican Nation indicated by email dated October 24, 2019 that it did not wish to participate in the Lake Lynn Project relicensing since the Lake Lynn Project is located outside its area of cultural interest.

# 3.0 INFORMATION TO BE PROVIDED BY AN APPLICANT WHO IS AN EXISTING LICENSEE

## 3.1 Measures Planned to Ensure Safe Management, Operation, and Maintenance of the Project (18 CFR Section 5.18(c)(1)(ii)(B))

The Lake Lynn Project is subject to Emergency Action Plan (EAP) requirements under Part 12-C of the Commission's regulations. The Lake Lynn Project EAP outlines specific monitoring, response, and communication actions by Lake Lynn operations staff and emergency response authorities under various potential emergency levels. The EAP is maintained and tested annually in compliance with the Commission's regulations and EAP guidelines.

### 3.1.1 Safe Management, Operation, and Maintenance

Lake Lynn implements a FERC-approved Public Safety Plan (PSP). The PSP summarizes public safety measures at the Lake Lynn Project, provides figures showing where public safety measures are located, and provides exhibits containing language for the public safety signs. The PSP contains public safety information only and is not intended to include each safety sign or warning device present for the benefit of Lake Lynn employees.

The Licensee's Station Operations and Maintenance Manager is responsible for the implementation of the PSP. The Licensee's Regional Operations Manager is responsible for implementation oversight, and for ensuring that all relevant personnel are trained in the requirements of the PSP. Lake Lynn's Compliance Director is responsible for periodically conducting reviews of the PSP to confirm its adequacy and reviewing and reporting any public safety incidents.

The Licensee's Station Operations and Maintenance Manager conducts a comprehensive compliance inspection at the beginning of the recreation season to ensure that the PSP is being fully implemented. Inspections are documented, and Inspection Checklist M from the PSP and inspection records are kept on file at the Lake Lynn Project powerhouse. Signs and other public safety mechanisms and measures are repaired or replaced as needed. A summary list of the safe management, operations, and maintenance provided in more detail within the PSP related to the Lake Lynn Project includes:

- Immediate Dam Area Public Safety Measures
- Tailrace Fishing Area Public Safety Measures

- Public Warning System
- Signs
- Public Safety Measures in First Mile of Tailrace
- Public Safety Measures at Substations Parking Area for Cheat Lake Trail
- Cheat Lake Trail Public Safety Measures
- Cheat lake Park and Hilltop Picnic Area Public Safety Measures
- Sunset Beach Marina Public Safety Measures

### 3.1.2 Description of Operation During Flood Conditions

A description of operations during flood conditions is provided in Exhibit B of this Final License Application.

### 3.1.3 Description of Warning Devices Used to Ensure Downstream Public Safety

The Lake Lynn Project has a downstream public warning system that is equipped with set points for warning devices that are used to ensure downstream public safety. The public warning system includes:

1. Monitoring Stream Flow

   At the initial opening of the gate to provide the minimum flow, the total flow changes from 1,100 cubic feet per second (cfs) (1 turbine at minimum discharge) to 212 cfs (maximum requirement for minimum flow). The opposite situation occurs based on initial closing. Twenty-five (25) cfs is the maximum subsequent change per hour in flow.

2. Mitigating Flood Conditions

   To mitigate during flood conditions with turbines already generating at full capacity of 9,700 cfs there are usually 2 gates operated every 10 minutes, but it is possible if necessary to operate a maximum of 8 gates at once in 18-inch increments. Once initiated, the warning will repeat every 10 minutes until stopped once the operator has positive knowledge that no more gates will be opened.

3. Public safety signs

- Case 1 Warnings - Notifying people of a change and to stay in the water (yellow lights, low sirens);
- Case 3, 5, 6, 7 - Advising people to evacuate the area immediately (red lights, high sirens);
- Case 3 - most critical case due to the frequency of occurrence and volume of water;
- Case 5 - second most critical case because of largest volume of water with shortest advance warning.

*Note: Sirens and lights are activated together to account for those with sight or hearing impairments.*

4. Warning Systems

To ensure public safety, prior to activation of equipment:

- Operators will determine the events that cause a decrease in flow as to not create a situation that would jeopardize public safety and the warning system will be activated only for increasing flow events.
- A voice message identifies that the water level will change by many feet within a few minutes indicating to the public to leave the area (based on tests, this is 3 feet in 10 minutes at 200 yards).
- If applicable the warning message will identify the need to evacuate the area immediately.
- A red light in the exclusion zone is activated to account for hearing impaired people.
- A voice message identifies the person violating the exclusion zone, warn that their safety is in jeopardy, and instruct them to leave the area immediately.

### 3.1.4 Discussion of Any Proposed Changes to the Operation of the Project or Downstream Development Affecting the Emergency Action Plan

Lake Lynn is not proposing any changes to the operation of the Lake Lynn Project that would affect the EAP. Lake Lynn is not aware of any proposed downstream development that would be affected by the Lake Lynn Project. Lake Lynn submitted the most recent annual update to the EAP for the Lake Lynn Project on January 18, 2022.

#### 3.1.5 Description of Monitoring Devices and Description of Maintenance and Monitoring Programs

Headpond and tailwater elevations are monitored at the Lake Lynn Project with electronic instrumentation and visual staff gages. Additional information regarding dam safety and monitoring is provided in the Lake Lynn Dam Safety Surveillance and Monitoring Plan (DSSMP), filed as Critical Energy Infrastructure Information (CEII) with the Commission. The DSSMP was last filed on March 30, 2022.

#### 3.1.6 Project's Employee Safety and Public Safety Record

The Licensee has an excellent record of operating in a safe-work environment. Since the Licensee acquired the Lake Lynn Project in February 2015, there have been no employee deaths, lost-time accidents, or recordable injuries at the Lake Lynn Project to our knowledge. Since the Licensee acquired the Lake Lynn Project in February 2015, there have been no Lake Lynn Project-related deaths or serious injuries to members of the public within the Lake Lynn Project boundary to our knowledge.

### 3.2 Current Project Operation (18 CFR Section 5.18(c)(1)(ii)(C))

A description of Lake Lynn Project operations is provided in Exhibit B of this Final License Application.

### 3.3 Project History (18 CFR Section 5.18(c)(1)(ii)(D))

A description of Lake Lynn Project construction history is provided in Exhibit C of this Final License Application.

### 3.4 Lost Generation Due to Unscheduled Outages (18 CFR Section 5.18(c)(1)(ii)(E))

A summary of any unscheduled outages and lost generation during the previous 5-year period (2017-2021) are provided in Table 1.

**Table 1 Summary of Unscheduled Outages and Lost Generation at the Lake Lynn Project**

| Unit | Outage Start Date | Outage End Date | Duration | Cause |
|---|---|---|---|---|
| 2 | 8/26/2018 | 8/27/2018 | 0.6 day | 2 broken shear pins (#11 and #12) |
| 4 | 11/5/2018 | 11/21/2018 | 16.1 days | Unable to clean racks effectively |
| Plant | 11/15/2018 | 11/16/2018 | 1 day | The 9" main cooling water heater ruptured |
| 2 | 11/23/2018 | 12/4/2018 | 11.6 days | 6 broken shear pins and 1 broken gate link arm. Several pieces of 4" diameter wood were found in the scroll case. On re-assembly 9 shear pins broke. 4 gates had rolled the gate stem keys causing the gates to be misaligned. |
| Plant | 12/4/2018 | 12/4/2018 | 0.3 day | Developed leak in the 9" cooling water main |
| 2 | 12/5/2018 | 12/5/2018 | 0.7 day | 2 broken shear pins gate 4 and 5. The loose gate arms broke the Downstream air admission piping free of the head cover. |
| 3 | 12/11/2018 | 12/14/2018 | 3.5 days | Replaced wicket gate packing |
| 2 | 1/30/2019 | 1/30/2019 | 0.1 day | 2 shear pins broke |
| 2 | 2/14/2019 | 4/15/2019 | 60.5 days | 6 shear pins broke and damaged the venturi piping. Also will be inspecting the head gates, trash racks and entire unit. |
| 4 | 2/17/2019 | 2/17/2019 | 0.2 day | Blew a control power fuse tripping the unit off-line |
| 4 | 3/15/2019 | 5/6/2019 | 52.3 days | Trash Screen Replacement and broken shear pins |
| 2 | 5/23/2019 | 6/3/2019 | 10.9 days | 2 broken shear pins |
| 4 | 7/22/2019 | 8/2/2019 | 11 days | Unit 4 excitation "on" permissive for initial current start cannot be obtained. |
| 1 | 9/18/2019 | 12/6/2019 | 79.3 days | Replace governor |
| 2 | 12/23/2019 | 1/20/2020 | 28 days | Unit 2 has two broken shear pins, one broken gate linkage arm, and the downstream air admission piping has been knocked loose of headcover |
| 3 | 5/17/2020 | 5/17/2020 | 0.2 day | Issue with oil flow switch |

| Unit | Outage Start Date | Outage End Date | Duration | Cause |
|---|---|---|---|---|
| 2 | 5/26/2020 | 5/27/2020 | 1 day | 2 broken shear pins gates 20 and 1. Delay in stopping the unit to install new pins. |
| 3 | 6/8/2020 | 6/8/2020 | 0.5 day | Broken shear pin. pin #3 |
| 2 | 6/16/2020 | 6/18/2020 | 1.6 days | 4 broken shear pins. # 1,5,16,20 |
| 4 | 8/24/2020 | 9/17/2020 | 24.2 days | Unable to get the unit to stop spinning. A rollertrain on the east side was jammed so the headgate could not seal. |
| 4 | 11/1/2021 | 5/26/2022 | 206.3 days | Replacing worn bushing in the Linkage. Replacing embedded steel in Unit 4 intake. Governor upgrade |
| 3 | 11/30/2021 | 12/1/2021 | 1.4 days | Unit outage to isolate unit 3 and 4 Governor from each other |

## 3.5 Record of Compliance (18 CFR Section 5.18(c)(1)(ii)(F))

The Lake Lynn Project has a good record of compliance with the terms and conditions of the existing license. A review of the Licensees' records indicates no violations of the terms and conditions of the license. In addition, the Licensee has no records of communication from the Commission indicating possible noncompliance.

## 3.6 Actions Affecting the Public (18 CFR Section 5.18(c)(1)(ii)(G))

The Licensee provides public access for recreation, including fishing, boating, nature viewing, picnicking, and hiking/biking opportunities. The Licensee provides and maintains a tailrace fishing area; a hiking/biking trail with two parking areas; a park that includes a winter/car-top boat ramp, 8 day-use boat docks, a playground, a swimming beach, shoreline picnic area, shoreline fishing, and fishing piers; an upper picnic area; a public boat ramp, and nature viewing areas.

## 3.7 Ownership and Operating Expenses that would be Reduced if the license were transferred (18 CFR Section 5.18(c)(1)(ii)(H))

This section is not applicable because there is no competing application to take over the Lake Lynn Project and no proposal to transfer the license.

## 3.8 Annual fees for use of federal or Native American lands (18 CFR Section 5.18(c)(1)(ii)(I))

This section is not applicable because the Lake Lynn Project uses no federal or Native American lands.

# Appendix H-1

## Single Line Diagrams (Filed as CEII)