FINAL ENVIRONMENTAL ASSESSMENT
FOR
HYDROPOWER LICENSE

Ellsworth Hydroelectric Project

Docket No. P-2727-092

Maine

Federal Energy Regulatory Commission
Office of Energy Projects
Division of Hydropower Licensing
888 First Street, NE
Washington, DC 20426

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ACRONYMS AND ABBREVIATIONS

Ellsworth Project	Ellsworth Hydroelectric Project
APE	area of potential effect
ASMFC	Atlantic States Marine Fishery Commission
°C	degree Celsius
C.F.R.	Code of Federal Regulations
cfs	cubic feet per second or cubic foot per second
cm	centimeters
Commission	Federal Energy Regulatory Commission
Commerce	U.S. Department of Commerce
CWA	Clean Water Act
CZMA	Coastal Zone Management Act
Design Criteria Manual	U.S. Fish and Wildlife Service Fish Passage Engineering Design Criteria Manual
DO	dissolved oxygen
EA	environmental assessment
EFH	essential fish habitat
EPA	U.S. Environmental Protection Agency
ESA	Endangered Species Act
°F	degree Fahrenheit
FERC	Federal Energy Regulatory Commission
Fishway Plan	Fishway Operations and Maintenance Plan
FPA	Federal Power Act
fps	feet per second or foot per second
Friends	Friends of Graham Lake
FWS	U.S. Fish and Wildlife Service
Gulf of Maine DPS	Gulf of Maine Distinct Population Segment
IPaC	U.S. Fish and Wildlife Service Information for Planning and Consultation
Interior	U.S. Department of the Interior
Black Bear Hydro	Black Bear Hydro Partners, LLC
Maine DEP	Maine Department of Environmental Protection
Maine DIFW	Maine Department of Inland Fisheries and Wildlife
Maine DMR	Maine Department of Marine Resources
Maine SHPO	Maine State Historic Preservation Commission Officer
mg/L	milligrams per liter
msl	mean sea level
MW	megawatt
MWh	megawatt-hours
National Register	National Register of Historic Places
NEFMC	New England Fishery Management Council
NERC	North American Electric Reliability Corporation

NHPA	National Historic Preservation Act
NLEB	northern long-eared bat
NMFS	National Marine Fisheries Service
NPCC	Northeast Power Coordinating Council, Inc.
NTU	Nephelometric Turbidity Units
PA	Programmatic Agreement
PCE	Primary Constituent Elements
SCORP	Statewide Comprehensive Outdoor Recreation Plan
SHRU	Salmon Habitat Recovery Unit
SPM	Suspended Particulate Matter
THPO	Tribal Historic Preservation Officer
TSS	Total Suspended Solids
USGS	U.S. Geological Survey
WQC	water quality certification

FINAL ENVIRONMENTAL ASSESSMENT

Federal Energy Regulatory Commission
Office of Energy Projects
Division of Hydropower Licensing
Washington, DC

ELLSWORTH HYDROLECTRIC PROJECT
Docket No. P-2727-092 – Maine

1.0 INTRODUCTION

1.1 APPLICATION

On December 30, 2015, Black Bear Hydro Partners, LLC (Black Bear Hydro) filed an application with the Federal Energy Regulatory Commission (Commission or FERC) for a new license to continue to operate and maintain the Ellsworth Hydroelectric Project No. 2727 (Ellsworth Project or project).[1] The 8.9-megawatt (MW) project is located on the Union River, in Hancock County, Maine (see Figure 1). The project does not occupy federal land.

1.2 PURPOSE OF ACTION AND NEED FOR POWER

1.2.1 Purpose of Action

The purpose of the Ellsworth Project is to provide a source of hydroelectric power. Therefore, under the provisions of the Federal Power Act (FPA), the Commission must decide whether to issue a new license to Black Bear Hydro and what conditions should be placed on any license issued. In deciding whether to issue a license for a hydroelectric project, the Commission must determine that the project will be best adapted to a comprehensive plan for improving or developing a waterway. In addition to the power and developmental purposes for which licenses are issued (such as flood control, irrigation, and water supply), the Commission must give equal consideration to the purposes of: (1) energy conservation; (2) the protection, mitigation of damage to, and

[1] An annual license for the project was issued on January 19, 2018 for the continued operation of the project under the terms and conditions of the prior license. The prior license for the project was issued on December 28, 1987, with an effective date of January 1, 1988 and a term of 30 years. *See Bangor-Hydro-Electric Company*, 41 FERC ¶ 62,304 (1987) (1987 License Order). The original license for the project was issued on April 12, 1977, with an effective date of January 1, 1938 and an expiration date of December 31, 1987. *See Bangor-Hydro-Electric Company*, 58 F.P.C. 212 (1977).

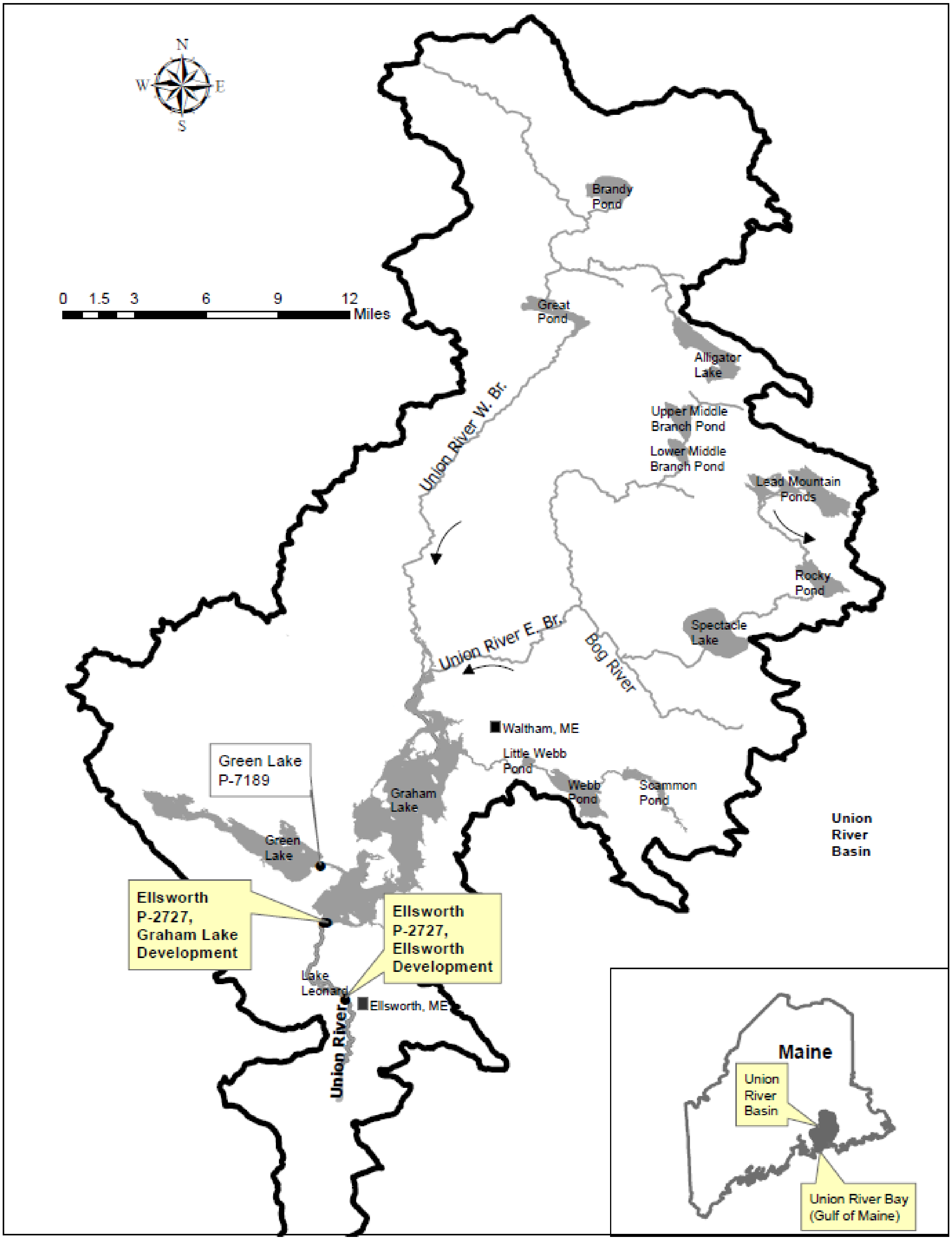

Figure 1. Location of the Ellsworth Project and other dams in the Union River Basin. (Source: staff)

enhancement of fish and wildlife resources; (3) the protection of recreational opportunities; and (4) the preservation of other aspects of environmental quality.

Issuing a new license for the Ellsworth Project would allow Black Bear Hydro to generate electricity at the project for the term of the new license, making electric power from a renewable resource available to the regional grid.

This draft environmental assessment (EA) analyzes the environmental and economic effects associated with operation of the project and alternatives to the project, and makes recommendations to the Commission on whether to issue a license, and under what terms and conditions to issue a license.

The draft EA assesses the environmental and economic effects of: (1) operating and maintaining the project as proposed by Black Bear Hydro; (2) operating and maintaining the project as proposed, with additional staff-recommended measures (staff alternative); and (3) the staff alternative with the mandatory conditions that have been filed to-date. We also consider the effects of the no-action alternative. Under the no-action alternative, the project would continue to operate as it does under the existing license, and no new environmental protection, mitigation, or enhancement measures would be implemented. The primary issues associated with relicensing the project are upstream and downstream passage for Atlantic salmon, alosines and American eels, and the surface elevation of Graham Lake.

1.2.2 Need for Power

The Ellsworth Project has an installed capacity of 8.9 megawatts (MW) and an average annual generation of about 30,511 megawatt-hours (MWh). The project's power is sold to the Independent System Operator of New England.

To assess the need for power, staff looked at the needs in the operating region in which the project is located. The Ellsworth Project is located within the Northeast Power Coordinating Council's New England region (NPCC-New England) of the North American Electric Reliability Corporation (NERC). NERC annually forecasts electrical supply and demand nationally and regionally for a 10-year period. According to NERC's 2017 Long-Term Reliability Assessment, the summer internal demand for this region is projected to decrease by 0.03 percent from 2018 to 2027.

Although demand is projected to decrease somewhat in the region, the project currently provides power that helps meet part of the region's power requirements and capacity needs. In addition, the project provides power that can displace non-renewable, fossil-fired generation and contribute to a diversified generation mix. Displacing the operation of non-renewable facilities may avoid some power plant emissions and create an environmental benefit.

1.3 STATUTORY AND REGULATORY REQUIREMENTS

A new license for the project would be subject to numerous requirements under the FPA and other applicable statutes. The major regulatory and statutory requirements are described below.

1.3.1 Federal Power Act

1.3.1.1 Section 18 Fishway Prescriptions

Section 18 of the FPA, 16 U.S.C. § 811, states that the Commission is to require the construction, operation, and maintenance by a licensee of such fishways as may be prescribed by the Secretaries of the U.S. Department of Commerce (Commerce) or the U.S. Department of the Interior (Interior). On April 10, 2018, the U.S. Fish and Wildlife Service (FWS), on behalf of Interior, and the National Maine Fisheries Service (NMFS), on behalf of Commerce, each timely filed preliminary fishway prescriptions for the project and requested that the Commission include a reservation of authority to prescribe fishways under section 18 in any license issued for the project. NMFS filed modified fishway prescriptions on April 24, 2019. On April 22, 2019, FWS filed a letter stating that its preliminary prescriptions should be incorporated, unchanged and unmodified, as the final prescriptions in any new license. The agencies' fishway prescriptions are summarized in section 2.3, *Modifications to Applicant's Proposal – Mandatory Conditions*, and included in Appendix C (Commerce) and Appendix D (Interior).

1.3.1.2 Section 10(j) Recommendations

Under section 10(j) of the FPA, 16 U.S.C. § 803(j)(1), each hydroelectric license issued by the Commission must include conditions based on recommendations provided by federal and state fish and wildlife agencies for the protection, mitigation, or enhancement of fish and wildlife resources affected by the project. The Commission is required to include these conditions unless it determines that they are inconsistent with the purposes and requirements of the FPA or other applicable law. Before rejecting or modifying an agency recommendation, the Commission is required to attempt to resolve any such inconsistency with the agency, giving due weight to the recommendations, expertise, and statutory responsibilities of such agency.

On March 27, 2018, the Maine Department of Marine Resources (Maine DMR) filed timely recommendations under section 10(j). In addition, on April 10, 2018, Interior filed timely recommendations under section 10(j). These recommendations are summarized in Table 41 and discussed in section 5.4, *Summary of Section 10(j) Recommendations*. In section 5.4, we also discuss how we address the agency recommendations and comply with section 10(j).

1.3.2 Clean Water Act

Under section 401(a)(1) of the Clean Water Act (CWA), 33 U.S.C. § 1341(a)(1), a license applicant must obtain either a water quality certification from the appropriate state pollution control agency verifying that any discharge from a project would comply with applicable provisions of the CWA, or a waiver of such certification. A waiver occurs if the state agency does not act on a request for certification within a reasonable period of time, not to exceed one year after receipt of such request.

On April 9, 2018, Black Bear Hydro applied to the Maine Department of Environmental Protection (Maine DEP) for section 401 certification for the Ellsworth Project. Maine DEP received this request on the same day. Subsequently, on March 21, 2019, Black Bear Hydro simultaneously withdrew its April 9, 2018 application and filed a new application for section 401 certification. Maine DEP has not yet acted on the application.

1.3.3 Endangered Species Act

Section 7 of the Endangered Species Act (ESA), 16 U.S.C. § 1536, requires federal agencies to ensure that their actions are not likely to jeopardize the continued existence of any endangered or threatened species or result in the destruction or adverse modification of the critical habitat of such species. On May 23, 2018 and June 24, 2019, we accessed FWS's Information for Planning and Consultation (IPaC) database to determine federally listed species that could occur in the project vicinity. According to the IPaC database, the federally endangered Gulf of Maine Distinct Population Segment of Atlantic salmon (*Salmo salar*)[2] and threatened northern long-eared bat (*Myotis septentrionalis*) could occur in the project vicinity.[3] In addition, the federally endangered shortnose sturgeon (*Acipenser brevirostrum*) and the federally threatened Atlantic sturgeon (*Acipenser oxyrinchus*) could occur in the Union River downstream of Ellsworth Dam. Designated critical habitat for Atlantic salmon is located within the project boundary. No critical habitat has been designated for the northern long-eared bat.

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[2] There are three other population segments of Atlantic salmon that are not federally listed: (1) Long Island Sound; (2) Central New England; and (3) Outer Bay of Fundy.

[3] *See* Interior's official list of threatened and endangered species, accessed by staff using the IPaC database (https://ecos.fws.gov/ipac/) on May 23, 2018, and added by staff to the Project No. 2727 docket on May 23, 2018. An updated list was generated by staff on June 24, 2019, and added by staff to the Project No. 2727 docket on June 25, 2019.

Our analysis of project impacts on the northern long-eared bat, Atlantic salmon, Atlantic sturgeon, and shortnose sturgeon is presented in section 3.3.4.2, *Threatened and Endangered Species – Environmental Effects*.

Northern Long-Eared Bat

Based on available information, Commission staff concluded in the draft EA that licensing the project would not be likely to adversely affect the northern long-eared bat, and any incidental take that may result from maintenance activities is not prohibited under the final 4(d) rule.[4] On November 26, 2018, Commission staff issued a letter to FWS requesting streamlined consultation under the 4(d) rule for the northern long-eared bat. In the letter, staff determined that, although the project may affect the northern long-eared bat, any resulting incidental take is not prohibited pursuant to the final 4(d) rule, and requested FWS's concurrence with this determination by December 27, 2018. FWS did not respond to the request. According to the streamlined consultation framework, as no response was received from FWS, staff's determination satisfies the Commission's responsibilities under the ESA for the northern long-eared bat. Therefore, no further consultation under the ESA is required for the northern long-eared bat.

Atlantic Salmon

Based on available information, Commission staff concluded in the draft EA that licensing the project may affect and is likely to adversely affect Atlantic salmon, but is not likely to adversely affect the designated critical habitat for Atlantic salmon. Commission staff requested formal consultation with NMFS on November 26, 2018 for Atlantic salmon. On December 21, 2018, NMFS filed a letter stating that the information presented in the draft EA was not sufficient to initiate formal consultation because NMFS and FWS had not issued modified section 18 fishway prescriptions, Maine DEP had not issued the section 401 water quality certification, and the inconsistencies with Maine DMR's section 10(j) recommendations had not yet been resolved. NMFS states that formal consultation cannot begin until NMFS receives the final EA. In addition, NMFS did not concur with Commission staff's finding in the draft EA that licensing the Ellsworth Project with the staff alternative including mandatory conditions would not likely adversely affect critical habitat for Atlantic salmon.

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[4] On January 14, 2016, FWS issued a final 4(d) rule that prohibits the following activities in areas of the country impacted by white-nose syndrome: incidental take within a hibernation site; tree removal within 0.25 mile of a known, occupied hibernaculum; and cutting or destroying known occupied maternity roost trees, or any other trees within 150 feet of that maternity roost tree, during the pup-rearing season (June 1 through July 31) (FWS, 2016b).

With regard to Atlantic salmon, staff retains its finding that licensing the project may affect and is likely to adversely affect Atlantic salmon. Accordingly, we are reinitiating our request for formal consultation with NMFS on Atlantic salmon. Based on NMFS's statement that it does not concur with staff's determination that the project is not likely to adversely affect Atlantic salmon critical habitat, we are also requesting formal consultation on Atlantic salmon critical habitat.

Sturgeon

Based on available information, Commission staff concluded in the draft EA that licensing the project would not be likely to adversely affect the Atlantic sturgeon or shortnose sturgeon. In its December 21, 2018 letter, NMFS states that it does not concur with Commission staff's finding that the project would not be likely to adversely affect sturgeon, because the handling of sturgeon anticipated by Black Bear Hydro's proposed sturgeon handling plan would be considered a take under the ESA. After reviewing the additional information provided by NMFS regarding Black Bear Hydro's proposed sturgeon handling plan, staff revises its finding in the final EA regarding Atlantic and shortnose sturgeon, and concludes that licensing the project is likely to adversely affect Atlantic and shortnose sturgeon. We are requesting formal consultation with NMFS on Atlantic and shortnose sturgeon.

1.3.4 Coastal Zone Management Act

The Coastal Zone Management Act of 1972 (CZMA), as amended, requires review of the project's consistency with a state's Coastal Management Program for projects within or affecting the coastal zone. Under section 307(c)(3)(A) of the CZMA, 16 U.S.C. §1456(c)(3)(A), the Commission cannot issue a license for a project within or affecting a state's coastal zone unless the state's 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 Ellsworth Project is within Maine's coastal zone, and on May 29, 2018, Black Bear Hydro submitted a consistency certification to the Maine DMR for compliance with the CZMA. In its submittal, Black Bear Hydro states that relicensing the Ellsworth Project complies with the enforceable policies in the approved Maine Coastal Zone Management Program, as conditioned by the Maine DEP's yet-to-be issued final section 401 certification and will be conducted in a manner consistent with those policies, including the conditions of the yet-to-be issued final section 401 certification for the project. In its consistency certification to Maine DMR, Black Bear Hydro also requests a stay of Maine DMR's six-month consistency review period.

Maine DMR received Black Bear Hydro's certification of consistency on May 29, 2018. On June 29, 2018, Black Bear Hydro filed an agreement between itself and Maine

DMR pursuant to 15 C.F.R. § 930.60(b), which provides that state agencies and applicants may mutually agree in writing to stay the six-month consistency review period. The agreement explains that Maine DMR's review of Black Bear Hydro's consistency certification will be based on Maine DEP's water quality certification under section 401 of the Clean Water Act, and that the one-year period for Maine DEP's section 401 review expires on April 8, 2019.

On March 21, 2019, Black Bear Hydro simultaneously withdrew its April 9, 2018 section 401 certification application and filed a new application. To continue to allow for Maine DMR's review of Black Bear Hydro's consistency certification to be based on Maine DEP's water quality certification under section 401 of the Clean Water Act, Black Bear Hydro entered into a new agreement with Maine DMR pursuant to 15 C.F.R. § 930.60(b), and filed the new agreement with the Commission on July 25, 2019. The new agreement stays Maine DMR's CZMA review process until March 19, 2020, and states that Maine DMR's CZMA review period will end on July 22, 2020.

1.3.5 National Historic Preservation Act

Section 106 of the National Historic Preservation Act (NHPA), 54 U.S.C. § 306108, requires that a federal agency "take into account" how its undertakings could affect historic properties. Historic properties are districts, sites, buildings, structures, traditional cultural properties, and objects significant in American history, architecture, engineering, and culture that are eligible for inclusion in the National Register of Historic Places (National Register).

On December 20, 2012, Commission staff designated Black Bear Hydro as its non-federal representative for the purposes of conducting section 106 consultation with the Maine Historic Preservation Commission, which functions as the State Historic Preservation Officer (Maine SHPO). As the Commission's designated non-federal representative, Black Bear Hydro consulted with the Maine SHPO pursuant to section 106 to identify historic properties, determine National Register eligibility, and assess potential adverse effects on historic properties within the project's area of potential effects (APE). This consultation, and other investigations conducted to date, identified the following historic resources within the APE as eligible for listing on the National Register: (1) two archeological sites around Lake Leonard; (2) the Ellsworth powerhouse and dam; (3) the Graham Lake Dam and bridge; and (4) the Maine Central Railroad Bridge over the Union River.

On May 5, 2015, the Maine SHPO informed Black Bear Hydro that based on the Phase I archeological studies performed as part of the relicensing, there are no significant archaeological sites located on the Graham Lake shoreline.[5] The Maine SHPO also

[5] *See* Black Bear Hydro's August 21, 2015 Updated Study Report (privileged).

stated that an assessment of archaeological sites under the Graham Lake impoundment would be necessary should the water level in the lake ever be dropped substantially, as during planned maintenance. In a December 22, 2015 letter, the Maine SHPO concurred that two of three surveyed archeological sites along Lake Leonard are eligible for listing in the National Register.

In the license application, Black Bear Hydro proposes to develop an Historic Properties Management Plan (HPMP) in consultation with the Maine SHPO. The HPMP would direct the management of historic properties within the project's APE, including measures to avoid, minimize, or mitigate adverse effects on historic properties throughout the term of a new license.

Absent a drawdown of the project impoundment, there is no imminent threat to the archaeological resources identified by the Maine SHPO. Construction of fish passage facilities could have an adverse effect on the listed Ellsworth Dam and eligible Graham Lake Dam. Our analysis presented in section 3.3.6, *Cultural Resources*, concludes that relicensing the project as proposed and with the staff-recommended measures would have no adverse effect on cultural resources that are eligible for or listed on the National Register because Black Bear Hydro would implement an HPMP to protect historic properties over the term of the license.

To meet the requirements of section 106 of the NHPA, we executed a Programmatic Agreement (PA) on May 15, 2019 for the protection of historic properties from the effects of continued operation and maintenance of the Ellsworth Project. The Maine SHPO signed the PA on June 6, 2019. The terms of the PA ensure that Black Bear Hydro protects all historic properties identified within the project's APE through the implementation of an HPMP.

1.3.6 Magnuson-Stevens Fishery Conservation and Management Act

Section 305 of the Magnuson-Stevens Fishery Conservation and Management Act, 16 U.S.C. § 1855(b)(2), requires federal agencies to consult with NMFS on all actions that may adversely affect Essential Fish Habitat (EFH). EFH for Atlantic salmon has been defined as, "all waters currently or historically accessible to Atlantic salmon within the streams, rivers, lakes, ponds, wetlands, and other water bodies of Maine, New Hampshire, Vermont, Massachusetts, Rhode Island and Connecticut."

The project area includes EFH for Atlantic salmon in that it is located in Maine and on the Union River, which was historically accessible to Atlantic salmon. Our analysis of project effects on Atlantic salmon EFH is presented in section 3.3.4.2, *Environmental Effects, Atlantic Salmon*. We conclude that relicensing the project as proposed and with the staff-recommended measures would have minor adverse effects on Atlantic salmon EFH, but by improving upstream and downstream fish passage, relicensing the project would provide a net benefit to EFH. Therefore, over the long term, aquatic habitat and EFH would be enhanced under the applicant's proposal and the additional staff modifications and measures discussed in section 5.2, *Comprehensive Development and Recommended Alternative*. We are providing NMFS with our EFH assessment and requesting that NMFS provide any EFH recommendations in response to our assessment.

1.4 PUBLIC REVIEW AND COMMENT

The Commission's regulations (18 C.F.R. § 16.8) require applicants to consult with appropriate resource agencies, tribes, and other entities before filing an application for a license. This consultation is the first step in complying with the Fish and Wildlife Coordination Act (16 U.S.C. § 661, *et seq*.), ESA, NHPA, and other federal statutes. Pre-filing consultation must be completed and documented according to the Commission's regulations.

1.4.1 Scoping

Before preparing this draft EA, we conducted scoping to determine what issues and alternatives should be addressed. Scoping Document 1 (SD1) was distributed to interested agencies and others on December 20, 2012. It was noticed in the Federal Register on December 31, 2012. Two scoping meetings were held to request oral comments on the project: one in Ellsworth, Maine on January 15, 2013, and the other in Milford, Maine on January 16, 2013. A court reporter recorded all comments and statements made at the scoping meetings, and these are part of the Commission's public record for the project. In addition to comments provided at the scoping meetings, the following entities provided written comments pertaining to SD1, the PAD, and additional study needs:

Commenting Entity	Date Filed
Maine DMR	February 15, 2013
Mark Whiting	February 15, 2013
Atlantic Salmon Federation	February 20, 2013
Maine Department of Inland Fisheries and Wildlife	February 20, 2013
Downeast Salmon Federation	February 21, 2013
FWS	February 21, 2013
Kenneth Kline	February 21, 2013
Maine DEP	February 21, 2013
NMFS	February 21, 2013
Douglas H. Watts	February 21, 2013
Penobscot East Resource Center	February 27, 2013

A revised scoping document (SD2), addressing these comments was issued on April 4, 2013.

1.4.2 Interventions

On February 9, 2018, the Commission issued a notice accepting the application and setting April 10, 2018 as the deadline for filing motions to intervene and protests. The notice was published in the *Federal Register* on February 16, 2018. In response to the notice, the following entities filed motions/notices to intervene (none opposed issuance of a license):

Intervenors	Date Filed
Maine Department of Inland Fisheries and Wildlife	February 15, 2018
Edward A. Damm	February 21, 2018
Mark C. Whiting	February 21, 2018
Robert P. Miller	February 26, 2018
Douglas H. Watts	March 6, 2018
Kathy Cook	March 8, 2018
Twyla Bryant	March 9, 2018
Schoodic Riverkeepers	March 15, 2018
Jeffrey S. and Theresa K. Smith	March 16, 2018
Town of Mariaville, Maine	March 22, 2018
Friends of Graham Lake Association	March 26, 2018
Town of Waltham, Maine	March 27, 2018
Monica and Dennis Coffey	March 29, 2018
Union Salmon Association	March 30, 2018
City of Ellsworth, Maine	April 3, 2018
Brett Ciccotelli	April 5, 2018
Maine Elver Fisherman Association	April 5, 2018
Darell Young	April 5, 2018
Hancock County Planning Commission	April 6, 2018
Maine Council of the Atlantic Salmon Federation	April 6, 2018
Downeast Salmon Federation	April 9, 2018
Frenchman Bay Conservancy	April 9, 2018
Maine Center for Coastal Fisheries	April 9, 2018
Conservation Law Foundation	April 10, 2018
Timothy M. Milbert	April 11, 2018*****

*Late intervention granted on October 18, 2018.

1.4.3 Comments on the Application

On February 9, 2018, the Commission issued a notice setting April 10, 2018 as the deadline for filing comments, recommendations, terms and conditions, and prescriptions. Responses were filed by the following entities:

Commenting Entity	Date Filed
Edward A. Damm	February 12, 2018
Jonas Clark	February 16, 2018
Robert Miller	February 22, 2018
Zach Sheller	February 22, 2018
Brad and Diane Perry	February 22, 2018
Donna Merrick	February 27, 2018
Toby A. Stephenson	March 1, 2018
David Zuk	March 1, 2018
Richard Arnold	March 6, 2018
Kathy Cook	March 8, 2018
Craig H. Schoppe	March 9, 2018
Douglas H. Watts	March 12, 2018
Eldred Bullard	March 14, 2018
Gene Flower	March 14, 2018
Michele Glassburg	March 14, 2018
Julia Paul	March 19, 2018
Jeffrey S. Smith	March 19, 2018
Dennis and Monica Coffey	March 26, 2018
Maine DMR[6]	March 27, 2018
Monica and Dennis Coffey	March 29, 2018
Jennifer R. Riefler	April 2, 2018
Cheri Domina	April 2, 2018
Kevin Bullard	April 3, 2018
Edward A. Damm	April 5, 2018
Friends of Graham Lake Association	April 6, 2018
Bryant G. Pake	April 6, 2018
Beth Warner	April 6, 2018
Jane Crosen Washburn	April 6, 2018
Edward A. Damm	April 6, 2018
Michelle R. Dawson	April 6, 2018
Carol Gregory	April 9, 2018
Kathryn Mullen	April 9, 2018
Chris Petersen	April 9, 2018
Scott Fuhrer	April 9, 2018
Becka Gagne	April 9, 2018
Gretchen Gardner	April 9, 2018
Malcolm Hunter	April 9, 2018

[6] MDMR's March 27, 2018 filing included its section 10(j) recommendations.

Maine Center for Coastal Fisheries	April 9, 2018
Residents of Maine[7]	April 9, 2018
Julie Staggs	April 9, 2018
Native Fish Coalition	April 9, 2018
Wayne Simmons	April 10, 2018
Interior[8]	April 10, 2018
Commerce[9]	April 10, 2018
Residents of Maine[10]	April 11, 2018
Thomas P. and Diane Dunn	April 18, 2018
Downeast Salmon Federation	April 24, 2018
Burris T. Jester	May 3, 2018
Downeast Salmon Federation	May 10, 2018

1.4.4 Comments on the Draft EA

Commission staff issued its draft EA for the relicensing of the project on November 21, 2018. Staff requested comments on the draft EA be filed within 60 days of the issuance date. Due to the funding lapse at certain federal agencies between December 22, 2018 and January 25, 2019, the Commission extended the comment period an additional 30 days. The following entities filed comments pertaining to the draft EA.

Commenting Entity	Date Filed
Kenneth Shellenberger III	January 16, 2019
Twyla Bryant	January 16, 2019
Twyla Bryant	January 18, 2019
Frenchman Bay Conservancy	January 18, 2019
Maine Department of Inland Fisheries and Wildlife (Maine DIFW)	January 22, 2019

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[7] Includes signatures from 43 residents of Hancock County, Maine, and neighboring counties.

[8] Interior's April 10, 2018 filing includes its section 10(j) recommendations and section 18 preliminary fishway prescriptions. On April 10, 2018, Interior filed the administrative record for its section 18 preliminary fishway prescriptions.

[9] Commerce's April 10, 2018 filing includes its section 18 preliminary fishway prescriptions. On April 11, 2018, Commerce filed the administrative record for its section 18 preliminary fishway prescriptions.

[10] Includes an additional 28 signatures from residents of Hancock County, Maine.

Maine Department of Marine Resources (Maine DMR)	January 22, 2019
Maine Elver Fisherman Association	January 22, 2019
Downeast Salmon Federation (DSF)	January 22, 2019
Black Bear Hydro Partners LLC (Black Bear Hydro)	January 22, 2019
Edward Damm	January 22, 2019
Brad Perry	January 22, 2019
James Birmingham and Michelle Dawson	January 22, 2019
DSF	January 24, 2019
Janice Buckingham	January 25, 2019
Leslie Hailui[11]	January 25, 2019
Unreadable	January 25, 2019
Michael Good	January 25, 2019
Frank Sloggs	January 25, 2019
Julie Staggs	January 25, 2019
Graham Plether	January 25, 2019
Roger Marks	January 25, 2019
Antonio Blasi	January 25, 2019
Sergei Breus	January 25, 2019
Catherine Fore	January 25, 2019
Gregory Michael	January 25, 2019
Deborah Richards	January 25, 2019
John Alzord	January 25, 2019
Mark Whiting	January 25, 2019
Rosamond Rea	January 25, 2019
Barbara Witham	January 25, 2019
Kent Lewis	January 25, 2019
Terance Yam	January 25, 2019
Alan Kane	January 25, 2019
Brad Perry	January 25, 2019
Edward Merrick	January 25, 2019
Paul Haster	January 28, 2019
Carla Haskell	January 28, 2019
Karla Ramsay	January 28, 2019
Victor Ryolizky	January 28, 2019
Hilly and Joe Crary	January 29, 2019

[11] Italics indicate attempts made by Commission staff to determine commenters' names when printed names were not provided and only signatures were included with the filing.

Martha Dickerson	January 29, 2019
George Leinbaugh	January 29, 2019
Jeffrey and Theresa Smith	January 29, 2019
Carol Gregory	January 29, 2019
Madea Steinman	January 29, 2019
Unreadable	January 31, 2019
Casey Teonson	February 4, 2019
Nathaniel Henson	February 4, 2019
Mark Whiting and Catherine Fox	February 4, 2019
DSF	February 4, 2019
Edward Damm	February 4, 2019
Brad Perry	February 6, 2019
Robert Miller	February 11, 2019
Gene Flower	February 13, 2019
National Marine Fisheries Service (NMFS)	February 15, 2019
Martin and Semena Curlik	February 15, 2019
DSF (Petition with 332 signatures)	February 19, 2019
Barbara Carrion	February 19, 2019
Gabrielle Wellman	February 20, 2019
U.S. Fish and Wildlife Service (FWS)	February 22, 2019
Schoodic Riverkeepers	February 22, 2019
Native Fish Coalition, Maine Chapter	February 22, 2019
Edward Damm	February 25, 2019
Todd and Christa Little-Siebold	February 25, 2019
Daniel Bierman	February 25, 2019
Arthur Smoeleye	February 25, 2019
Burris Jester	February 25, 2019
Friends of Graham Lake (Brad Perry)	February 25, 2019
Vivian Jester	February 25, 2019
DSF	February 26, 2019
Martin and Semena Curlik	February 26, 2019
Thomas Hansen	March 1, 2019
Tammy and Robert Packis	March 8, 2019

2.0 PROPOSED ACTION AND ALTERNATIVES

2.1 NO ACTION ALTERNATIVE

Under the no-action alternative, the project would continue to operate under the terms and conditions of the existing license, and no new environmental protection, mitigation, or enhancement measures would be implemented. We use this alternative as the baseline environmental condition for comparison with other alternatives.

2.1.1 Existing Project Facilities

The Ellsworth Project is located on the Union River, in the City of Ellsworth, the towns of Waltham and Mariaville, and the township of Fletchers Landing in Hancock County, Maine. The project consists of two developments, Graham Lake and Ellsworth. The project facilities are shown in Figure 2 and Figure 3.

Graham Lake Development

Graham Lake Dam is a 630-foot-long earthen concrete structure that includes: (1) a 80-foot-long, 58-foot-high concrete spillway section with three 20-foot-wide, 22.5-foot-high Tainter gates, a crest elevation of 104.2 feet mean sea level (msl), and a 4-foot-wide overflow weir controlled with stoplogs that are positioned inside an 8-foot-wide sluice gate; and (2) a 550-foot-long, 45-foot-high earthen embankment section with a concrete and sheet pile core wall.

A flood control structure is located on the downstream side of the earthen embankment to reinforce the earthen embankment, with the following structures: (1) a 720-foot-long, 58-foot-high concrete gravity flood control structure; (2) a 65-foot-diameter, 55-foot-high stone-filled sheet pile retaining structure; and (3) a 71-foot-long, 36.5-foot-high concrete wing wall.

The dam impounds the approximately 10,000-acre Graham Lake at a normal maximum surface elevation of 104.2 feet msl. The impoundment is approximately 10 miles long and has a usable storage capacity of 133,150 acre-feet between a normal minimum surface elevation of 93.4 feet msl and a normal maximum surface elevation of 104.2 feet msl. From Graham Lake, water enters the Union River through the Tainter gates and overflow weir.

There are no generation or transmission facilities at the Graham Lake Development.

Downstream passage for river herring[12] and Atlantic Salmon at Graham Lake Dam is provided by the normal operation of: (1) the three 20-foot-wide Tainter gates; and (2) a 4-foot-wide by 7.5-foot-deep surface-oriented bypass that is located on the west end of the spillway, 16.2 feet above the tailwater, and is capable of releasing flows up to at

[12] Blueback herring and alewife are difficult to distinguish visually and are therefore often collectively referred to as river herring.

least 50 cubic feet per second (cfs).[13] Flows from the surface bypass weir and Tainter gates discharge into an approximately 9.5 foot-deep natural plunge pool in the Union River, below the dam. In addition to river herring and Atlantic salmon, eels are also known to use these facilities for passive downstream passage at Graham Lake Dam. There are no upstream fish passage facilities at the Graham Lake Development.

Figure 2. Graham Lake Development facilities (Source: U.S. Geological Survey, 2013, as modified by staff).

Ellsworth Development

Ellsworth Dam is a 377-foot-long concrete gravity structure that includes: (1) a 275-foot-long, 57-foot-high concrete overflow spillway with 1.7-foot-high flashboards and a crest elevation of 66.7 feet msl; and (2) a 102-foot-long, 60-foot-high concrete bulkhead section with: (a) a 15-foot-wide, 10-foot-high headgate with a 15-foot-wide,

[13] In the spring of 2017, Black Bear Hydro modified the existing bypass weir in the log sluice by adding a sloped floor, two side panels, and a bell-shaped entrance to create an "Alden weir" to enhance downstream fish passage based on the results of the 2016 Salmon Smolt Survival Study. An Alden weir is a surface-oriented flume with a large bell-shaped entrance that gradually slopes upward to create a uniform accelerating flow that conveys downstream migrating fish to a high-velocity (greater than 3 meters per second) bypass flow. The Commission has not issued an amendment order requiring permanent installation of the Alden weir. Therefore, throughout this document, we refer to the Alden weir as the "temporarily-installed Alden weir."

12.5-foot-high trashrack with 2.44-inch clear spacing; and (b) an 87-foot-long, 60-foot-high concrete dam section. An 88.4-foot-wide, 32-foot-high intake structure is located on the west end of the bulkhead structure, and includes: (1) two 15-foot-wide, 15-foot-high headgates with 15-foot-wide, 13.75-foot-high trashracks with 1-inch clear spacing for the top approximately 6.75 feet of the trashrack, and 2.37-inch clear spacing for the bottom 7 feet; and (2) one 12-foot-wide, 15-foot-high headgate with a 15-foot-wide, 15.75-foot-high trashrack with 1-inch clear spacing for the top approximately 6.75 feet of the trashrack, and 2.37-inch clear spacing for the bottom 9 feet. An 85-foot-long, 71-foot-high concrete non-overflow wall is located perpendicular to the dam, on the west end of the bulkhead section. In addition, a 26-foot-high abutment is located at the east end of the spillway.

The dam impounds the approximately 90-acre Lake Leonard at a normal maximum surface elevation of 66.7 feet msl. Lake Leonard is approximately 1 mile long and has a gross storage capacity of 2,456 acre-feet between a normal minimum surface elevation of 65.7 feet msl and a normal maximum surface elevation of 66.7 feet msl.

From Lake Leonard, flows are conveyed to a generating facility that is integral with the dam (Generating Facility No. 1) by entering a 10-foot-diameter, 74-foot-long penstock through the 15-foot-wide, 10-foot-high headgate. Water flows from the penstock to a single 2.5-MW turbine-generator unit (Unit 1) located in a 26-foot-long, 28-foot-wide concrete and masonry powerhouse that is integral to the concrete non-overflow dam, and then back into the Union River.

Flows are also conveyed from the impoundment through the 88.4-foot-wide intake structure to three parallel penstocks, including an 8-foot-diameter, 164-foot-long penstock, an 8-foot-diameter, 195-foot-long penstock, and a 12-foot-diameter, 225-foot-long penstock. Water flows from the penstocks to two 2.0-MW turbine-generator units (Units 2 and Unit 3) and one 2.4-MW (Unit 4) turbine-generator unit located in a 52.5-foot-long, 68-foot-wide concrete and masonry powerhouse that is attached to a 15-foot-long, 30-foot-wide switch house, and then back into the Union River.

The project generators connect to the local utility's electric distribution system through a 450-foot-long, 2.3 kilovolt generator lead line and step-up transformer.

Downstream fish passage at Ellsworth Dam is provided for Atlantic salmon and river herring by the operation of: (1) three 3-foot-wide surface weirs, one of which is located between the east powerhouse intake for Unit 1 and the overflow spillway of the dam (eastern surface weir) and is capable of releasing 16 cfs when open by 17 inches, and two of which are located on either side of the west powerhouse intake to Units 2, 3, and 4 (western surface weirs) and are capable of releasing a combined flow of 20 cfs each when open by 21 inches; (2) a recirculating pump to return up to 35 cfs (28 cfs under normal conditions) of the 40 cfs conveyance flow from the western surface weirs to Lake Leonard; (3) a 48-inch-wide spillway flume, with a harden-plastic bottom and 18-inch-high steel sidewalls, that uses 16 cfs conveyance flow to transport fish from the eastern surface weir down the face of the spillway into a natural plunge pool[14] at the toe of the dam in the tailrace; and (4) a 30-inch-diameter downstream migrant pipe, that uses 12 cfs conveyance flow during normal operation to transport fish from the western surface weirs and across the downstream face of the non-overflow section of the dam to the spillway flume. Upstream fish passage is provided by a 120-foot-long, 8-foot-wide vertical slot fishway with a 3-foot-wide opening and collection station.

Figure 3. Ellsworth Development facilities (Source: U.S. Geological Survey, 2013, as modified by staff).

The project has three recreation facilities that Black Bear Hydro owns and maintains: (1) the Shore Road boat launch on Lake Leonard that includes a parking area and a 6-foot-wide concrete ramp for carry-in boats; (2) the Graham Lake boat launch near Graham Lake Dam that includes a parking area and a 12-foot-wide concrete ramp for

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[14] In its October 10, 2018 response to Commission staff's request for additional information, Black Bear Hydro explains that it does not have drawings of the river bed at the base of the spillway to confirm the depth of the plunge pool, but "the minimum depth of the plunge pool appears to be several feet with a potential depth of approximately 12 feet."

motorized boats; and (3) an approximately 360-foot-long canoe portage trail around the east side of Graham Lake Dam, which is also used to provide angler access to the Union River downstream of the dam.

2.1.2 Existing Project Boundary

The current project boundary encloses approximately 3,350 acres of land and 10,099 acres of open water, and consists of: (1) land and water up to a contour elevation of 107.0 feet msl on Graham Lake, and several islands of various sizes located on Graham Lake; (2) land and water within the Union River bank on an approximately 3.1-mile-long riverine reach of the Union River between Graham Lake Dam and Lake Leonard; (3) land and water up to a contour elevation of 66.7 feet msl on Lake Leonard, and land and water within the Union River bank on the approximately 3.1-mile-long riverine reach of the Union River between Graham Lake Dam and Lake Leonard; (4) approximately 800 feet of the Union River and shoreline downstream of the Ellsworth Dam; and (5) land associated with the project's two dams, flood control structures, powerhouse, a generator lead line and step-up transformer, recreation facilities, and appurtenant facilities.

2.1.3 Project Safety

The Ellsworth Project has been operating for more than 30 years under its existing license. During this time, Commission staff has conducted operational inspections focusing on the continued safety of the structures, identification of unauthorized modifications, efficiency, and safety of operations, compliance with the terms of the license, and proper maintenance.

As part of the licensing process, Commission staff will evaluate the continued adequacy of the project's facilities under a new license. Special articles will be included in any license issued, as appropriate. Commission staff will continue to inspect the project during the term of any new license to assure continued adherence to Commission-approved plans and specifications, special license articles relating to construction (if any), operation and maintenance, and accepted engineering practices and procedures.

2.1.4 Existing Project Operation

The Ellsworth Project operates as both a water storage facility and as a peaking generation facility, depending on available inflows.

The Graham Lake Development is operated as a water storage facility where water is stored for later use in supplementing downstream generation at the Ellsworth Development. There are no generating facilities at the Graham Lake Development. The current project license requires the water level in Graham Lake to be maintained between 93.4 and 104.2 feet msl. The Graham Lake Development generally follows an informal target operating curve where the impoundment is drawn down during the summer and winter and refilled in the fall and spring. According to the operating curve used by the licensee, Graham Lake is drawn down from a target elevation of approximately 102 feet msl on January 1 to a target elevation of 93.4 feet msl on March 31. Graham Lake is then filled to a target elevation of 104.2 feet msl between April 1 and mid-May, and is gradually drawn down over the summer to a target elevation of 97.8 feet msl by early October. Graham Lake is then partially refilled from mid-October to the end of December to a target elevation of approximately 102 feet msl.

The Ellsworth Development operates as a generation peaking facility by utilizing stored water released from the Graham Lake Development. The current project license requires that the water level in Lake Leonard be maintained between 65.7 and 66.7 feet msl. The Ellsworth Development can generate electricity using flows between approximately 87 cfs (minimum hydraulic capacity of the 2.0-MW turbine-generator unit) and 2,460 cfs (maximum combined hydraulic capacity of the four turbine-generator units). During high flow events above the maximum hydraulic capacity, flows are released to the main stem of the Union River over the overflow flashboards on the spillway at the dam.

In accordance with Article 401 of the project's license,[15] Black Bear Hydro releases a continuous minimum flow of 250 cfs downstream of each development from May 1 to June 30 each year. The minimum flow release from each development is reduced to 105 cfs from July 1 to April 30 each year. The minimum flow at the Graham Lake Development is released primarily through the downstream fish passage facility or the Tainter gates. The minimum flow at the Ellsworth Development is released through the turbine units, through the downstream fish passage facilities, or directly over the concrete overflow spillway section of the dam.

Black Bear Hydro operates the downstream fish passage facilities for river herring and Atlantic salmon at both dams from April 1 to December 31 of each year and operates the upstream fish passage facility for river herring at the Ellsworth Development from early May to mid-June of each year and for Atlantic salmon from May 1 to October 31.[16]

The project is operated automatically via a Programmable Logic Controller system that monitors and controls operation, including headpond levels at each development.

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[15] *See Bangor Hydro-Electric Company*, 41 FERC ¶ 62,304 (1987).

[16] Black Bear Hydro began operating the upstream fish passage facility from May 1 to October 31 as part of an Atlantic salmon upstream passage study. *See* Commission staff's December 30, 2014 study modification determination letter.

Black Bear Hydro states that plant operators visit the project three to five times each week.

2.2 APPLICANT'S PROPOSAL

2.2.1 Proposed Project Facilities

Black Bear Hydro is proposing no changes to the existing project boundary, which encloses the project works, impoundments, and lands necessary for project purposes.

2.2.2 Proposed Operation and Environmental Measures

Black Bear Hydro proposes to:

Water Elevation and Minimum Flow Measures

- Continue releasing a continuous minimum flow of 105 cfs from July 1 through April 30, and a continuous minimum flow of 250 cfs from May 1 through June 30 from the Ellsworth and Graham Lake developments during normal project operation, for the protection of fishery resources;
- Continue to operate Lake Leonard between the elevations of 65.7 and 66.7 feet msl, and operate Graham Lake between the elevations of 93.4 and 104.2 feet msl during normal operation;[17]
- Continue monitoring reservoir elevation levels and minimum flow releases using pressure-sensitive headwater sensors and generation outflow;
- Temporarily modify the proposed minimum flow releases and elevation limits at the Ellsworth and Graham Lake developments during: (1) approved maintenance activities; (2) extreme hydrologic conditions;[18] (3) emergency

[17] On March 29, 2019, Black Bear Hydro filed a new application for water quality certification (WQC) with Maine DEP that includes a proposal to operate Graham Lake between 98.5 and 104.2 feet msl. However, Black Bear Hydro has not filed an amended final license application stating that it is revising its formal proposal to continue operating Graham Lake between 93.4 and 104.2 feet msl. To ensure a comprehensive environmental analysis, we include Black Bear Hydro's WQC proposal as an alternative operating range throughout the final EA. We refer to this alternative as "BBH Alternative."

[18] Black Bear Hydro defines "extreme hydrologic conditions" as the occurrence of events beyond their control such as, but not limited to, abnormal precipitation, extreme

electrical system conditions;[19] or (4) agreement between the Licensee, the Maine DEP, and appropriate state and/or federal fisheries management agencies;

- Finalize and implement a draft operation compliance monitoring plan that includes measures for monitoring, recording compliance with, and reporting on deviations from the requisite minimum flow releases and impoundment elevations;

Downstream Fish Passage Measures

- Modify the invert elevation of the temporarily-installed Alden weir at Graham Lake Dam by May 1 of the third year following issuance of any new license to provide a 3-foot-deep flow over the weir over the full range of lake elevations allowed in any new license from April 1 to December 31 of each year;

- Test the effectiveness of the proposed modifications to the existing downstream passage weir for Atlantic salmon smolt passage at Graham Lake Dam for a 1- to 3-year period using a performance standard of 90 percent effectiveness for total project downstream passage (*i.e.*, at least 95 percent effectiveness, on average, per development), beginning in the year following implementation of the modifications;

- Implement additional adaptive management measures in consultation with resource agencies, as necessary to improve downstream fish passage effectiveness at Graham Lake Dam to meet the 90 percent performance standard;

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runoff, flood conditions, ice conditions or other hydrologic conditions such that the operational restrictions and requirements for minimum flow releases and impoundment elevation limits are impossible to achieve or are inconsistent with the safe operation of the project.

[19] Black Bear Hydro defines “emergency electrical system conditions” as operating emergencies beyond their control which require changes in flow regimes to eliminate such emergencies which may in some circumstances include, but are not limited to, equipment failure or other temporary abnormal operating conditions, generating unit operation or third-party mandated interruptions under power supply emergencies, and orders from local, state, or federal law enforcement or public safety authorities.

- Test the effectiveness of any adaptive management measures that are implemented for Atlantic salmon smolt passage at Graham Lake Dam for a 1- to 3-year period following implementation of the measures, using a performance standard of 90 percent effectiveness for total project downstream passage (*i.e.*, at least 95 percent effectiveness, on average, per development);

- Conduct a 1-year study to investigate the potential causes of Atlantic salmon smolt mortality in the downstream portion of Graham Lake within three years of issuance of any new license;

- Continue to provide downstream passage for out-migrating Atlantic salmon and river herring at Graham Lake Dam through the existing surface weir and Tainter gate from April 1 to December 31 of each year until the proposed modifications to the surface weir are operational;

- Install a fish guidance system (Worthington boom[20] or similar technology) with 10- to 15-foot-deep, rigid panels at Ellsworth Dam by May 1 of the third year following issuance of any new license;

- Install full-depth trashracks or trashrack overlays with 1-inch clear-spacing at the intakes for generating Units 2, 3, and 4 at Ellsworth Dam by May 1 of the third year following issuance of any new license;

- Provide downstream passage at the Ellsworth Dam from April 1 to December 31 of each year through the three surface bypass weirs and improve the existing downstream fish passage system at Ellsworth Dam by May 1 of the third year following issuance of any new license, as follows: (1) modify the existing downstream fish passage weir entrance that is adjacent to the intake for generating Unit 1 by increasing the depth of the weir to a minimum of 3 feet, installing tapered walls similar to an Alden weir, and increasing the weir capacity to pass up to 5 percent of station hydraulic capacity; (2) increase the height of the sides of the spillway flume in consultation with the resource agencies, to improve containment of fish passing through the flume; (3) modify the existing fish downstream migrant pipe to improve its discharge angle into the spillway flume to limit potential injury to fish that are exiting the pipe; and (4) prioritize operation of generating Units 1 and 4 over Units 2 and 3 during

[20] A Worthington boom is a floating mechanical guidance structure consisting of lightweight panels or nets suspended under floats deployed in the forebay. It is designed to direct surface-migrating fish species towards the entrance of a surface bypass facility.

critical downstream passage seasons, as determined in consultation with the agencies.

- Test the effectiveness of the proposed downstream fish passage measures for Atlantic salmon smolt passage at Ellsworth Dam for a 1- to 3-year period beginning in the year following implementation of the modifications, using a performance standard of 90 percent effectiveness for total project downstream passage (*i.e.*, at least 95 percent effectiveness, on average, per development);

- Implement the following adaptive management measure(s) in consultation with resource agencies, as necessary to improve downstream fish passage effectiveness at Ellsworth Dam to meet the 90 percent performance standard: (1) add panels or curtains to deepen the fish guidance system; (2) increase flows over the spillway by reducing generation or shutting down turbines at night for two weeks during May; and (3) modify the spillway ledge, plunge pool, or spillway surface to reduce injury to fish passing over the spillway;

- Test the effectiveness of any adaptive management measures that are implemented for Atlantic salmon smolt passage at Ellsworth Dam for a 1- to 3-year period following implementation of the measures, using a performance standard of 90 percent effectiveness for total project downstream passage (*i.e.*, at least 95 percent effectiveness, on average, per development);

- Continue to provide downstream passage for out-migrating Atlantic salmon and river herring from April 1 to December 31 of each year at the Ellsworth Dam through the three existing surface weirs until the proposed modifications to the surface weir are operational;

<u>Upstream Fish Passage Measures</u>

- Design and install new upstream eel passage facilities at the Ellsworth and Graham Lake dams within 2 years of the effective date of any new license, in consultation with the fisheries management agencies.

- Test the effectiveness of the existing fishway trap and truck facility at Ellsworth Dam for passing Atlantic salmon for a 1- to 3-year period using a performance standard of 90 percent effectiveness for total project upstream passage (*i.e.*, at least 95 percent effectiveness, on average, per development), to be conducted after downstream passage improvements have been implemented and smolts stocked upstream of Ellsworth Dam have had a chance to return as upstream migrating adults;

- Design and install new upstream Atlantic salmon passage measures at Ellsworth and Graham Lake dams 15 years after issuance of any new license, unless the management or restoration priorities of the resource agencies would warrant a delay in construction of the new passage measures; and operate the new facilities from May 1 to October 31 of each year;

- Test the effectiveness of the new upstream Atlantic salmon passage measures at Ellsworth Dam and Graham Lake Dam for 1 to 3 years using a performance standard of 90 percent effectiveness for total project upstream passage (*i.e.*, at least 95 percent effectiveness, on average, per development), beginning in the second fish passage season after each fish passage measure is operational;

- Modify the upstream fish passage facilities for Atlantic salmon if the 90 percent performance standard is not met in two of the test years following implementation of fish passage measures;

- Continue to provide upstream passage for alosines[21] and Atlantic salmon by maintaining and operating the existing fishway trap and truck facility from May 1 to October 31 of each year at Ellsworth Dam until the proposed upstream fish passage measures are operational;

- Continue to implement and update as needed, a fish passage operation and maintenance plan that describes how Black Bear Hydro would operate and maintain the existing fish passage facilities, including: (1) the period in which the facilities are to be operated; (2) guidance on the annual start-up and shut-down procedures; (3) routine operating guidelines; (4) debris management; and (5) safety rules and procedures;

- Implement a sturgeon handling plan to reduce the potential for adverse effects on Atlantic and shortnose sturgeon that may be encountered during fish passage operation or routine maintenance activities at the Ellsworth Dam;

<u>Recreation Measures</u>

- Continue to operate and maintain the Shore Road boat launch on Lake Leonard, the Graham Lake boat launch near Graham Lake Dam, the canoe portage route around Graham Lake Dam, and the angler access trail at Graham Lake Dam;

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[21] Alosine refer to fish in the Genus *Alosa*, such as American shad, alewife, and blueback herring.

- Replace the existing canoe portage facility on the east end of Graham Lake Dam with a new canoe portage trail located at the west end of Graham Lake Dam

- Install a canoe take-out area on the existing Graham Lake Dam boat launch property that is separate from the hard surface ramp used by motorized watercraft;

- Improve drainage and stabilize existing erosion areas at the existing Graham Lake boat launch facility by grading and compacting the gravel section of the boat launch;

- Improve and maintain the existing angler access trail on the east side of Graham Lake Dam;

- Implement the proposed Recreation Facilities Management Plan that includes measures for maintaining the existing and proposed recreation facilities and directional and safety signage at each project recreation facility; and

<u>Cultural Resources Measures</u>

- Implement the draft HPMP filed on December 30, 2015 to provide for management of historic resources throughout the term of any new license.

2.3 MODIFICATIONS TO APPLICANT'S PROPOSAL – MANDATORY CONDITIONS

The following mandatory conditions have been provided and are summarized below.

Section 18 Prescriptions

Interior's section 18 prescription would require Black Bear Hydro to provide upstream and downstream passage for American eels at the Ellsworth and Graham Lake developments and downstream passage for anadromous fish at the Ellsworth and Graham Lake developments. Specifically, Interior's prescription would require Black Bear Hydro to:

- Modify the temporarily-installed Alden weir at the Graham Lake Development within 2 years of license issuance to provide safe timely, and effective downstream passage for American eel and anadromous fish species, with the following weir design specifications: (1) a uniform accelerating discharge that is provided by an Alden weir or a weir with a similar design; (2) at least a 2-foot depth of flow over the weir at all potential water surface elevations included in any new license; and (3) the weir must pass the minimum flow required by any new license;

- Cease generation at the Ellsworth Development nightly (8 PM to 4 AM) from September 1 to October 31 to facilitate safe and timely downstream eel passage;

- Cease generation at the Ellsworth Development for three consecutive nights (8 PM to 4 AM) following each rain storm event exceeding 1-inch of rainfall in a 24-hour time period during the month of August, to facilitate downstream eel passage;

- Within 2 years of license issuance, install full-depth trashrack overlays with 1-inch clear spacing over the intakes of generating Units 2, 3, and 4 at the Ellsworth Development from August 1 to October 31 of each year;

- Modify the existing downstream fish passage facility at the Ellsworth Development within 2 years of license issuance in consultation with resource agencies to provide safe, timely, and effective passage for American eel and anadromous fish species, including the following structural modifications: (1) increase the total combined flow through the three existing surface weirs to 5 percent of the maximum station capacity (approximately 123 cfs); (2) realign the end of the downstream fish downstream migrant pipe so that water discharges downward to the spillway flume and fish do not impact the spillway when exiting the pipe; and (3) eliminate leakage at the sidewalls of the spillway flume and eliminate discharge from the flume to the ledges at the toe of the dam;

- Operate the modified downstream passage surface weirs at the Ellsworth and Graham Lake dams on an annual basis from August 1 to October 31;

- Design the downstream eel passage facility at the Graham Lake Development and the upstream eel passage facilities at the Ellsworth and Graham Lake developments in a manner that is consistent with the FWS's 2017 Fish Passage Engineering Design Criteria Manual (Design Criteria Manual; FWS, 2017), and submit design plans to the FWS for review and approval prior to Commission approval;

- Develop a fishway operation and maintenance plan within 12 months of license issuance that includes provisions for operating and maintaining upstream and downstream fish passage facilities at the project for anadromous fish and eels; submit the fishway operation and maintenance plan to FWS for review and approval; update the fishway operation and maintenance plan upon request of the FWS, and on an annual basis to reflect changes in fishway operation and maintenance; and obtain approval from FWS for any requested modification to the fishway operation and maintenance plan;

- Develop a downstream American eel passage effectiveness monitoring plan within six months of license issuance that includes effectiveness monitoring at the Ellsworth and Graham Lake dams using radio telemetry to determine migratory delay, route of downstream passage (*i.e.*, via surface bypasses, turbines, or spillage), immediate survival, and latent survival;

- If the downstream fish passage facilities at the Ellsworth or Graham Lake developments do not pass eels in a safe, timely, and effective manner, implement passage improvements approved by FWS, including but not limited to: (1) extending the passage season; (2) restricting generation to certain times of the day; (3) installing trashrack overlays with 0.75-inch clear spacing; (4) installing a deep bypass gate; and/or (5) constructing a new downstream eel passage facility with angled trash racks;

- Construct upstream fish passage ramps for American eel at the Ellsworth and Graham Lake dams within 2 years of license issuance, with the exact location of the ramps to be determined in consultation with FWS and Maine DMR, and

- Operate the upstream fish passage ramps on an annual basis from June 1 to August 31;

- Develop an upstream American eel effectiveness monitoring plan within six months of license issuance that includes standard methods previously required by FWS and Maine DMR for eel ramp fishways at Maine hydroelectric projects (*e.g.*, FERC Project No's. 2555, 2556, 2364, 2365, 2611, 2574, 2322, 2325, 5073, 2942, 2984, 2931, 2941, and 2932), including evaluating: (1) attraction efficiency over a minimum of three nights during the first year of operation (*i.e.*, total number of migrating eels at the project versus the number of eels that pass upstream using the eel ramp); and (2) passage effectiveness (*i.e.*, whether 90 percent of eels pass from the entrance of the fishway to the exit of the fishway in 24 hours);[22]

- If 90 percent of eels do not pass over the upstream fishway within 24 hours during the effectiveness test, then modify the upstream eel passage facility in

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[22] Interior states that FWS may develop numerical criteria for upstream American eel passage attraction efficiency in the future when additional information about eel abundance and movement in the vicinity of the project becomes available.

consultation with FWS by, *e.g.*, changing the substrate, reducing the slope of the ramp, increasing the attraction flow, or modifying the conveyance flow;

- Provide FWS personnel and FWS-designated representatives with timely access to the fish passage facilities and to pertinent project records for the purpose of inspecting the fishways and determining compliance with the fishway prescription.

In addition to the specific fish passage measures listed above, Interior reserves authority to prescribe fishways at the project under section 18 of the FPA during the term of any new license.

Commerce's section 18 prescription would require Black Bear Hydro to provide upstream and downstream passage for anadromous fish and Atlantic salmon. Specifically, Commerce's fishway prescription would require Black Bear Hydro to:

- Modify the temporarily-installed Alden weir at the Graham Lake Development to allow at least 3 feet of water to flow over the weir under all headpond conditions, by May 1 of the third year of the new license;[23]

- Modify the downstream fish passage facility at the Ellsworth Development by May 1 of the third year of the new license to provide safe, timely, and effective passage for anadromous fish species, including the following structural modifications: (1) install a fish guidance system that consists of a rigid hanging curtain or boom that leads to the surface weir entrance(s); (2) increase the total combined flow through the surface weir(s) to five percent of station capacity (approximately 120 cfs) by modifying the fish passage entrance to provide a minimum water depth of 3 feet, with tapered walls similar to an Alden weir; (3) realign the discharge from the downstream fish downstream migrant pipe to improve the discharge angle to the spillway flume; and (4) increase the height of the sides of the spillway flume to contain the increased conveyance flow and reduce spillage;

- Provide downstream fish passage from April 1 to December 31 each year;

- Curtail operation of Unit 1 and prioritize operation of Unit 4 over Units 2 and 3 at the Ellsworth Development during the critical downstream fish passage seasons, to be determined in consultation with the resource agencies;

[23] Staff assumes that Commerce is referencing the Alden weir described in Black Bear Hydro's December 29, 2017 study report of the *Evaluation of Atlantic Salmon Smolt Passage Study*.

- Install full-depth trashrack overlays with 1-inch clear spacing over the intakes of Units 2, 3, and 4 by May 1 of the third year of the new license;

- Submit design plans for 1-inch full-depth trashrack overlays at the Ellsworth Development to the resource agencies for review and approval at least 6 months prior to the first passage season following issuance of any new license.

- Continue to operate and maintain the existing upstream fish passage facility for alosines at the Ellsworth Development from May 1 to July 31;

- Construct, operate, and maintain a swim-through fishway (*e.g.*, a vertical slot, Denil, Ice Harbor, or fishlift) that provides safe, timely, and effective upstream passage for Atlantic salmon from May 1 to November 15 at the Ellsworth and Graham Lake dams no later than year 15 of any new license;

- Meet with resource agencies annually to discuss fish passage operation, study results, and the siting, design, and construction of the new upstream fishways for Atlantic salmon;

- Continue to operate and maintain the existing upstream fish passage facility for Atlantic salmon at the Ellsworth Development from May 1 to November 15 until the prescribed upstream fish passage facilities at the Ellsworth and Graham Lake developments are operational;

- Submit design plans for alosine and Atlantic salmon fishways to the resource agencies for review and approval no later than 2 years before the anticipated operational date;

- File final as-built drawings for any new fishways with Commerce and FWS after construction is complete;

- Monitor upstream and downstream fishways at the Ellsworth and Graham Lake dams to ensure fish passage protection measures are constructed, operated, and functioning as intended for the safe, timely and effective passage of migrating fish, based on performance standards that Commerce is currently developing for alosine and Atlantic salmon.

- Develop study design plans in consultation with resource agencies to monitor the effectiveness of upstream and downstream fish passage facilities for juvenile and adult life stages of alosines and Atlantic salmon using scientifically accepted practices, beginning at the start of the first migratory season after each fish passage facility is operational and continuing for up to three years;

- Prepare and submit fish passage monitoring study reports to the resource agencies for review and consultation prior to submitting the reports to the Commission for final approval on an annual basis during the monitoring study;

- If the downstream fish passage facility fails to meet Commerce's performance standards, then modify the facility to reduce fish injury and mortality by, *e.g.*, increasing the depth of the guidance system, curtailing or shutting down turbines, or modifying the spillway and/or the ledge at the base of the dam; and

- Maintain fishways in proper working order; remove trash, logs, and material from fishways that would otherwise hinder fish passage; and perform routine maintenance before a migratory period so that fishways can be tested, inspected, and operational prior to the migratory periods.

In addition to the specific fish passage measures listed above, Commerce reserves authority to prescribe fishways at the project under section 18 of the FPA during the term of any new license.

2.4 STAFF ALTERNATIVE

Under the staff alternative, the project would be operated as proposed by Black Bear Hydro except for 9 of the proposed measures, with all but 7 of the fishway prescriptions filed by Commerce (Appendix A), and with all but 3 of the fishway prescriptions filed by Interior (Appendix B). The staff alternative for the project includes modifications of and additions to Black Bear Hydro's proposed measures as follows:

<u>Water Elevation and Minimum Flow Measures</u>

- Operate Graham Lake between the elevations of 98.5 and 103.0 feet msl during normal operation instead of operating Graham Lake between the elevations of 93.4 and 104.2 feet msl, as proposed by Black Bear Hydro;

- Pass minimum flows through the modified Alden weir at Graham Lake from April 1 through December 31, or ice-in;

<u>Downstream Fish Passage Measures</u>

- Prioritize operation of generating Units 1 and 4 over Units 2 and 3 throughout the downstream passage season for Atlantic salmon, alosines, and American eel (April 1 – December 31), as opposed to Black Bear Hydro's proposal to prioritize generating Units 1 and 4 during critical downstream passage seasons that would be determined in consultation with the resource agencies;

- Cease generation at the Ellsworth Development nightly (8 PM to 4 AM) from September 1 to October 31 to facilitate safe and timely downstream eel passage, as prescribed by Interior;

- Cease generation at the Ellsworth Development for three consecutive nights (8 PM to 4 AM) following each rain storm event exceeding 1-inch of rainfall in a 24-hour time period during the month of August, to facilitate downstream eel passage, as prescribed by Interior;

- Cease operation of generating Unit 1 during a 15-day period in the spring after water temperature in the Union River reaches 50° F to protect Atlantic salmon smolts from entrainment;

- Install a diversionary guidance boom at the Ellsworth Development, as proposed by Black Bear Hydro and prescribed by Commerce, with the following additional measures: (1) place the guidance boom in the headpond of Ellsworth Dam so that it extends at an angle from the western shore of the impoundment to a point on Ellsworth Dam that is located between the east end of the eastern powerhouse intake structure and the eastern surface weir; (2) design the curtains/panels of the guidance boom to have a maximum clear 0.12-inch spacing; and (3) construct the curtains out of lightweight yet rigid panels.

- Eliminate discharge from the spillway flume to the ledges at the toe of the dam, as prescribed by Interior;

- Construct the proposed modifications to the temporarily-installed Alden weir at Graham Lake Dam within 2 years of license issuance, as prescribed by Interior, and perform all construction activities outside of the downstream migration season of April 1 to December 31 (or ice-in) for Atlantic salmon, American eel, and alosines;

- Construct the proposed modifications to the downstream fish passage system at the Ellsworth Development (including a new diversionary guidance boom and modifications to the eastern surface weir, spillway flume, downstream migrant pipe, and plunge pool) prior to the third migration season after license issuance, as prescribed by Commerce;

- During the interim period between license issuance and implementation of the proposed and recommended modifications to the downstream fish passage facilities, monitor the forebay of Graham Lake Dam and the tailrace of

Ellsworth Dam for out-migrating alosines during the downstream passage season (June 1 – November 30) and implement generation shut down procedures at the Ellsworth Development if: (1) a school of out-migrating alosines is observed at Graham Lake following a storm event that exceeds 17 percent of the total average monthly rainfall; or (2) dead or injured alosines are observed in the tailrace of Ellsworth Dam;

<u>Upstream Fish Passage Measures</u>

- Provide upstream passage for alosines and Atlantic salmon from May 1 to November 15 of each year by operating and maintaining the existing fishway trap and truck facility at Ellsworth Dam during the term of any new license;

- Design and construct the proposed upstream fish passage ramps for American eel using the FWS's Design Criteria Manual, including that the upstream eel passage facility should: (1) consist of a covered metal or plastic volitional ramp that is lined with a wetted substrate and angled at a maximum slope of 45 degrees, with one-inch-deep resting pools that are sized to the width of the ramp and spaced every 10 feet along the length of the ramp; and (2) be sized to accommodate a maximum capacity of 5,000 eels/day;

- Construct the proposed upstream eel ramp at the Ellsworth Dam at the bedrock outcrop adjacent to the eastern end of the dam, instead of consulting with FWS and Maine DMR on the exact location of the eel ramp;

- Operate the proposed upstream eel ramps on an annual basis from June 1 to October 31, consistent with Maine DMR's 10(j) recommendation and inclusive of the dates included in Interior's prescription (June through August);

- Construct the proposed new upstream eel passage facilities at the Ellsworth and Graham Lake dams within 2 years of license issuance, as prescribed by Interior, and perform all construction activities outside of the upstream migration season of June 1 to October 31;

- Develop an upstream American eel effectiveness monitoring plan within six months of license issuance that evaluates: (1) attraction efficiency over a minimum of three nights during the first year of operation (*i.e.*, total number of migrating eels at the project versus the number of eels that pass upstream using the eel ramp); and (2) passage effectiveness (*i.e.*, whether 90 percent of eels pass from the entrance of the fishway to the exit of the fishway in 24 hours), as prescribed by Interior;

- If 90 percent of eels do not pass over the upstream fishway within 24 hours during the effectiveness test, then modify the upstream eel passage facility in consultation with FWS by, *e.g.*, changing the substrate, reducing the slope of the ramp, increasing the attraction flow, or modifying the conveyance flow, as prescribed by Interior;

- Develop and implement an effectiveness testing plan for the Atlantic salmon effectiveness testing studies proposed by Black Bear Hydro in the Species Protection Plan;

- Operate each new/modified fish passage facility for a one-season "shakedown" period and make adjustments to the facilities if they are not operating as designed;

- Modify the proposed fish passage operation and maintenance plan within 12 months of license issuance to include the following additional measures to help ensure that project fishways are operated and maintained in proper working order during the term of any new license: (1) a schedule of fishway operating times and minimum conveyance flows; (2) procedures for maintaining the downstream passage facilities in proper order and clear of trash, logs, and material that would hinder fish passage; (3) procedures for completing any anticipated maintenance before a migratory period such that fishways can be tested, inspected, and operational prior to the migratory periods, as prescribed by Interior and Commerce; (4) provisions for updating the plan on an annual basis to reflect any changes in fishway operation and maintenance for the following year;

Threatened and Endangered Species Measures

- Avoid cutting trees between June 1 and July 31 to protect roosting northern long-eared bats; and

Recreation Measures

- Revise the recreational facilities maintenance plan to provide additional detail on the recommended improvements to the fisherman access trail; to provide additional detail on Black Bear Hydro's proposal to correct the erosion problem at the Graham Lake boat ramp, including details on the size of the area that needs to be stabilized; and to require public notice of site access and the schedule for resolving any issues concerning restrictions to public access to project waters and recreation facilities.

Fishway Prescriptions Not Recommended

The staff alternative does not include the following Interior fishway prescriptions:

- Develop a downstream American eel passage effectiveness monitoring plan within six months of license issuance that includes effectiveness monitoring at the Ellsworth and Graham Lake dams using radio telemetry to determine migratory delay, route of downstream passage (*i.e.*, via surface bypasses, turbines, or spillage), immediate survival, and latent survival;

- If the downstream fish passage facilities at the Ellsworth or Graham Lake developments do not pass eels in a safe, timely, and effective manner, implement passage improvements approved by FWS, including but not limited to: (1) extending the passage season; (2) restricting generation to certain times of the day; (3) installing trashrack overlays with 0.75-inch clear spacing; (4) installing a deep bypass gate; and/or (5) constructing a new downstream eel passage facility with angled trash racks; and

The staff alternative does not include the following Commerce fishway prescriptions:

- Curtail operation of Unit 1 during the critical downstream fish passage season for alosines, to be determined in consultation with the resource agencies;

- Construct, operate, and maintain a swim-through fishway (*e.g.*, a vertical slot, Denil, Ice Harbor, or fishlift) that provides safe, timely, and effective upstream passage for Atlantic salmon from May 1 to November 15 at the Ellsworth and Graham Lake dams no later than year 15 of any new license;

- Continue to operate and maintain the existing upstream fish passage facility for Atlantic salmon at the Ellsworth Development from May 1 to November 15 until the prescribed upstream fish passage facilities at the Ellsworth and Graham Lake developments are operational;

- Monitor upstream and downstream fishways at the Ellsworth and Graham Lake dams to ensure fish passage protection measures are constructed, operated, and functioning as intended for the safe, timely, and effective passage of migrating fish, based on performance standards that Commerce is currently developing for alosine and Atlantic salmon.

- Develop study design plans in consultation with resource agencies to monitor the effectiveness of upstream and downstream fish passage facilities for juvenile and adult life stages of alosines and Atlantic salmon using scientifically accepted practices, beginning at the start of the first migratory season after each fish passage facility is operational and continuing for up to three years;

- Prepare and submit fish passage monitoring study reports to the resource agencies for review and consultation prior to submitting the reports to the Commission for final approval on an annual basis during the monitoring study; and

- If the downstream fish passage facility fails to meet Commerce's performance standards, then modify the facility to reduce fish injury and mortality by, e.g., increasing the depth of the guidance system, curtailing or shutting down turbines, or modifying the spillway and/or the ledge at the base of the dam.

Section 10(j) Measures Not Recommended[24]

The staff alternative does not include the following section 10(j) recommendations submitted by Maine DMR:

- Operate the proposed downstream fish passage facility for diadromous fish species within three years of license issuance;

- Cease operation of Unit 1 and operate Unit 4 before operating Units 2 and 3 at the Ellsworth Development during critical downstream fish passage seasons determined in consultation with the resource agencies within 3 years of license issuance

- Provide FWS personnel, and FWS-designated representatives access to the fish passage facilities at the project and to pertinent project operational records to document compliance with the fishway prescription;

- Modify the eel passage operating schedule during the term of the license based on empirical passage data developed for the project and/or a predictive model for eel movements through the project;

- Test the effectiveness of the modified downstream fish passage facilities at the Ellsworth and Graham Lake developments for passage of adult eels using radio telemetry methods; and

[24] *See* section 5.3, *Summary of Section 10(j) Recommendations*, for additional details on the recommendations.

- Test the effectiveness of the downstream fish passage facilities at the Ellsworth and Graham Lake developments to determine if the downstream fish passage facilities meet performance standards for Atlantic salmon developed through the course of consultation under the ESA, and if the performance standards are not met, implement additional measures including increasing the depth of the Worthington fish guidance system, curtail project operation, spill or nighttime shutdowns; and modifying the ledge/plunge pool and spillway surfaces.

2.5 STAFF ALTERNATIVE WITH MANDATORY CONDITIONS

We recognize that the Commission is required to include all section 18 fishway prescriptions in any license issued for the project. Therefore, the staff alternative with mandatory conditions includes all of the section 18 fishway prescriptions not included in the staff alternative discussed above in section 2.4.

2.6 ALTERNATIVES CONSIDERED BUT ELIMINATED FROM DETAILED ANALYSIS

The following alternatives were considered but have been eliminated from further analysis because they are not reasonable in the circumstances of this case: (1) issuing a non-power license, (2) federal government takeover of the project, and (3) retiring the project.

2.6.1 Issuing a Non-Power License

A non-power license is a temporary license that the Commission would terminate when it determines that another governmental agency will assume regulatory authority and supervision over the land and facilities covered by the non-power license. At this point, no agency has suggested a willingness or ability to do so. No party has sought a non-power license for the project and we have no basis for concluding that the project should no longer be used to produce power.

2.6.2 Federal Government Takeover of the Project

Federal takeover and operation of the project would require Congressional approval. While that fact alone would not preclude further consideration of this alternative, there is currently no evidence to indicate that federal takeover should be recommended to Congress. No party has suggested federal takeover would be appropriate, and no federal agency has expressed an interest in operating the project.

2.6.3 Project Decommissioning

As the Commission has previously held, decommissioning is not a reasonable alternative to relicensing a project in most cases, when appropriate protection, mitigation, and enhancement measures are available.[25] The Commission does not speculate about possible decommissioning measures at the time of relicensing, but rather waits until an applicant actually proposes to decommission a project, or there are serious resource concerns that cannot be addressed with appropriate license measures, making decommissioning a reasonable alternative to relicensing.[26] This is consistent with the National Environmental Policy Act (NEPA) and the Commission's obligation under section 10(a) of the FPA to issue licenses that balance developmental and environmental interests.

Project retirement could be accomplished with or without dam removal.[27] Either alternative would involve denial of the license application and surrender or termination of the existing license with appropriate conditions.

No participant recommended project retirement in response to the Commission's February 9, 2018 notice accepting the application and soliciting protests, comments, recommendations, terms and conditions, and prescriptions, and we have no basis for recommending project retirement. The Ellsworth Project is a source of clean, renewable energy. This source of power would be lost if the project were retired. There also could

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[25] *See, e.g.*, *Eagle Crest Energy Co.*, 153 FERC ¶ 61,058, at P 67 (2015); *Public Utility District No. 1 of Pend Oreille County*, 112 FERC ¶ 61,055, at P 82 (2005); *Midwest Hydro, Inc.*, 111 FERC ¶ 61,327, at PP 35-38 (2005).

[26] *See generally Project Decommissioning at Relicensing; Policy Statement*, FERC Stats. & Regs., Regulations Preambles (1991-1996), ¶ 31,011 (1994); *see also City of Tacoma, Washington*, 110 FERC ¶ 61,140 (2005) (finding that unless and until the Commission has a specific decommissioning proposal, any further environmental analysis of the effects of project decommissioning would be both premature and speculative).

[27] In the unlikely event that the Commission denies relicensing of a project or a licensee decides to surrender an existing project, the Commission must approve a surrender "upon such conditions with respect to the disposition of such works as may be determined by the Commission." 18 C.F.R. § 6.2 (2019). This can include simply shutting down the power operations, removing all or parts of the project (including the dam), or restoring the site to its pre-project condition.

be significant costs associated with retiring the project's powerhouse and appurtenant facilities.

Project retirement without dam removal would involve retaining the dam and disabling or removing equipment used to generate power. Certain project works could remain in place and could be used for historic or other purposes. This approach would require the State of Maine to assume regulatory control and supervision over the remaining facilities. However, no participant has advocated for this alternative, nor do we have any basis for recommending it. Removing the dam would be more costly than retiring it in place, and removal could have substantial, negative environmental effects.[28]

3.0 ENVIRONMENTAL ANALYSIS

This section includes: (1) a general description of the project vicinity, (2) an explanation of the scope of our cumulative effects analysis, and (3) our analysis of the proposed action and other recommended environmental measures. Sections are organized by resource area (aquatic, recreation, *etc.*). Historic and current conditions are described under each resource area. The existing conditions are the baseline against which the environmental effects of the proposed action and alternatives are compared, including an assessment of the effects of the proposed protection, mitigation, and enhancement measures, and any cumulative effects of the proposed action and alternatives. Staff conclusions and recommended measures are discussed in section 5.2, *Comprehensive Development and Recommended Alternative*.[29]

3.1 GENERAL DESCRIPTION OF THE RIVER BASIN

The Union River from its headwaters to the Ellsworth Dam has a drainage area of approximately 547 square miles. The East Branch of the Union River and West Branch of the Union River converge at Graham Lake. The source of the West Branch of the

[28] Black Bear Hydro's Upstream Fish Passage Alternatives Study report includes cost estimates for project decommissioning. According to the study report, the estimated cost of decommissioning the project and fully removing the Ellsworth and Graham Lake dams is $22.7 million. The estimated cost of decommissioning the project and partially removing the Ellsworth and Graham Lake dams is $11.2 million. *See* Black Bear Hydro's December 30, 2015 Final License Application, Appendix E-7, at 41.

[29] Unless otherwise indicated, our information is taken from the application for license filed by Black Bear Hydro on December 30, 2015, Black Bear Hydro's May 12, 2016 response to staff's request for additional information, Black Bear Hydro's September 28, 2018 Atlantic Salmon Draft Biological Assessment and Species Protection Plan, and Black Bear Hydro's October 10, 2018 response to staff's request for additional information.

Union River is Great Pond; the source of the Middle Branch is Upper Middle Branch Pond (Alligator Lake); and the source of the East Branch is Rocky Pond (see Figure 1). In addition, Graham Lake receives flow from the outlets of Beech Hill Pond, Webb Pond, Green Lake, and several smaller tributaries. Lake Leonard receives flow from the outlet of Branch Lake and several smaller tributaries. From Lake Leonard, the Union River flows approximately three miles downstream to the Union River Bay, which is part of the Gulf of Maine in the Atlantic Ocean.

Graham Lake Dam is located at approximately river mile 9, and the Ellsworth Dam is located at approximately river mile 3, which is also the head of tide. The two project dams are the only two dams on the main stem of the Union River. Green Lake Dam, which is part of the FERC-licensed Green Lake Project No. 7189, is the only other operational hydroelectric dam in the Union River basin. There are also five retired, unlicensed hydroelectric projects upstream of the project.

The Union River basin has a relatively flat topography representative of a formerly-glaciated coastal drainage area, with flat or gently rolling plains and numerous lakes, ponds, and streams. The basin contains a few bedrock ridges and monadnocks.[30] Land in the project vicinity is predominantly rural and lightly developed, except for the City of Ellsworth, which is an area of relatively dense population within Hancock County, Maine. The climate of the project is strongly influenced by the Gulf of Maine, resulting in lower summer and higher winter temperatures than in areas found as little as 20 miles inland. On average, the warmest month is July (58 Fahrenheit (°F) to 78°F) and the coolest month is January (11°F to 30°F). Precipitation occurs year-round and is typically distributed evenly throughout the year, although some flooding may occur in late winter and early spring due to rain and snowmelt events. The average annual precipitation is 46.8 inches.

3.2 SCOPE OF CUMULATIVE EFFECTS ANALYSIS

According to the Council on Environmental Quality's regulations for implementing the National Environmental Policy Act (40 C.F.R. § 1508.7), a cumulative effect is the impact on the environment that results from the incremental impact of the action when added to other past, present, and reasonably foreseeable future actions, regardless of what agency (federal or non-federal) or person undertakes such other actions. Cumulative effects can result from individually minor, but collectively significant actions taking place over a period of time, including hydropower and other land and water development activities.

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[30] A monadnock, also known as an inselberg, is an isolated small mountain that rises above a plain.

Based on information provided in the license application, we have identified migratory fish (including alewife, American shad, Atlantic salmon, Atlantic sturgeon, American eel, blueback herring, sea lamprey, shortnose sturgeon, and striped bass), aquatic habitat, wetlands, and water quality, as resources that could be cumulatively affected by the proposed continued operation and maintenance of the project in combination with other hydroelectric projects and activities in the Union River Basin.

3.2.1 Geographic Scope

The geographic scope of the cumulative effects analysis defines the physical limits or boundaries of the proposed action's effects on the resource, and contributing effects from other hydropower and non-hydropower activities within the Union River Basin. We have identified the geographic scope for migratory fish species to include the Union River Basin from Union River Bay upstream to Alligator Lake and Brandy Pond on the West Branch of the Union River, to Upper Middle Branch Pond on the Middle Branch of the Union River, and to Upper Lead Mountain Pond on the Starvation Branch. We have identified the geographic scope for aquatic habitat and wetlands to include the Union River Basin from the upstream extent of the Ellsworth Project boundary to the mouth of the Union River at Union River Bay.

3.2.2 Temporal Scope

The temporal scope of our cumulative effects analysis includes a discussion of past, present, and reasonably foreseeable future actions and their effects on each resource that could be cumulatively affected. Based on the potential term of a new license, the temporal scope looks 30 to 50 years into the future, concentrating on the effects on the resources from reasonably foreseeable future actions. The historical discussion is limited, by necessity, to the amount of available information. We identified the present resource conditions based on the license application, agency comments, and comprehensive plans.

3.3 PROPOSED ACTION AND ACTION ALTERNATIVES

In this section, we discuss the project-specific effects of the project alternatives on environmental resources. For each resource, we first describe the affected environment, which is the existing condition and baseline against which we measure project effects. We then discuss and analyze the site-specific environmental issues.

Only the resources that would be affected, or about which comments have been received, are addressed in detail in this EA. Based on this, we have determined that geology and soil resources; aquatic resources; terrestrial resources; threatened and endangered species; land use, recreation, and aesthetic resources; and cultural resources may be affected by the proposed action and alternatives. We have not identified any substantive issues related to socioeconomics associated with the proposed action;

therefore, socioeconomics is not addressed in the EA. We present our recommendations in section 5.2, *Comprehensive Development and Recommended Alternative*.

3.3.1 Geology and Soil Resources

3.3.1.1 Affected Environment

The Ellsworth Project extends across three biophysical regions in the State of Maine: the Central Interior, Eastern Lowlands, and Penobscot Bay regions. The subsurface geology within these biophysical regions consists of sedimentary and metamorphic bedrock, granite, and alternating bands of metasedimentary and metavolcanic rocks.

Soils within the Union River Basin consist mainly of marine clays in the low-lying areas, and glacial tills above. The tills are of a coarse sandy or stony nature, are well to excessively drained, and contain hardpan about 2 to 3 feet below the surface. Soils in the immediate vicinity of the project consist of four dominate soil association units: Lamoine-Lyman-Dixfield (loamy and clayey soils deposited over bedrock); Hermon-Dixfield-Lyman (sandy loams with high stone and boulder context, on upland till ridges); Colton-Sheepscot-Adams (deep, moderately-to-excessively drained soils formed in sand and gravel); and the Dixfield-Marlow-Brayton (deep, compact, upland glacial till). The majority of the project lies within the Lamoine-Lyman-Dixfield unit.

Sections of the shoreline along Graham Lake consist of highly erodible soils, including sand and gravel. Erosion is occurring in select areas along the shoreline of Graham Lake, including bank slumps located primarily along the western shore of the impoundment. Small amounts of localized erosion are also occurring around the shoreline. The shoreline of Lake Leonard, which consists of ledge and stony glacial soils with gentle to moderate slopes, is less susceptible to erosion, and there is no evidence indicating any notable amount of erosion along the shoreline or other areas surrounding the Ellsworth development.

3.3.1.2 Environmental Effects

Black Bear Hydro proposes to continue to maintain Lake Leonard between the elevations of 65.7 and 66.7 feet msl (1-foot drawdown on an annual basis), and maintain Graham Lake between the elevations of 93.4 and 104.2 feet msl (10.8-foot drawdown on an annual basis). Black Bear Hydro also proposes the following measures that could require land disturbance: (1) installing upstream eel and salmon passage facilities at Ellsworth and Graham Lake dams; (2) constructing and maintaining a new portage trail around the west end of Graham Lake Dam; and (3) improving and maintaining a fisherman's downstream access trail on the east side of Graham Lake Dam.

Commerce's and Interior's fishway prescriptions, and Maine DMR's section 10(j) recommendation include the following measures that could require land disturbance and impoundment drawdowns: (1) install full-depth trashrack overlays at the generating unit intakes at the Ellsworth Dam; (2) modify the existing surface bypass weirs at the Ellsworth and Graham Lake dams by increasing the total fishway flow through the facility; and (3) increase the height of the sides of the spillway flume at the Ellsworth Dam to contain the increased conveyance flow and reduce spillage.

Commerce's fishway prescription would also require Black Bear Hydro to install upstream fish passage facilities at the Ellsworth and Graham Lake dams that pass Atlantic salmon. Commerce's prescription also requires, and Maine DMR recommends, that Black Bear Hydro install a fish guidance system leading to a bypass surface entrance at the Ellsworth Development. Interior's fishway prescription would also require, and Maine DMR recommends, that Black Bear Hydro construct upstream fish passage ramps for American eel at the Ellsworth and Graham Lake dams.

Our Analysis

Land Disturbing Activities

Land disturbance and in-water construction can lead to shoreline erosion and sedimentation that could adversely affect water quality. Areas that are cleared of stabilizing vegetation to make way for recreational enhancements, including through the construction and maintenance of a new canoe portage trail, would be exposed to an increased risk of erosion and sedimentation. Sediments from construction materials and equipment could also be released into the river, impoundments, and wetland areas during installation of fish passage facilities required by Commerce, Interior, and Maine DMR. Sediments can clog stream channels and affect aquatic resources by covering fish spawning habitat and reducing downstream water quality. The movement of personnel and heavy equipment in and around water during construction would also likely result in localized short-term shoreline erosion and sedimentation.

Even though these activities have the potential to contribute to erosion of soils and sedimentation, any potential effects on soils from construction activities would be temporary and limited to the construction footprint. The Commission's standard terms and conditions for a hydropower license require a licensee to take reasonable measures in the construction, maintenance, and operation of a project to prevent stream sedimentation and soil erosion on lands adjacent to streams or other waters.

Impoundment Drawdowns

The presence of erodible soils and water level drawdown associated with project operation and maintenance may contribute to shoreline erosion within Graham Lake. In addition, wave and ice movement on the Graham Lake impoundment could contribute to shoreline erosion at Graham Lake. In 1990, the licensee conducted a study to determine, in part, the effectiveness of a water elevation management plan in controlling shoreline erosion. The study confirmed that while a majority of the shoreline at Graham Lake has been subject to erosion forces since the establishment of the original impoundment, the target operating curve that is used by the licensee to guide seasonal drawdowns and impoundment refilling (see section 2.1.3, *Existing Project Operation*) has helped reduce the erosion conditions and reduce the risk of erosion. The study pointed out that while erosion continues to take place along some sections of the shoreline, the erosion is predominantly due to wave action under the maximum water levels that occur in the spring.

Under Black Bear Hydro's proposal, Graham Lake would still be maintained between 93.4 and 104.2 feet msl during normal project operation. The impoundment would continue to be drawn down during the summer and winter and refilled in the fall and spring. Therefore, shoreline erosion would continue at similar rates compared to existing conditions.

Several landowners recommend that the maximum lake elevation of 104.2 feet msl be reduced by as much as two feet to help alleviate shoreline erosion from high water levels in the spring. The landowners' recommendation could help reduce the potential for shoreline erosion at the higher elevation. The effects of shoreline erosion on water quality, terrestrial resources, and recreational and land used resources are discussed below in sections 3.3.2, (*Aquatic Resources*), 3.3.3 (*Terrestrial Resources*), and 3.3.5 (*Land Use, Recreation, and Aesthetics*), respectively.

3.3.2 Aquatic Resources

3.3.2.1 Affected Environment

Water Quantity

Graham Lake is located at the confluence of the East and West branches of the Union River and serves as the project's storage reservoir. Graham Lake is approximately 10 miles long and has an estimated maximum surface area of 10,042 acres at an elevation of 104.2 feet msl. The maximum depth of Graham Lake is 47 feet, and the average depth is 17 feet. However, extensive shallow flats exist at several locations around the lake that become exposed at the lower end of the lake's operating range (see Figure 4), which is between 93.4 and 104.2 feet msl and varies seasonally as shown in Figure 5. The operating range provides approximately 133,150 acre-feet of usable storage.

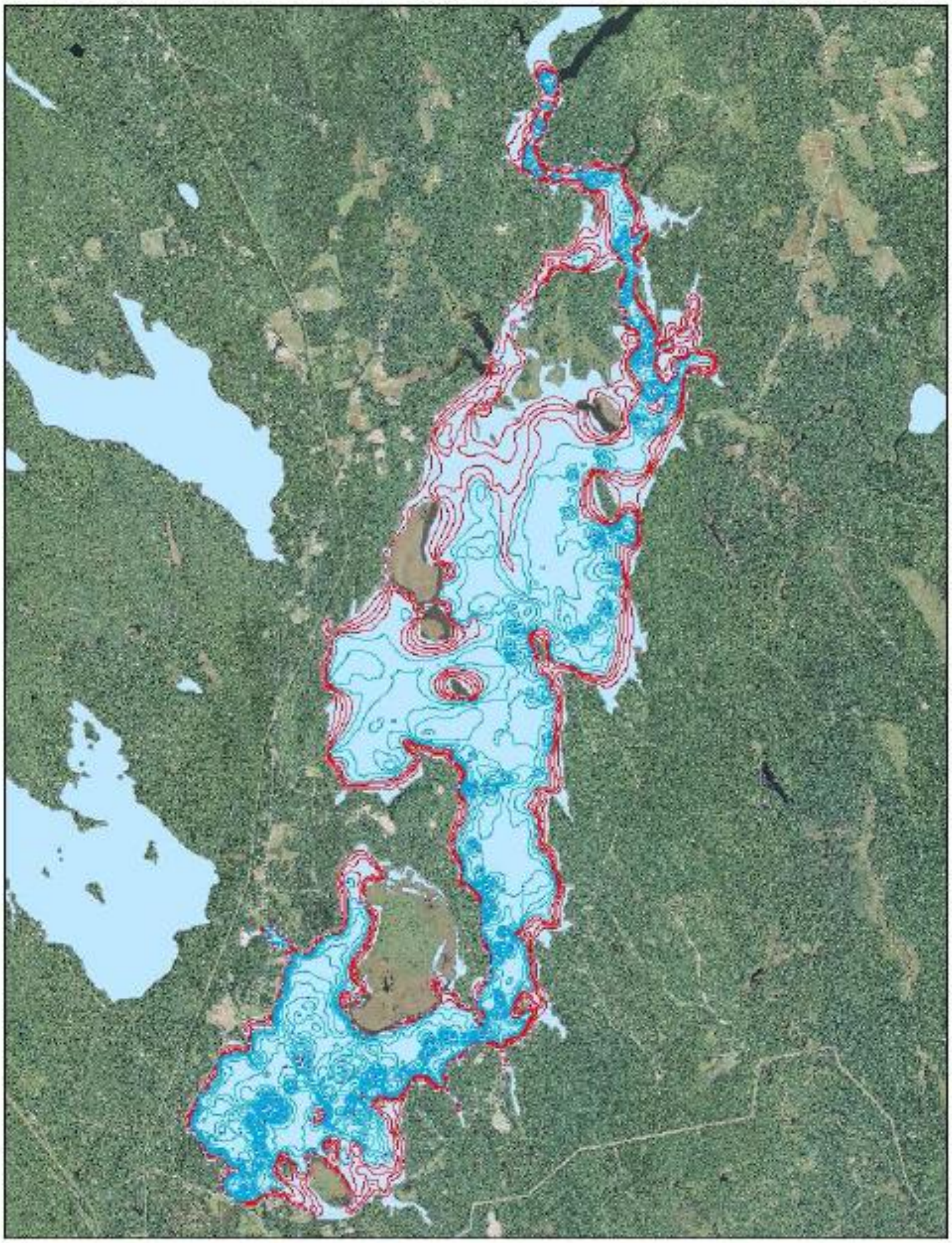

Figure 4. Bathymetry of Graham Lake. Contour lines shown in red identify elevations where land is exposed at 93.4 feet msl (1929), which is the lower limit of the lake's operating range under the current license (Source: Maine DIFW[31]).

[31] *See* Maine DIFW's November 2, 2017 letter.

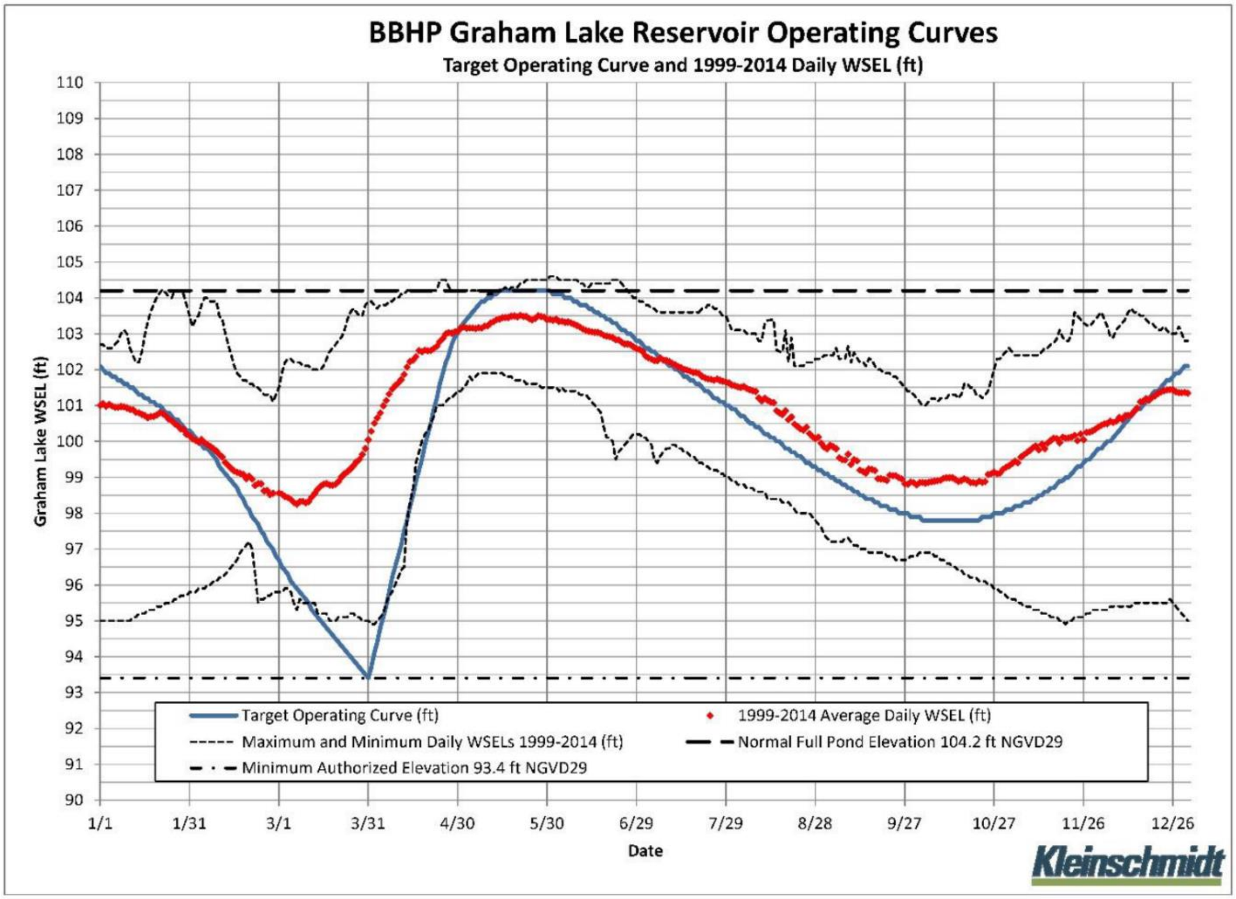

Figure 5. Graham Lake Operating Curves. (Source: Black Bear Hydro, 2015b).

The estimated average daily flow for the Union River at Graham Lake is 1,114 cfs.[32] The Union River generally exhibits highest mean monthly flows during April and lowest mean monthly flows during August (see Table 1). The current license requires seasonal minimum flow releases from both impoundments. Black Bear Hydro must release 105 cfs from July 1 to April 30 and 250 cfs from May 1 to June 30. Flows exceed 2,460 cfs (*i.e.*, the maximum hydraulic capacity of the project) about 10.6 percent of the time, 250 cfs about 82.9 percent of the time, and 105 cfs about 96.9 percent of the time.

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[32] There are no stream gages on the Union River. Therefore, staff calculated flow statistics using data collected from 1971 through 2016 at U.S. Geological Survey gage no. 01022500, located on the Narraguagus River in Cherryfield, Maine (approximately 23 miles east of Graham Lake). Staff prorated the Narraguagus River flow data by a factor of 2.14 to compensate for the difference in drainage area at Graham Lake Dam (486 square miles) and the USGS gage (227 square miles).

Flow exceedance rates based on actual generation releases are slightly different than the estimated average daily flows using the prorated Narraguagus River flows. Based on hourly generation data from August 1, 2007 to December 31, 2015, flows exceed 2,460 cfs about 4.2 percent of the time, 250 cfs about 87.5 percent of the time, and 105 cfs 100.0 percent of the time.

Table 1. Mean, minimum, and maximum monthly discharge for the Union River at Graham Lake Dam estimated from prorated data from the Narraguagus River using information from U.S. Geological Survey gage no. 01022500.

Month	Mean Monthly Flow (cfs)	Minimum Monthly Flow (cfs)	Maximum Monthly Flow (cfs)
January	1,092	165	9,377
February	1,027	176	7,215
March	1,754	240	14,023
April	2,561	492	13,852
May	1,418	283	14,537
June	855	150	7,665
July	483	92	6,102
August	356	54	5,438
September	385	15	7,536
October	769	59	11,390
November	1,245	98	9,420
December	1,434	110	13,188

(Source: USGS, 2018, as modified by staff).

Lake Leonard is located approximately three miles downstream of Graham Lake Dam, is one mile long, and has a surface area of approximately 90 acres at 66.7 feet msl. The maximum and average depths of Lake Leonard are 55 and 25 feet, respectively. The operational range of Lake Leonard is between 65.7 feet and 66.7 feet msl, which results in an estimated 2,456 acre-feet of storage. The water surface elevation of Lake Leonard varies within the one-foot operating range in response to releases from Graham Lake.

Water Quality

State Water Quality Classifications

Maine's water quality laws (38 M.R.S. §§ 464 *et. seq.*) establish the state's classification system for surface waters. The Union River from the outlet of Graham Lake to the tidewater, excluding Lake Leonard, is classified as Class B.[33] Class B waters must be of such quality that they are suitable for the designated uses of drinking water supply after treatment, fishing, agriculture, recreation in and on the water, industrial processes, cooling water supply, hydroelectric power generation, navigation, and unimpaired habitat for fish and other aquatic life.[34] The dissolved oxygen (DO) content of Class B waters may not be less than 7 milligrams per liter (mg/L) or 75 percent of saturation, whichever is higher. Maine has not established water quality standards for temperature, although DO percent saturation is dependent on temperature. The Maine Class B water quality standards for DO and statewide criteria for pH are shown in Table 2. Currently, Maine has no standards for nutrient concentrations in freshwater, although draft criteria for nutrient concentrations and environmental response indicators (*i.e.*, chlorophyll a[35] and Secchi disk depth[36]) are available (Maine DEP, 2012a) (see Table 2). Discharges to Class B waters may not cause adverse impact to aquatic life, such that the receiving waters must be of sufficient quality to support all aquatic species indigenous to the receiving water without detrimental changes in the resident biological community.

Maine DEP classifies Graham Lake and Lake Leonard as "GPA" waters, which are defined, in part, as any inland body of water artificially formed or increased with a surface area exceeding 30 acres.[37] There are no numeric water quality standards for DO for GPA waters, but water quality conditions in hydropower impoundments classified as

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[33] Maine Statute, Title 38, § 467(18)(A) (2017).

[34] Maine Statute, Title 38, § 465(3) (2017).

[35] Chlorophyll *a* is a pigment in plants that is central to photosynthesis and can serve as a measure of the abundance of phytoplankton and a reflection of the biological productivity of the water body.

[36] Secchi depth is a measure of water transparency. To measure Secchi depth, an 8-inch disk with a black and white pattern is lowered into the water column until it is no longer visible from the surface and then the disk is raised until it is visible again. The depths at which the disk disappears and reappears are averaged and reported as the Secchi depth.

[37] Maine Statute, Title 38, § 480-B(5) (2017).

GPA waters must satisfy Class C aquatic life requirements, which states that discharges to Class C waters may cause some changes to aquatic life, except that the receiving waters must be of sufficient quality to support all species of fish indigenous to the receiving waters and maintain the structure and function of the resident biological community.[38]

Table 2. Established and draft Maine water quality standards for applicable parameters.

Parameter	Class B Criteria	GPA Criteria
Statutory Criteria		
DO[1]	7.0 milligrams per liter (mg/l) or 75 percent saturation. From October 1 to May 14, the 7-day mean DO concentration may not be less than 9.5 mg/l, and the 1-day minimum DO concentration may not be less than 8.0 mg/l in identified fish spawning areas.	NA
pH[1, 2]	6.0 to 8.5	6.0 to 8.5
Draft Criteria		
Total Phosphorus[3]	≤ 30 µg/L	≤ 15 µg/L
Chlorophyll a[3]	≤ 8 µg/L	≤ 8 µg/L
Secchi Disk Depth[2, 3]	≥2.0 meters	≥2.0 meters

[1] Maine Statute, Title 38, § 465.
[2] Criteria apply to all Maine waters.
[3] Maine DEP (2012a).

Water Quality Monitoring

Black Bear Hydro conducted water quality studies in 2013 to collect information on water quality in the vicinity of the project,[39] including: (1) collecting baseline lake trophic data in the two project impoundments; (2) collecting baseline DO and water temperature data in the Graham Lake tailrace; and (3) sampling benthic

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[38] Maine Statute, Title 38, § 464(9-A)(D) and 465(4)(C) (2017).

[39] *See* Commission staff's September 4, 2013 study plan determination.

macroinvertebrates in the Union River downstream of Graham Lake Dam. The objectives of the water quality monitoring study was to update baseline information and document DO concentrations, water temperature, and water quality conditions upstream of the Ellsworth Development. The objective of the macroinvertebrate study was to collect information on the aquatic macroinvertebrate community in the Union River downstream of Graham Lake Dam to assess the community in terms of Maine's aquatic life standards to confirm the Class B water quality classification.

Graham Lake

Black Bear Hydro collected water quality samples from three monitoring stations that were located in the deepest area of the northern, central, and southern sections of Graham Lake (see Figure 6) every two weeks from late April through late October 2013. At each station, Black Bear Hydro collected water temperature and DO profiles at 1-meter intervals. Black Bear Hydro also measured Secchi depth, chlorophyll *a*, total phosphorus, and pH.

Temperature and DO concentrations were similar among the three stations (see Table 3). During the survey period, water temperature in the project's impoundment ranged from 48 °F to 84 °F. DO concentrations ranged from 0.3 to 12.7 mg/L. Temperature and DO profiles indicated thermal stratification[40] occurred two to five times during the study at each station with stratification occurring more frequently at the southern station. Stratification occurred in late June, July, and August. The thermocline generally occurred at 10 feet at the northern and central stations and either at 13 or 36 feet at the southern station. The lowest observed DO values occurred near the bottom of the water column when the impoundment was stratified.

[40] Thermal stratification is a natural phenomenon that occurs when water bodies form distinct thermal layers, including a warm surface layer (epilimnion), a layer with an abrupt change in temperature (thermocline), and a cool dense lower layer (hypolimnion). A thermocline is identified by a rapid decrease in temperature as depth increases, typically greater than 1 degree Celsius per meter of depth. Persistent stratification can result in low DO concentrations in the lower part of the water column.

Figure 6. Graham Lake water quality monitoring stations. (Source: Google Earth, as modified by staff)

Table 3. The mean for water quality parameters in Graham Lake, mainstem Union River, and Lake Leonard during the 2013 survey. Minimum and maximum values are shown in parentheses.

Water Quality Parameter	Station 3 (north)	Station 1 (central)	Station 2 (south)	Graham Lake Tailrace[1]	Lake Leonard
Depth[2] (ft)	19.4 (11.5-24.6)	33.9 (14.8-42.7)	31.3 (14.8-42.7)	12.2 (9.8-13.1)	48.6 (42.7-55.8)
Temperature (°F)	65.0 (49.1-77.4)	65.5 (48.0-78.4)	65.3 (47.7-83.7)	72.0 (66.6-78.4)	66.0 (57.7-75.4)
DO (mg/L)	8.3 (4.1-12.1)	8.2 (3.3-12.5)	7.8 (0.3-12.7)	9.1 (8.3-10.4)	7.6 (0.4-10.1)
pH	6.7 (6.6-6.8)	6.8 (6.6-6.9)	6.8 (6.5-6.9)	nc	6.8 (6.7-6.9)
Total phosphorus (µg/L)	17.4 (6.0-28.0)	15.5 (5.5-26.0)	16.3 (4.5-28.0)	nc	14.6 (4.8-19.0)
Chlorophyll (µg/L)	2.4 (1.1-4.8)	2.2 (1.0-3.9)	2.3 (1.1-3.9)	3.3 (2.0-5.1)	2.4 (1.2-3.4)
True color (PCU)	89.1 (53.0-121.0)	73.7 (48.0-104.0)	62.8 (39.0-95.0)	nc	67.8 (56.0-92.0)
Turbidity (NTU)	3.57 (2.27-6.62)	3.05 (2.15-4.44)	3.27 (2.19-7.53)	nc	2.59 (1.60-3.78)
Secchi depth (meters)	1.7 (0.7-2.6)	1.7 (1.0-2.6)	1.9 (1.0-2.9)	2.2 (1.7-2.7)	2.1 (1.5-2.5)

"nc" = not collected.

[1] The values shown for the Graham Lake tailrace are averages of the morning and afternoon samples.

[2] The depth at each sampling location varied during the survey. However, Black Bear Hydro collected data from greater depths at each location from late June through September when stratification and low DO conditions were more likely to develop. (Source: Black Bear Hydro, 2014, as modified by staff).

Chlorophyll *a*, total phosphorus, turbidity, and Secchi depth were also similar among stations and exhibited seasonal patterns (see Table 3). Chlorophyll *a* ranged from 1.0 to 4.8 µg/L. Chlorophyll *a* was lowest in April, peaked during August, and declined to early October. Total phosphorus ranged from 4.5 to 28 µg/L. The highest total phosphorus values occurred in April and October, and the lowest occurred during June.

Turbidity[41] ranged from 2.15 to 7.53 NTU with the highest values occurring in mid to late-October. Secchi depth ranged from 0.7 to 2.9 with the lowest (*i.e.*, shallowest) values occurring in April and October and the highest values occurring in July.

The true color values Black Bear Hydro reported indicate that the water in Graham Lake is strongly colored.[42] True color values consistently declined from the northern station to the southern station. True color values also varied seasonally during the study with the lowest values observed in April and May and the highest values observed in September.

Maine DEP stated that additional analysis may be required to assess overall water quality in Graham Lake.[43] Chlorophyll *a* concentrations and pH appear consistent with the established draft criteria, but Secchi depth and total phosphorus concentrations were not always consistent with the draft criteria. Values for total chlorophyll *a*, phosphorus, and Secchi depth indicate that the impoundment could be characterized as mesotrophic[44]

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[41] Turbidity is reported in several different units, including nephelometric turbidity units (NTUs). Turbidity is also reported in total suspended solids (TSS) and suspended particulate matter (SPM), which are equivalent and are measured in mg/L. Measurements reported in NTUs and TSS are not always directly comparable, but an approximate rule of thumb is 1 mg/L TSS (or SPM) is equivalent to 1 to 1.5 NTUs (Lakesuperiorstreams, 2009). Secchi depth is a measure of water transparency that cannot be directly compared to measures of turbidity, but turbid water has low transparency and would have a shallow Secchi depth.

[42] True color is measured after filtering the water sample and represents the color caused by dissolved material, such as tannins, humic acid, and fulvic acid. When decaying plant material comes in contact with water, these compounds dissolve into the water and impart a brown color, which is similar to what happens while steeping tea leaves. Because water color affects light penetration into the water column, water color can reduce water transparency and Secchi depth.

[43] *See* Maine DEP's October 7, 2015 letter.

[44] The trophic level of a body of water (lake, impoundment, river, or stream) describes the amount of dissolved nutrients in the water, which affects the amount of phytoplankton in the water. For example, an oligotrophic impoundment is nutrient-poor and has low phytoplankton productivity. Conversely, a eutrophic impoundment is nutrient-rich and has high phytoplankton productivity. A mestrophic impoundment is one that has a moderate amount of dissolved nutrients and phytoplankton productivity. The high nutrient levels in a eutrophic impoundment can produce nuisance or harmful algal blooms to aquatic life. The high phytoplankton production in a eutrophic

based on Maine's lake trophic status guidelines (Maine DEP, 2012b). Based on the 2013 study results, Maine DEP concludes that Graham Lake is turbid, but does not show signs of nutrient enrichment, and the trophic level is stable or declining (*i.e.*, the lake is not becoming eutrophic).[45]

The Lake Stewards of Maine (Lake Stewards) have periodically collected water quality data from Graham Lake from 1978 to 2016 at the three stations Black Bear Hydro monitored in the 2013 water quality study.[46] The Graham Lake water quality data Black Bear Hydro collected in 2013 are consistent with historical and more recent data collected by the Lake Stewards (see Table 4). The Lake Stewards measured total phosphorus and chlorophyll *a* at all three stations in 2003. Total phosphorus concentration was similar in 2003 and 2013, but chlorophyll *a* was generally higher in 2003. True color values recorded by the Lake Stewards were lower than those Black Bear reported. However, the Lake Stewards only measured true color in July and August, and the values shown in Table 4 are consistent with those recorded by Black Bear in those months. In addition, the Lake Stewards collected water temperature and DO profiles once during August in 1998, 2003, and 2016 at the central station and in 1978 and 2014 at the southern station. The Lake Stewards observed thermal stratification at the central station in 1998: DO was 6.6 mg/L at the bottom despite the stratification. Thermal stratification at the southern station in 1978 resulted in DO concentrations of 0.3 to 0.4 mg/L in the lower 10 feet of the water column.

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impoundment can cause low DO concentrations near the bottom when the phytoplankton die, and settle to the bottom to decompose.

[45] *See* Maine DEP's October 7, 2015 letter.

[46] The Lake Stewards is a non-profit organization whose mission is to help protect Maine lakes through widespread citizen participation in the gathering and dissemination of scientific information pertaining to lake health. The Lake Stewards collect water quality data from Maine lakes in partnership with Maine DEP and the U.S. Environmental Protection Agency (EPA). The Lake Stewards use the same data collection protocols as Maine DEP and maintain a water quality database using an EPA-approved quality management plan to help ensure data integrity (Maine DEP, 2004).

Table 4. The mean for water quality parameters in Graham Lake based on data collected by the Lake Stewards. Minimum and maximum values are shown in parentheses.

Station	Year	Temperature (°F)	DO (mg/L)	Total phosphorus (µg/L)	Chlorophyll (µg/L)	True Color (PCU)
Station 3 (north)	2003	nc	nc	16	5.6 (5.1-6.0)	50 (48-52)
Station 1 (central)	1998	73.5 (72.1-76.3)	7.1 (6.6-8.0)	17	4.5	nc
	2003	73.4 (71.8-74.3)	7.0 (5.7-7.7)	14	4.3 (3.4-5.6)	51 (49-55)
	2016	73.7 (72.9-75.4)	7.8 (7.2-8.4)	21	3.3	57
Station 2 (south)	1978	68.4 (54.0-76.1)	6.0 (0.3-8.9)	nc	3.6	nc
	2003	nc	nc	17	5.6 (3.4-6.1)	44 (40-47)
	2014	72.9 (71.2-77.7)	7.5 (7.0-8.1)	nc	nc	nc

"nc" = not collected.
(Source: Maine DEP 2018a; 2018b, as modified by staff).

The Secchi depths observed by Black Bear Hydro and the Lake Stewards in Graham Lake are frequently shallower than Maine DEP's draft Secchi depth criterion of 2 meters. According to data from Maine DEP and the Lake Stewards, Graham Lake is much more turbid than other lakes in Maine monitored by the Lake Stewards (see Figure 7). Graham Lake's shallow Secchi depth appears to be related to suspended sediment in the water column rather than phytoplankton abundance because Graham Lake has higher total phosphorus concentrations but lower chlorophyll *a* concentrations than many other lakes in Maine. Furthermore, Secchi depth varies seasonally (see Figure 8). Secchi depth is often shallowest during May and June, deeper during July and August, and shallower during September.

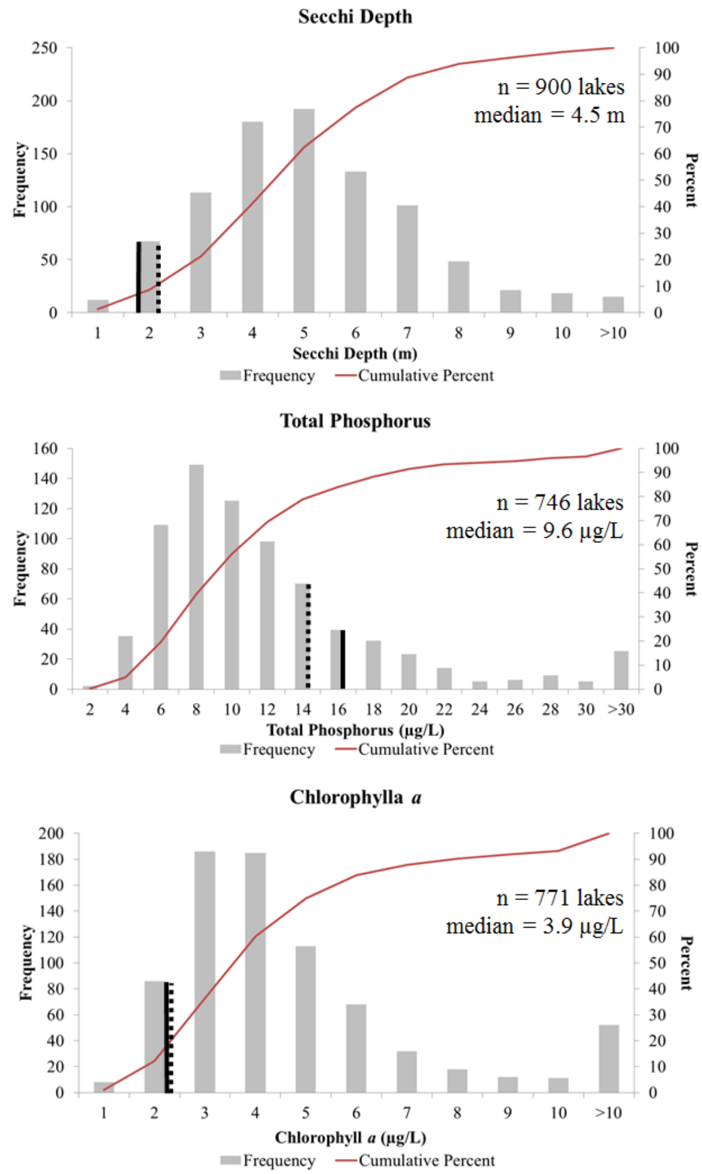

Figure 7. Secchi depth, total phosphorus, and chlorophyll *a* histograms for lakes and impoundments sampled by the Lake Stewards. Average values calculated from Black Bear Hydro's 2013 study are shown for Graham Lake (solid black line) and Lake Leonard (dashed black line). The red curve shows the cumulative percentage for each water quality parameter. (Source: Black Bear Hydro, 2014 and Maine DEP, 2017, as modified by staff).

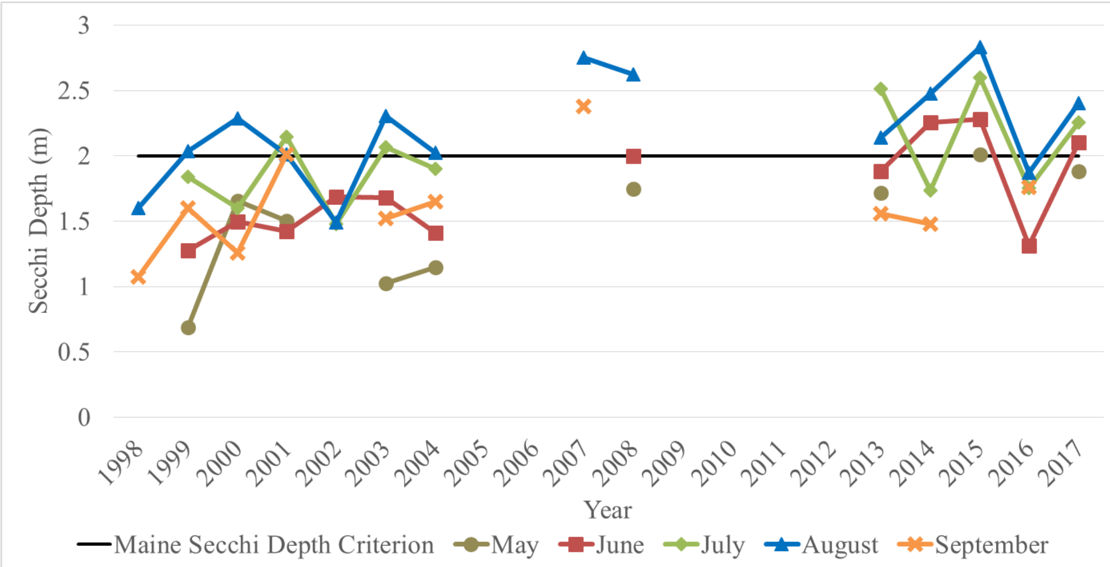

Figure 8. Monthly Secchi depth data for Graham Lake. Black Bear Hydro collected the data shown for 2013, and the Lake Stewards collected the data for all other years. The solid black line represents Maine DEP's draft Secchi depth criterion of two meters. (Source: Maine DEP, 2018a, as modified by staff)

The data Black Bear Hydro and the Lake Stewards collected also indicate that Graham is more strongly colored than many other lakes and impoundments in Maine (Figure 9). Based on 2,361 annual mean values reported from 583 lakes, true color values from Graham Lake are among the 10 percent highest true color values (Maine DEP, 2018c).

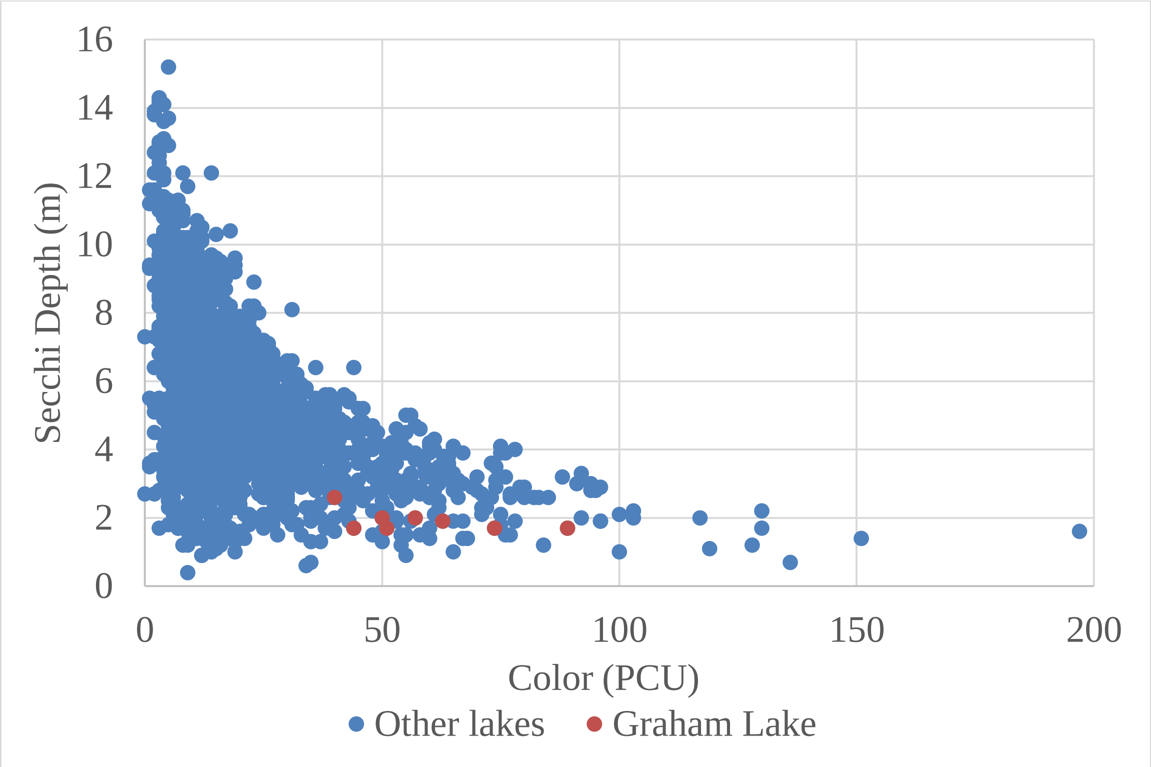

Figure 9. Annual mean Secchi depth versus true color for lakes and impoundments sampled by the Lake Stewards. Data shown for Graham Lake includes date Black Bear Hydro collected in 2013. (Source: Maine DEP, 2018c, as modified by staff)

Graham Lake tailrace

Black Bear Hydro recorded water temperature, DO concentration, chlorophyll *a*, and Secchi depth from a midstream location in the Graham Lake tailrace once a week from July 2 through September 12, 2013. Black Bear Hydro measured DO concentration and temperature at 1-meter intervals and collected chlorophyll *a* samples from just below the water surface. Black Bear Hydro visited the sampling location in the morning and in the afternoon on each sampling day.

Water quality parameters for Graham Lake and the tailrace were generally similar (see Table 3). During the survey period, water temperature in Graham Lake's tailrace ranged from 67 °F to 78 °F. DO concentrations ranged from 8.3 mg/L to 10.4 mg/L. Chlorophyll *a* ranged from 2.0 micrograms per liter (µg/L) to 5.1 µg/L, and Secchi depth from 1.7 to 2.7 meters. When Graham Lake and the tailrace were sampled on the same days, the Union River was approximately 1 to 2 °F warmer and had DO concentrations approximately 1 mg/L higher than Graham Lake. Maine DEP stated that DO concentrations in the tailrace met or exceeded applicable Class A standards of 7 mg/L or 75 percent saturation under conditions of low flow and high water temperature.[47]

Lake Leonard

Black Bear Hydro collected water quality samples from a deep area in Lake Leonard approximately 300 feet upstream of the Ellsworth Dam every two weeks from mid-June through late-October 2013. As with the sampling in Graham Lake, Black Bear Hydro collected water temperature and DO profiles at 1-meter intervals and measured Secchi depth, chlorophyll *a*, total phosphorus, and pH.

Water quality parameters for Lake Leonard were similar to those of Graham Lake and the Union River (see Table 3). However, thermal stratification was observed more frequently in Lake Leonard and occurred on 6 out of the 10 sampling days. Black Bear Hydro first documented thermal stratification on June 27, 2013, and stratification persisted until September 19, 2013. DO concentrations at the bottom of the water column approached 0 mg/L on July 25, August 8, August 22, and September 5. The thermocline occurred at a depth of approximately 23 feet on June 27, 2013 and became increasing deeper until it reached approximately 39 feet by September 5, 2013. Maine DEP stated that Lake Leonard is not significantly affected by the water quality of Graham Lake, does not show signs of nutrient enrichment, and has a stable or declining trophic level.[48]

Tailwater Macroinvertebrates

Black Bear Hydro sampled the benthic macroinvertebrate community in the Union River downstream of Graham Lake during the summer of 2014 and 2015 to assess stream health.[49] The monitoring results demonstrated that the benthic macroinvertebrate community downstream of the Graham Lake Dam was abundant but composed of only a few species. The community was dominated by filter feeding caddisflies, which are intermediate between species that are sensitive to environmental conditions and those that are tolerant of a wide variety of conditions. Few mayflies and no stoneflies were collected in either year. As a result, the macroinvertebrate community did not attain Maine's Class B aquatic life standards, which state that discharges to Class B waters may

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[47] *See* Maine DEP's October 7, 2015 letter.

[48] *Id.*

[49] The benthic macroinvertebrate community can be used as an indicator of overall stream health. In general, an unpolluted waterbody has a higher percentage of taxa from the orders Ephemeroptera (mayflies), Plecoptera (stoneflies), and Trichoptera (caddisflies); whereas, pollution tolerant taxa (*e.g.*, midge flies) dominate the community in poor-quality waters.

not cause adverse impact to aquatic life, such that the receiving waters must be of sufficient quality to support all aquatic species indigenous to the receiving water without detrimental changes in the resident biological community

Aquatic Habitat

Impoundment Habitat

Graham Lake

Graham Lake is 10 miles long, has a maximum width of approximately 3 miles, and an average depth of 17 feet. At the maximum elevation limit of 104.2 feet msl, the surface area of Graham Lake is approximately 10,042 acres. The northwestern and southeastern regions of Graham Lake contain extensive shallow areas that may become exposed as the water surface elevation approaches the minimum elevation limit of 93.4 feet msl (see Figure 4).

Most of the shoreline along Graham Lake consists of highly erodible substrates. A combination of clay, sand, gravel, and organic substrates occur where the Union River enters the northern portion of Graham Lake. A boulder and cobble substrate mixed with sand and gravel is the most common substrate along the eastern shore of Graham Lake and the islands on Graham Lake. Soils along the western shore of Graham Lake include varying ratios of clay and finer sands as well as medium to coarse sands and some fine gravel. Small areas in the southwestern shore of Graham Lake also contain boulder and cobble. Erosion has been observed in select areas along the shoreline of Graham Lake, including bank slumps located primarily along the western shore of the impoundment.

Lake Leonard

Lake Leonard is one mile long, has a maximum width of approximately 0.3 mile, and an average depth of 25 feet. The shoreline of Lake Leonard is composed of ledge and stony glacial soils with gentle to moderate slopes. The Ellsworth Dam is located in a gorge of solid bedrock.

Mainstem Union River Habitat

The Union River between Graham Lake and Lake Leonard is approximately three miles long with long runs as the predominate habitat type (see Figure 10).[50] The upper

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[50] The Union River between Graham Lake and Lake Leonard contains three habitat types: riffles, runs, and pools. Riffles are shallow areas with fast, turbulent water running over rocks, typically gravel, cobble, boulders, or bedrock. Runs are deep areas with fast water with slightly smaller substrate than riffles (*e.g.*, sand, gravel, and cobble)

reach is dominated by run habitat, and riffles and pools are more common in the middle and lower reaches. The current license requires Black Bear Hydro to release 250 cfs from Graham Lake Dam from May 1 to June 30 and 105 cfs from July 1 through April 30. Minimum flows at Graham Lake are released through the downstream fish passage facilities or the Tainter gates at the Graham Lake Dam. Based on flow data derived from project generation, flow exceeds 250 cfs 82.9 percent of the time and exceeds 105 cfs 100 percent of the time.

Black Bear Hydro conducted an instream flow study in September 2014 to evaluate the relationship between flow and aquatic habitat characteristics (*e.g.*, depth, water velocity, wetted width) in the Union River between the two project impoundments. Black Bear Hydro reported aquatic habitat characteristics for each reach at 150, 300, 1,350, and 2,100 cfs (see Table 5).[51] Black Bear Hydro also extrapolated water velocity, depth, and wetted width estimates for a flow of 105 cfs based on the data collected at the other flows (see Table 5). In addition, Black Bear Hydro evaluated the suitability of each reach for spawning and nursery habitat for Atlantic salmon and river herring.[52]

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and little or no turbulence. Pools are deep areas with low water velocity and typically finer substrate than riffles and runs (*e.g.*, silt, sand, and gravel).

[51] The selected flows represent the two seasonal minimum flows, a mid-level generating flow, and a high generating flow. The two lowest flows are higher than the required seasonal minimum flows. Black Bear Hydro states that it releases slightly more water than required from the Graham Lake Dam to ensure compliance with the minimum flow requirements of the 1987 License Order. *See* Black Bear Hydro's September 9, 2015 updated study report meeting summary.

[52] Black Bear Hydro evaluated habitat suitability for Atlantic salmon based on criteria reported by Stanley and Trial (1995) (see Table 6). Black Bear Hydro stated that no habitat suitability criteria exist for river herring. However, Pardue (1983) provides some general information and states that alewives spawn in areas of low water velocity and at depths ranging from 6 inches to 10 feet while blueback herring spawn in swift-flowing, deeper areas with hard substrate or slower-flowing tributaries and with soft substrate and detritus. The larvae of both species remain near, or slightly downstream of, the spawning sites. Juveniles of both species occupy tributary and mainstem habitats until they migrate downstream.

Figure 10. Union River instream flow study area. Graham Lake is located at the top of the figure, and Lake Leonard is located at the bottom. (Source: Black Bear Hydro, 2015a).

Table 5. Aquatic habitat characteristics for the three reaches of the Union River surveyed during 2014. Black Bear Hydro extrapolated the values for 105 cfs based on the data from the other flows. (Source: Black Bear Hydro, 2015a)

Reach	Habitat	Flow (cfs)	Wetted Width (feet)	Wetted Width (Percent of Bankfull)	Mean Depth (feet)	Maximum Depth (feet)	Mean Velocity (feet per second)	Substrate
Upper	Riffle/Run	105	304	83	3.0	6.5	0.12	Cobble, boulder, bedrock, woody debris
		150	310	85	3.2	6.7	0.31	
		300	329	90	3.5	7.2	NC	
		1,350	358	98	4.6	8.7	NC	
		2,100	362	99	4.9	9.0	NC	
	Pool	105	191	83	5.5	9.2	0.16	Bedrock, boulder, cobble, woody debris, silt
		150	191	83	5.7	9.4	0.32	
		300	193	84	6.1	10.1	NC	
		1,350	218	94	5.7	12.4	NC	
		2,100	230	99	6.4	13.3	NC	
Middle	Riffle	105	179	74	1.8	6.7	0.35	Boulder, cobble, gravel
		150	181	75	1.9	6.8	1.01	
		300	186	77	2.3	7.2	2.36*	
		1,350	220	92	3.1	8.6	4.32*	
		2,100	233	97	3.6	9.1	4.34*	
	Run	105	128	68	1.8	2.8	0.47	
		150	134	71	1.9	2.9	0.96	

		300	153	81	2.2	3.3	2.36*	Boulder, gravel, silt
		1,350	170	90	3.1	4.7	4.32*	
		2,100	177	94	3.5	5.1	4.34*	
	Pool	105	172	73	2.3	4.5	0.27	Boulder, gravel, silt
		150	176	75	2.4	4.7	0.90	
		300	190	81	2.8	5.3	2.36*	
		1,350	214	90	3.8	6.6	4.32*	
		2,100	223	95	4.1	7.1	4.34*	
Lower	Riffle	105	173	73	4.2	9.1	0.15	Bedrock, boulder, gravel
		150	174	74	4.4	9.2	0.59	
		300	175	74	4.6	9.5	NC	
		1,350	197	84	5.4	10.9	NC	
		2,100	215	91	5.1	11.4	NC	
	Run/Pool	105	139	74	6.5	11.0	0.10	Boulder, woody debris, silt
		150	139	74	6.7	11.0	0.24	
		300	140	74	6.8	11.1	NC	
		1,350	144	76	7.0	11.6	NC	
		2,100	145	77	7.2	11.8	NC	

"NC" = not collected.

*Black Bear Hydro estimated the velocity for the entire reach rather than for the different habitat units.

(Source: Black Bear Hydro, 2015a).

Table 6. Atlantic salmon habitat suitability criteria. (Source: Stanley and Trial, 1995).

Life Stage	Velocity (feet per second)	Depth (ft)	Substrate
Fry	0-1.97	0.16-1.80	Sand, pebble/gravel, cobble
Parr	0-2.62	0.33-2.03	Pebble/gravel, cobble
Spawning Adults	1.14-2.95	0.33-2.03	Pebble/gravel, cobble

(Source: Stanley and Trial, 1995).

Across all reaches, the lowest flows have the lowest mean water velocities and the lowest depths. The upper reach has the greatest wetted width, with approximately 100 to 150 feet more wetted area than the other two reaches. The four test flows provided 83 to 99 percent of the bankfull wetted width in the upper reach.[53] The four test flows provided 71 to 97 percent of the bankfull wetted width in the middle reach. The lower reach is the deepest reach and has intermediate mean velocities at the lowest flow. The four test flows provided 74 and 91 percent of the bankfull wetted width in the lower reach.

All three reaches contain areas with suitable depth and water velocity for Atlantic salmon spawning and nursery habitat at 150 and 300 cfs. At flows greater than 300 cfs, the mean velocity in the middle reach exceeds the optimum velocity range for salmon fry, parr, and spawning, but some lower-velocity areas may be available in the middle reach. In addition, the lower reach pool/run habitat lacks the gravel and cobble substrate necessary for spawning. All three reaches appear sufficiently deep to allow upstream and downstream passage of adult Atlantic salmon.

Black Bear Hydro stated that the middle and lower reach contain suitable spawning and nursery habitat for river herring. Several tributaries join the Union River in these reaches, and the mouths of the tributaries contain slow-moving, backwater habitat and areas of low velocity and a range of depths and substrate types (*e.g.*, cobble, gravel, silt) used by spawning adults and juveniles. Furthermore, Black Bear Hydro observed schools of juvenile river herring in these reaches during the instream flow study in 2014.

[53] The bankfull width is the width of the stream beyond which any additional flow would enter the floodplain. The bankfull flow represents the typical maximum flow observed during a 1 to 2-year interval.

Tributary Access

Graham Lake

To determine if adult river herring and Atlantic salmon could access the tributaries of Graham Lake at a low water surface elevation, Black Bear Hydro visited eight tributaries (see Figure 11; Table 7) in October 2014 when the water surface elevation of Graham Lake was approximately 98 feet msl and conducted a qualitative assessment of accessibility. Black Bear Hydro, Maine DIFW, Maine DMR, and Commerce visited several of the tributaries again to assess tributary accessibility (see Table 7) in September and October 2016 when the water surface elevation of Graham Lake was approximately 97 feet msl. Based on the field observations, Black Bear Hydro stated that all eight tributaries are accessible to adult river herring and Atlantic salmon when the water surface elevation of Graham Lake is approximately 97 to 98 feet msl.

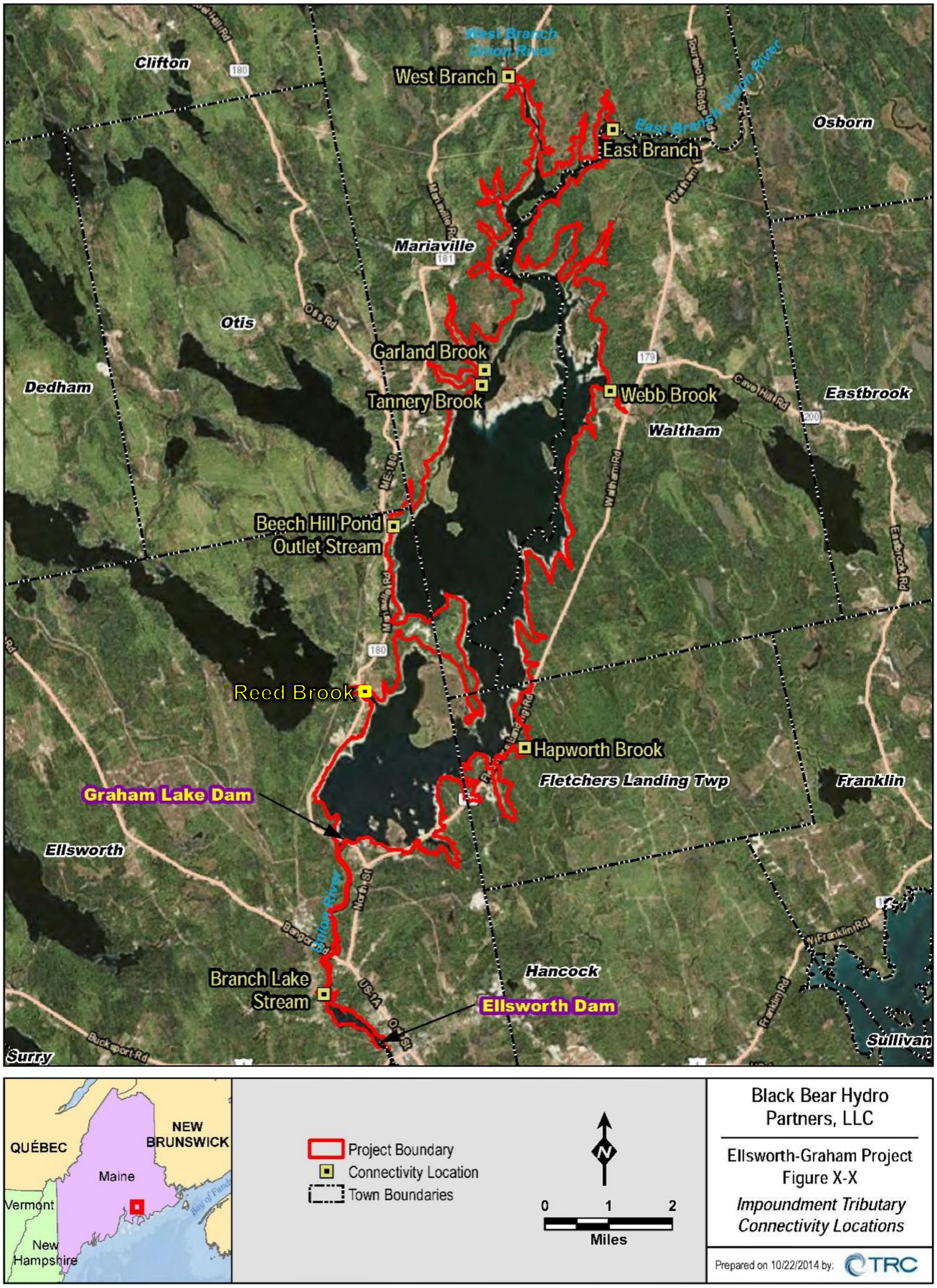

Figure 11. Tributary access survey sites in Graham Lake and Lake Leonard. (Source: Black Bear Hydro, 2015a).

Table 7. Habitat characteristics of tributaries at the confluence with Graham Lake.

Tributary	Year Visited	Width (ft)	Depth (ft)	Substrate
West Branch of the Union River	2014	20 to 50	0.5 to 2+	boulder, bedrock
East Branch of the Union River	2014, 2016	50 to 100	0.5 to 2+	boulder, bedrock
Garland Brook	2014	30 to 75	5+	silty sand
Tannery Brook	2014, 2016	25 to 50	0.5 to 2+	silty sand
Webb Brook	2014, 2016	20 to 50	0.5 to 2	boulder, bedrock
Beech Hill Pond Stream	2014	300[1]	0.5 to 2+	silty sand, boulder, woody debris
Reed Brook	2014	300	2 to 3	cobble, gravel
Hapworth Brook[2]	2014	culvert	5+	cobble, silt, sand

[1] The August 21, 2015 updated study report states that Beech Hill Pond Stream enters Graham Lake via an approximately 1,600-foot-wide inlet. However, staff measured the confluence using Google Earth images, and the confluence width appears to be approximately 300 feet.

[2] Hapworth Brook enters Graham Lake through a concrete culvert of unknown dimensions. The reported depth and substrate are from the lake side of the culvert.

(Source: Black Bear Hydro, 2015a, as modified by staff).

Union River

During the September 2014 instream flow study, Black Bear Hydro qualitatively evaluated tributary access for river herring and Atlantic salmon for four tributaries to the mainstem Union River between Graham Lake and Lake Leonard (see Figure 12; Table 8) during the 150 and 300 cfs test flows. In addition, Black Bear Hydro qualitatively evaluated habitat suitability for river herring and Atlantic salmon at the confluence of each tributary based on visual observation of substrate type, depth, and water velocity at 150 and 300 cfs.

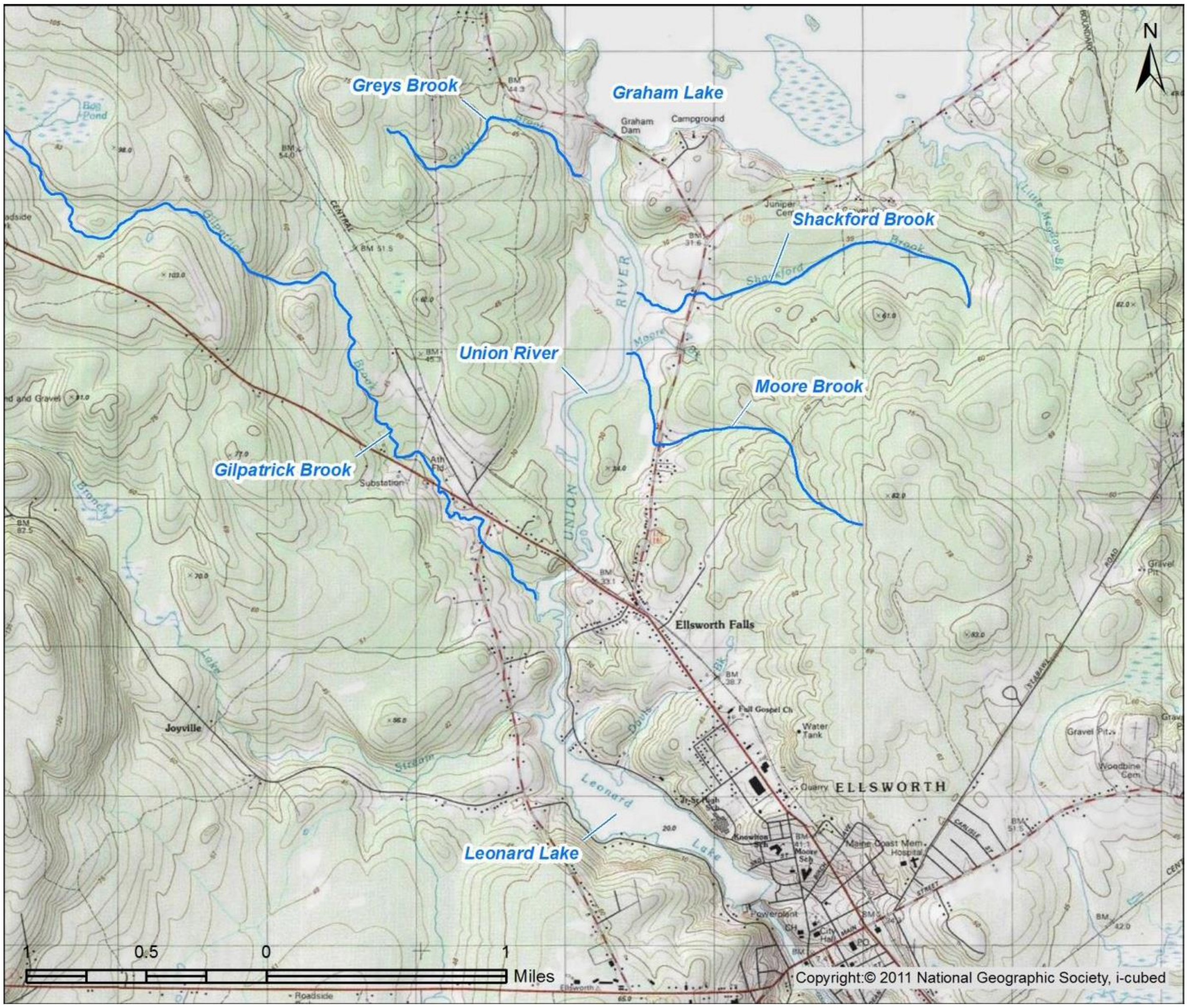

Figure 12. Union River tributaries. The survey sites were at each tributary's confluence with the Union River. (Source: Black Bear Hydro, 2015a).

Table 8. Habitat characteristics of tributaries at their confluence with the Union River.

Tributary	Depth (ft)	Substrate	Habitat Suitability
Greys Brook	2.0 to 3.0	silt, boulder	river herring spawning and nursery habitat
Shackford Brook	2.0 to 3.5	silt, boulder	river herring spawning and nursery habitat
Moore Brook	0.5 to 1.0	silt	river herring nursery habitat
Gilpatrick Brook	1.3 to 1.5	cobble, gravel, boulder	potential salmon fry, parr, and spawning habitat

(Source: Black Bear Hydro, 2015a).

Black Bear Hydro stated all four tributaries appeared to be accessible to adult river herring and Atlantic salmon at 150 and 300 cfs. However, Black Bear Hydro stated the confluences of Greys Brook, Shackford Brook, and Moore Brook contained silty, backwater habitat that would be unsuitable for all Atlantic salmon life stages. In contrast to the other three tributaries, Black Bear Hydro reported that the depth, water velocity, and substrate of the Gilpatrick Brook confluence may be suitable for Atlantic salmon spawning and nursery. Maine DIFW stated that brook trout (another coldwater salmonid species) inhabits Gilpatrick Brook,[54] which further suggests that the tributary may be suitable for Atlantic salmon.

Black Bear Hydro stated that juvenile river herring were present in Greys Brook and Moore Brook during the habitat assessment, and the confluence of Greys Brook is likely suitable as juvenile river herring habitat. Black Bear Hydro stated that Greys Brook, Shackford Brook, and Moore brook may contain suitable habitat for adult river herring.

Fishery Resources

The Union River historically supported runs of diadromous fish, including American eel, American shad, Atlantic salmon, Atlantic sturgeon, Atlantic tomcod, rainbow smelt, river herring, shortnose sturgeon, and striped bass. However, access to the Union River for migratory fish species has been restricted since the first dams were constructed on the river in the late 1700s (NMFS, 2009b). Construction of the Ellsworth

[54] *See* the consultation meeting summary in Black Bear Hydro's Tributary Access Study Report, filed December 22, 2016.

Dam began in 1907 at the site of a former Milliken saw mill dam (Ambursen Hydraulic Construction Company, 1908; NMFS, 2009a). Graham Lake Dam was constructed in the early 1920s as a flow-control dam to support the operation of the Ellsworth Development (NMFS, 2009b; Black Bear Hydro, 2015b).

An upstream fish passage facility at the Ellsworth Dam was constructed in 1974 to trap and transport Atlantic salmon and river herring; however, only three Atlantic salmon of wild or hatchery origin have returned to the upstream fish passage facility during the past 10 years (URFCC, 2018). Separately, although there are no existing upstream fishways for American eels at the project, juvenile eels appear able to pass upstream of both project dams to some degree (Black Bear Hydro, 2014; URFCC, 2016; 2017; 2018).

Besides Atlantic salmon, river herring, and American eel, seven other native migratory fish species (American shad, Atlantic sturgeon, Atlantic tomcod, rainbow smelt, sea lamprey, shortnose sturgeon, and striped bass) could occur downstream of Ellsworth Dam. With the exception of American shad, the upstream extent of the migration of these species is either unknown or did not extend beyond Ellsworth Falls, which is currently inundated by Lake Leonard.

The Union River watershed also contains a variety of resident coolwater and warmwater fish species that offer sport fishing opportunities. Such species include brook trout, chain pickerel, striped bass, white perch, yellow perch, as well as non-native largemouth and smallmouth bass and brown trout.

Union River Fisheries Management

Management of alewife, blueback herring, and shad is guided by the Atlantic States Marine Fishery Commission's[55] (ASMFC) management plan for river herring and shad (ASMFC, 1985; 1999). The management plan calls for improving habitat accessibility for river herring and shad by providing fish passage at dams, improving water quality to support habitat needs, and preventing mortality at water withdrawal facilities. The management plan also calls for stocking programs to enhance depressed stocks of fish in historic habitat (ASMFC, 1985).

The AMSFC's American Eel Fishery Management Plan guides the management of eels in the territorial seas and inland waters along the Atlantic coast from Maine to

[55] The ASMFC is a deliberative body of Atlantic coastal states that coordinates the conservation and management of 27 fish species. Its mission is to promote better utilization of the Atlantic seaboard fisheries through the development of a joint program for the promotion and protection of such fisheries, and by the prevention of physical waste of the fisheries. The ASMFC collaborates with state agencies, NMFS, and FWS to accomplish its mission.

Florida (ASMFC, 2000; 2014). Relevant goals of the plan are to protect and enhance American eel abundance in all watersheds where eels now occur; restore American eel to waters where they historically occurred; and contribute to the viability of American eel spawning populations.

Management of Atlantic salmon in the Gulf of Maine is guided by NMFS's and FWS's "Final Recovery Plan for the Gulf of Maine Distinct Population Segment (DPS) of Atlantic Salmon (*Salmo salar*)" (Recovery Plan) (FWS and NMFS, 2018). Similarly, the "Final Recovery Plan for Shortnose Sturgeon" guides the management and protection of the Penobscot DPS and Kennebec System DPS of shortnose sturgeon (NMFS, 1998). No recovery plan has been developed for Atlantic sturgeon; however, the objectives of the ASMFC Fishery Management Plan for Atlantic Sturgeon and Amendment 1 to the Fishery Management Plan include restoration of Atlantic sturgeon stocks, protection of current spawning habitat, and reestablishing access to historic spawning areas (ASMFC, 1990; 1998). The goals and objectives of the Recovery Plans and Fishery Management Plan are further discussed in section 3.3.3, *Threatened and Endangered Species*.

In addition, the 2002 amendment of Article 406 of the license[56] required the licensee to file a Comprehensive Fisheries Management Plan for the Union River (CFMP) and to update the plan every five years.[57] Following the amendment, the licensee developed the CFMP in consultation with the Union River Fisheries Coordinating Committee (URFCC), which includes the FWS, Maine DIFW, Maine DMR, and additional stakeholders. The CFMP serves as an interim upstream passage plan until sufficient information is developed from studies and other management activities to allow for the resolution of permanent upstream fish passage measures at the project for river herring and salmon. The original CFMP specified the number of river herring to be stocked in Graham Lake and Lake Leonard, required an evaluation of the efficacy of achieving the restoration goal using the specified stocking rate, and required an assessment of whether there are conflicts between the numbers of river herring stocked in Graham Lake and the lake's smallmouth bass fishery.[58] The original plan also addressed the restoration of Atlantic salmon, American eel, and other migratory fishes;

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[56] *See PPL Maine, LLC*, 100 FERC ¶ 62,209 (2002).

[57] *See id*.

[58] Since 2000, the river herring target stocking level specified by the URFCC has increased from 100,000 to 315,000. The restoration goal is an annual river herring run of approximately 2.4 million fish with a harvestable surplus of approximately 2.0 million fish.

interim and permanent fish passage; and management strategies for resident fishes throughout the Union River basin.

The plan was updated in 2006, 2010, and 2015[59] (URFCC 2006; 2010; 2015). In addition to including many of the same goals and activities included in the previous plans, the 2015 plan also provided for river herring stocking in five additional ponds within the Union River watershed. However, stocking the additional lakes has not occurred due to a perceived lack of suitable access for the stocking truck (URFCC, 2018). The 2015 plan also required Black Bear Hydro to address recurring fish mortality at the Ellsworth Development. In response, Black Bear Hydro developed interim passage measures that included prioritizing operation of the generating units and ceasing operation when fish mortality is observed in the Ellsworth Development's tailrace.

<u>Anadromous Fish[60]</u>

River Herring

Alewives and blueback herring spend most of their lives at sea, but return to their natal (birth) rivers along the eastern seaboard of North America to reproduce (Greene *et al*., 2009). Spawning runs of alewife occur earlier (May through June in Maine) than those of blueback herring and American shad (June through July) (Loesch, 1987; Saunders *et al*., 2006). In New England, blueback herring primarily spawn in lotic (mainstem river) habitats, whereas alewife generally spawns in lentic (lake or pond) habitats within a river basin (Loesch, 1987). Upstream of the Ellsworth Dam, the Union River watershed has a mix of lotic and lentic habitats where blueback herring and alewife historically spawned.

In Maine, river herring can live to be five to nine years old and can return to their natal rivers to spawn one to four times.[61] However, 93 percent of the river herring run

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[59] The 2015 update covered the period from 2015 to 2017 when the current license expired.

[60] An anadromous fish, born in fresh water, spends most of its life in the sea and returns to fresh water to spawn. Additional information on threatened and endangered anadromous fish, including the federally endangered Gulf of Maine DPS of anadromous Atlantic salmon (*Salmo salar*), the federally threatened Gulf of Maine DPS of Atlantic sturgeon (*Acipenser oxyrinchus*), and the federally endangered shortnose sturgeon (*Acipenser brevirostrum*), can be found in section 3.3.4, *Threatened and Endangered Species*.

[61] *See* Maine DMR's July 1, 2013 letter.

population in the Union River is composed of three and four-year-old fish that are first-time spawners, which is the highest proportion of first-time spawners of any river herring population harvested in Maine.[62] Post-spawn adult fish migrate downstream shortly after spawning. Fish produced from spawning events generally remain in river habitats for a few months before out-migrating to the sea as juveniles during late summer and early fall. Juveniles generally spend three to five years at sea, where they mature, and subsequently return to their natal rivers in the spring to spawn (Saunders *et al*. 2006; Greene *et al*., 2009).

Upstream River Herring Passage

Black Bear Hydro operates a trap and truck facility at the Ellsworth Development that provides upstream passage for river herring from early May to mid-June (Black Bear Hydro, 2015b). In addition to collecting river herring to transport upstream, the City of Ellsworth harvests river herring from the trap and truck facility which are sold as lobster bait to commercial fishers under a cooperative management agreement with Maine DMR (URFCC, 2015). The trap and truck facility consists of an approximately 36-foot-long vertical slot fishway leading to a 420-cubic foot holding pool that contains a 61-cubic foot hopper with metal sides. The hopper is lifted from the trap pool using a hoisting structure and emptied into a 99.5-cubic foot circular holding tank on a trailer (Black Bear Hydro, 2015c). The tank and trailer are then towed to release sites at Graham Lake and Lake Leonard.[63] Black Bear Hydro operates two transport trailers so that operation of the trap and truck facility can continue while river herring are being transported upstream. When the trap and truck facility is used to harvest river herring, a similarly-size hopper with wire mesh sides is used. The wire mesh sides allow the water in the hopper to drain as the hopper is lifted.

Efforts to restore river herring to the Union River began in 1972 when Maine DMR began stocking river herring collected from the Orland River watershed into the Union River (URSG, 2000). The current trap and truck facility was completed in 1974. In 1984, Maine DMR developed an area-based target for the number of fish to be transported upstream and a target "run" size (*i.e.*, the number of fish returning to spawn) using commercial landings data from six watersheds (Maine DMR, 2016). Based on the harvest records and the area of the lakes where the river herring (primarily alewives) spawned, Maine DMR estimated that harvesting 200 fish per acre and allowing 35 fish per acre to be transported upstream to spawn (referred to as "escapement") would result in a sustainable river herring fishing. Therefore, Maine DMR's target run size for a

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[62] *See* Maine DMR's August 13, 2013 letter.

[63] As required by the Union River CFMP, Lake Leonard is only stocked once during the river herring upstream passage season.

watershed is 235 fish per acre. For the Union River, the target run size is 2.3 million fish, and the target escapement is 315,000, which the URFCC agreed to in 2015, as represented in the updated CFMP.[64] Currently, Black Bear Hydro transports the first 150,000 fish that are trapped at the beginning of the upstream migration season to the upstream release point in Graham Lake. For the remainder of the seasonal run, river herring are harvested during the week and then transported upstream during the weekend (URFCC, 2015). If the target escapement of 315,000 river herring cannot be met solely through weekend transport, Maine DMR can suspend the herring harvest until the target escapement is reached. After June 10, Black Bear Hydro releases approximately 1,600 river herring into Lake Leonard to provide escapement for blueback herring, which become more prevalent near the end of the run (URFCC, 2015).

Since the initiation of river herring restoration in 1972, the number of river herring transported upstream has varied from 0 to 336,220 (see Figure 13). The river herring run size has never reached Maine DMR's target run size of 2.3 million fish or 235 fish per acre.

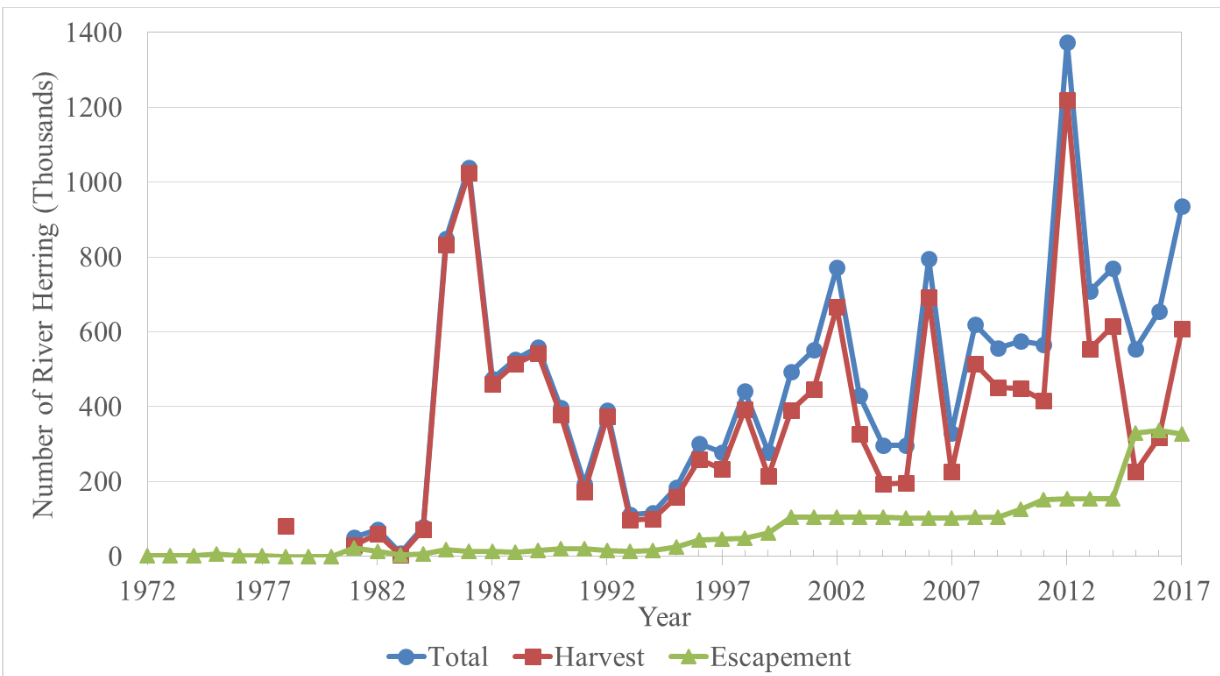

Figure 13. The number of river herring harvested and transported upstream (escapement) from the Ellsworth Project trap and truck facility. (Source: URFCC, 2000-2018 as modified by staff).

[64] The current escapement value is based on approximately 31 fish per acre to reduce the immediate impact on businesses dependent on the river herring harvest while the run is rebuilding (URFCC, 2015).

Upstream Fish Passage Trap Operation

During May and June 2014, Black Bear Hydro quantified the amount of time required to collect and transport river herring upstream. Black Bear Hydro generally operated the trap and truck facility from approximately 1:00 PM to 7:00 PM each day of operation. The results[65] indicate that the most common time required to fill and empty the trap was 7 minutes (see Table 9). Black Bear Hydro states that it used two trucks when transporting river herring upstream. Typically, it took 12 minutes for one truck to transport the fish from the trap and truck facility to the Graham Lake release site (see Table 9). Transporting the fish to Lake Leonard took 10 minutes. On average during 2014, Black Bear Hydro transported an average of 1,418 river herring per trip and 11,620 river herring per day. Black Bear Hydro transported a total of 153,765 river herring upstream in 2014, which slightly exceeded the URFCC target of 150,000 river herring for that year (URFCC, 2015).

Table 9. Upstream fish passage facility operation for river herring. Values include the time (minutes) required for the Ellsworth Project trap and truck facility to reach capacity (trap fill time), to transfer fish from the trap hopper to the transport tank (trap emptying time), and to transport the fish to the Graham Lake release site (transport time to Graham Lake).

	Trap Fill Time	**Trap Emptying Time**	**Transport Time to Graham Lake**
Minimum	4.0	0.0	9.0
Mean	17.4	1.6	12.5
Median	6.0	1.0	12.0
Mode	6.0	1.0	12.0
Maximum	210.0	14.0	18.0

(Source: Black Bear Hydro, 2014, as modified by staff).

Downstream River Herring Passage

Black Bear Hydro operates downstream fish passage facilities at both Graham Lake Dam and Ellsworth Dam. Downstream fish passage at Graham Lake Dam is currently provided by the normal operation of: (1) three 20-foot-wide Tainter gates; and

[65] *See* Attachment 2-14 of Black Bear Hydro's Initial Study Report, filed September 4, 2014.

(2) a 4-foot-wide by 7.5-foot-deep surface-oriented bypass weir (Alden weir)[66] located on the west-end of the spillway, 16.2 feet above the tailwater, capable of releasing flows of at least 50 cfs. Black Bear Hydro operates the Alden weir from April 1 through December 31 each year to provide a surface-oriented means for migrating fish to pass downstream of the dam. Flows from the Alden weir and Tainter gates discharge into an approximately 9.5-foot-deep natural plunge pool in the Union River below the dam. The 4-foot-wide overflow weir discharges approximately 150 to 200 cfs into the plunge pool.

Black Bear Hydro operates a downstream fish passage facility[67] at Ellsworth Dam for river herring and Atlantic salmon from April 1 through December 31 of each year. The existing downstream fish passage facility consists of three, 3-foot-wide surface weirs that are located on either side of the west powerhouse intake to Units 2, 3, and 4, and between the east powerhouse intake for Unit 1 and the overflow spillway of the Ellsworth Dam. Fish pass from the eastern surface weir directly to a flume that transports the fish down the face of the spillway into a natural plunge pool at the toe of the dam in the tailrace. Fish that enter the two weirs at the west powerhouse intake are conveyed through a 30-inch-diameter downstream migrant pipe that crosses the downstream face of the non-overflow section of the dam and discharges directly into the flow from the eastern surface weir and the spillway flume, just below the dam crest elevation. The weirs at the western powerhouse intake are 53 feet apart and the weir at the eastern powerhouse intake is approximately 120 feet apart from nearest weir at the western powerhouse intake. Black Bear Hydro opens the western surface weirs approximately 21 inches to pass approximately 20 cfs from each weir. Black Bear Hydro opens the eastern surface weir approximately 17 inches to provide an attraction and conveyance flow of 16 cfs. The downstream fish passage facility also includes a recirculating pump that is capable of returning up to 35 cfs of the 40 cfs conveyance flow from the two western surface weirs to the headpond. Under normal operation, Black Bear Hydro maintains a 12-cfs conveyance flow through the 30-inch downstream migrant pipe. The conveyance

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[66] *See* description of an Alden weir in the "Downstream Eel Passage" section above. In the spring of 2017, Black Bear Hydro modified the existing bypass weir in the log sluice by adding a sloped floor, two side panels, and a bell shaped entrance to create an Alden weir to enhance downstream fish passage based on the results of the 2016 Salmon Smolt Survival Study, which indicated that existing bypass weir had low passage efficiency and high mortality (41 percent). The Commission has not issued an amendment order requiring permanent installation of the Alden weir and the Union River Comprehensive Management Plan does not provide specific guidance on the installation of the Alden weir to improve downstream fish passage.

[67] The downstream fish passage facility was constructed in 1989 and became operational in 1990. *See Bangor Hydro-Electric Company*, 66 FERC ¶ 62,079 (1994).

flow from the eastern surface weir (16 cfs) and conveyance flow from the downstream migrant pipe (12 cfs) combine just below the crest elevation of the dam to transport migrants down the spillway flume. The spillway flume is 48-inches wide with 18-inch high steel sidewalls and a hard plastic bottom. The spillway flume empties into a plunge pool at the base of the spillway.[68]

The intakes for Units 2 through 4 have trashracks with 1-inch clear spacing for the top approximately 6.75 feet of the trashrack, and 2.37-inch clear spacing for the bottom 7 feet for Units 2 and 3 and for the bottom 9 feet for Unit 4. Unit 1 has 2.44-inch clear spacing for the full depth of the trashrack. Black Bear Hydro operates the downstream fish passage facilities at both dam from April 1 to December 31.

Black Bear Hydro has not evaluated the efficiency of the downstream passage facilities for river herring. However, Black Bear Hydro has instituted a fish passage operation and maintenance plan as a result of a fish kill that occurred in 2014.[69]

American Shad

A remnant population of American shad is likely present in the Union River downstream of the Ellsworth Dam (URFCC, 2015). Shad have been observed in the commercial river herring harvest and by anglers in the Union River, but are not currently stocked in the Union River due to a lack of available broodstock (URFCC, 2015). The historic distribution of shad in the Union River watershed is unknown because it is unclear if shad could have ascended Ellsworth Falls, which is now submerged in Lake Leonard. However, alewives, which are closely related to shad, historically migrated approximately 30 miles upstream of Ellsworth Dam (Houston *et al.*, 2007). Maine DMR (2014) indicates that the Union River contains 4.9 miles of potential habitat for American shad, compared to the total of 1,007 miles statewide based on a statewide assessment of habitat information, including historic distribution. Black Bear Hydro (2015b) states that of the 4.9 miles of potential habitat, two miles exists upstream of Ellsworth Dam.

Shad spawn in a variety of habitats but appear to prefer broad, shallow areas of rivers and streams over sand and gravel substrate (Stier and Crance, 1985). In northern

[68] In its October 10, 2018 response to Commission staff's request for additional information, Black Bear Hydro explains that it does not have drawings of the river bed at the base of the spillway to confirm the depth of the plunge pool, but "the minimum depth of the plunge pool appears to be several feet with a potential depth of approximately 12 feet."

[69] Black Bear Hydro filed the fish passage operation and maintenance plan on November 12, 2015.

latitudes such as New England, shad often survive spawning, unlike in southern regions (south of Cape Hatteras) where most fish die after spawning (Leggett and Carscadden, 1978). For instance, Grote *et al*. (2014) found that 75 to 95 percent of American shad in the Penobscot River were repeat spawners.[70]

Young shad generally remain in river habitats for a few months before out-migrating to the sea as juveniles during late summer and early fall. Peak out-migration occurs when water temperatures begin to steadily fall below 66-69 ^{o}F (O'Leary and Kynard, 1986). Although the timing of out-migration in a given river system can vary from year to year depending on environmental conditions (O'Leary and Kynard, 1986; Limburg *et al*., 2003), out-migration of juveniles and adults in Maine generally occurs from mid-July through October (Saunders *et al*., 2006). Collette and Klein-MacPhee (2002) reported that male shad mature after three to five years at sea, while females mature in four to six years.

Rainbow Smelt

Rainbow smelt occur in the Union River estuary below Ellsworth Dam and spawn in the mainstem of the Union River (URFCC, 2015). Rainbow smelt support a small recreational fishery in the Union River below Ellsworth Dam. Harvest of rainbow smelt is limited to hook–and–line fishing or dip netting (URFCC, 2015). Anadromous rainbow smelt typically migrate a short distance into rivers and streams during their annual spawning migrations, which take place in late winter and early spring, as they cannot negotiate rapids or other significant natural barriers (URFCC, 2015). Their current and historical range in the project area is the Union River downstream of Ellsworth Dam (Houston *et al*., 2007).

Striped Bass

Striped bass use the Union River estuary as foraging habitat during the spring, summer, and fall, but are not known to use the river for spawning (URFCC, 2015). Striped bass observed in the Union River are believed to originate from Hudson River, Delaware River, and Chesapeake Bay populations (URFCC, 2015). Historically, striped bass may have occupied the Union River upstream to Ellsworth Falls, which is now inundated by Lake Leonard (Houston *et al*., 2007). Striped bass are a popular sportfish in

[70] The term "repeat spawners" refers to adult shad that survive spawning and return to the river in subsequent years to spawn.

the Union River estuary, but angling opportunities have declined since 2007 due to a regional decline in striped bass abundance (URFCC, 2015).

Sea Lamprey

Sea lamprey spend most of their life at sea, with the early life stages occurring in freshwater. The life of the sea lamprey begins in freshwater, where egg and larval life stages (ammocoetes) occur in streams after they are spawned. After ammocoete transformation, sea lamprey move out to sea for the parasitic phase of its life (up to 2 years). Sea lamprey will parasitize fish as their source of food, and this often results in the death of the host fish.

After up to 2 years at sea, sea lamprey adults move into gravel areas of tributary streams during spring and early summer to spawn (Great Lakes Fishery Commission, 2000). Immediately after spawning, females drop downstream and soon die, while the male may remain on the nest for a short period before dying.

Historically, sea lamprey likely inhabited nearly the entire Union River watershed (Houston *et al*., 2007); however, their historical and current distribution and abundance are unknown.

Catadromous Fish

American eel

American eel is the only catadromous fish species that occurs at the project.[71] The American eel spends most of its life in fresh or brackish water before migrating to the Sargasso Sea in the middle of the North Atlantic to spawn. It occurs throughout warm and cold waters of the Atlantic Ocean and Atlantic coastal drainages in North America (Boschung and Mayden, 2004). Within its range, it is most abundant throughout the Atlantic coastal states (ASMFC, 1999).

Spawning likely occurs from February through April in the Sargasso Sea, although the act of spawning has never been observed (Boschung and Mayden, 2004). Fertilized eggs and larvae, known as the planktonic phase, drift with the Gulf Stream currents along the east coast of the United States (Jenkins and Burkhead, 1993). Following this phase, the planktonic leptocephali, ribbon-like eel larvae, metamorphose (or transform) into what is termed a "glass" eel as it approaches coastal waters. Glass eels are completely

[71] A catadromous fish spends most of its life in freshwater and migrates to saltwater to breed.

transparent and make their way into brackish waters by the use of flood tides. Once skin pigments develop in glass eels, they are considered "elvers."[72]

As eels mature, elvers become juvenile, or "yellow" eels. The majority of eels collected in freshwater rivers are typically yellow eel, which is considered the primary growth phase of its life cycle (Ross *et al*., 2001). Yellow eels are typically sedentary during the day, often burying in mud or silt, and becoming active at night to feed (Jenkins and Burkhead, 1993). They associate with pools or backwater habitats, and often have relatively small home ranges (Gunning and Shoop, 1962). The juvenile stage can last from five to 40 years before finally maturing into silver eels and out-migrating in the fall and mid-winter months to spawning grounds (*i.e.*, Sargasso Sea) (Boschung and Mayden, 2004).[73] Adult eels are presumed to die after spawning (Boschung and Mayden, 2004; Jenkins and Burkhead, 1993).

In New England, adult eels out-migration typically occurs from mid-August through mid-November (Haro *et al*., 2003). Adult eels often move downstream in intermittent pulses, with a large number of eels moving downstream during short periods of activity (1-3 days) followed by longer periods of time (7-20 days) with relatively little downstream eel movement (EPRI, 2001). Peak downstream movements often occur at night, during periods of increasing river flow (Richkus and Whalen, 1999). Other environmental cues such as local rain events and moon phase may also encourage downstream movements of out-migrating eels (EPRI, 2001; Haro *et al*., 2003).

Juvenile eels are abundant downstream of Ellsworth Dam. This region of the Union River supports an active fishery for glass eels and elvers, which is open from late March to early June. From 2007 to 2014, commercial fishers have landed between 173 to 1,501 pounds of glass eels and elvers each year from the Union River, which represent between six and 10 percent of statewide landings (see Table 10).

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[72] Elvers often serve as important forage fish for striped bass and other large piscivores.

[73] Juvenile eels that reside in estuaries reach maturity and migrate earlier than juveniles found in freshwaters. These eels can reach full maturity without migrating to freshwater (Shepard, 2015).

Table 10. Union River elver glass eel landings from 2007 to 2014.

Year	Union River Glass Eel and Elver Landings (pounds)	Percent of Statewide Landings
2007	306	10
2008	494	8
2009	424	9
2010	173	7
2011	436	6
2012	1,183	8
2013	1,501	10
2014	570	6

(Source: Black Bear Hydro, 2015b).

Based on reports of dead adult eels found downstream of the Ellsworth Dam, adult eels appear to occupy areas upstream of the Ellsworth Dam despite the lack of dedicated juvenile eel upstream passage facilities. On October 31, 2014, November 1, 2014, and June 15, 2017, members of DSF found large eels with apparent turbine-relate passage injuries downstream of Ellsworth Dam.[74] In addition, Black Bear Hydro documented 35 dead adult eels downstream of the Ellsworth Dam during the fall of 2015, 7 adult eels in 2016, and 10 adult eels in 2017 (URFCC, 2016; 2017; 2018). During the fall of 2017, adult eels were observed wedged under the Graham Lake gates when Black Bear Hydro was permitted to release a lower minimum flow.[75] These observations of large adult eels suggest that some juveniles successfully migrate upstream past the project dams, and that there is habitat upstream capable of supporting eels until adulthood.

Other Migratory Species

Atlantic tomcod are a small (*i.e.*, maximum size of approximately 13 inches) relative of cod, hake, and haddock that inhabit coastal areas from the Hudson River to northern Newfoundland (Stewart and Auster, 1987). Adults spawn in shallow areas of

[74] *See* letters filed by DSF on November 4, 2014 and June 22, 2017.

[75] *See* Interior's letter providing preliminary terms and conditions and preliminary prescriptions, filed April 10, 2018.

freshwater, estuarine, and marine environments, larvae are typically found in freshwater areas, and juveniles typically occupy estuaries. Spawning occurs from November to February. The historic range of tomcod in the project area is the Union River downstream of Ellsworth Falls (Houston et al., 2007), but little is known about their current abundance and distribution (URFCC, 2015).

Resident Fish

The resident fish community in the Union River watershed is composed of cool water and warm water riverine fish species that include trout species and landlocked salmon, yellow perch, white perch, chain pickerel, largemouth and smallmouth bass, and a variety of minnow and sunfish species (Black Bear Hydro, 2015b). The West and Middle branches of the Union River are popular brook trout waters (URFCC, 2015), and brook trout habitat also exists in Tannery Brook and Gilpatrick Brook.[76] Brown trout are stocked in other lakes and ponds within the Union River watershed, and wild brown trout still occur in the Union River (Black Bear Hydro, 2015b). Graham Lake supports productive fisheries for pickerel and white perch (URFCC, 2015). Graham Lake also has a productive fishery for smallmouth and largemouth bass (URFCC, 2015) with bass weighing up to five pounds caught during a tournament in 2014 (Black Bear Hydro, 2015b).

Freshwater Mussels

Ten species of freshwater mussels have been documented in Maine (Swartz and Nedeau, 2007), including three that are state-listed as threatened: brook floater, tidewater mucket, and yellow lampmussel. Six freshwater mussel species have been reported to occur in the Union River watershed (see Table 11) based on multiple surveys conducted by Maine DIFW from 1992 to 1998. Brook floater, eastern elliptio, eastern floater, eastern pearlshell, and triangle floater have been found in Graham Lake, the mainstem Union River, or in tributaries in the project vicinity.

[76] *See* the consultation meeting summary in Black Bear Hydro's Tributary Access Study Report, filed December 22, 2016.

Table 11. Freshwater mussel species reported to occur in the Union River watershed. Locations shown in bold include water bodies within the project boundary or tributaries connected to the project boundary.

Location	Alewife Floater	Brook Floater	Eastern Elliptio	Eastern Floater	Eastern Pearlshell	Triangle Floater
Alligator Lake			✓	✓		✓
Alligator Stream					✓	
Beech Hill Pond			✓			
Branch Lake			✓	✓	✓	✓
Branch Pond			✓	✓		✓
Brandy Pond			✓	✓		
Brandy Stream			✓			
Dead Stream			✓	✓		
Floods Pond			✓	✓		
Graham Lake			✓	✓		
Great Pond			✓			✓
Green Lake			✓	✓	✓	
Main Stream			✓	✓	✓	✓
Molasses Pond			✓	✓		✓
Phillips Lake	✓		✓	✓		
Rocky Pond			✓	✓		
Spectacle Pond			✓	✓		
Tannery Brook					✓	
Union River			✓	✓	✓	✓
Union R. (East Branch)			✓	✓	✓	✓
Union R. (Middle Branch)			✓		✓	✓
Union R. (West Branch)		✓	✓	✓	✓	✓
Webb Brook			✓	✓		✓
Webb Pond			✓	✓		✓

(Source: MDIFW, 2016, as modified by staff).

Black Bear Hydro surveyed the mainstem Union River between Graham Lake and the Route 1A bridge for state-listed brook floater during the summer of 2014. Black Bear Hydro conducted a reconnaissance survey of the entire shoreline, SCUBA surveys along 19 transects, and viewtube surveys of areas less than 3 feet deep around the Route 1A bridge. No brook floaters or other mussels were found during the surveys.

3.3.2.2 Environmental Effects

Impoundment Levels

Graham Lake

Black Bear Hydro proposes to operate Graham Lake between 93.4 feet msl and 104.2 feet msl on an annual basis.[77] Black Bear Hydro proposes to temporarily modify the elevation limits at Graham Lake and Lake Leonard during: (1) approved maintenance activities; (2) extreme hydrologic conditions;[78] (3) emergency electrical system conditions;[79] or (4) agreement among Black Bear Hydro, the Maine DEP, and appropriate state and/or federal fisheries management agencies.

Several commenters filed recommendations to modify the existing minimum and maximum water surface elevations to address concerns regarding the: (1) turbidity of Graham Lake and the Union River; (2) prevention of stranding mussels; and (3) protection of littoral habitat.

In a letter filed on February 9, 2018, Mark Whiting recommends that Black Bear Hydro maintain the water surface elevation of Graham Lake between 98.5 and 103 feet msl to reduce turbidity. In comments filed on April 9, 2018, DSF recommends that Black

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[77] On March 29, 2019, Black Bear Hydro filed a new application for WQC with Maine DEP that includes a proposal to operate Graham Lake between 98.5 and 104.2 feet msl. Although Black Bear Hydro has not filed an amended final license application stating that it is revising its formal proposal to continue operating Graham Lake between 93.4 and 104.2 feet msl, we include Black Bear Hydro's WQC proposal as an alternative operating range to ensure a comprehensive environmental analysis. We refer to this alternative as "BBH Alternative."

[78] *See* note 15, *supra*.

[79] *See* note 16, *supra*.

Bear Hydro maintain Graham Lake between 99.2 and 103.2 feet msl.[80] In a letter filed April 6, 2018, Edward Damm recommends that Black Bear Hydro operate Graham Lake between 96.4 and 102.2 feet msl.[81] Jane Washburn and the Friends of Graham Lake (Friends) recommend that Black Bear Hydro reduce the drawdown of Graham Lake's water surface elevation from 10.8 feet to 5 or 6 feet.[82] In a letter filed April 18, 2018, Thomas and Diane Dunn recommend that Black Bear Hydro operate Graham Lake between 96 and 103 feet msl.

In a letter filed November 2, 2017, Maine DIFW recommends a new maximum drawdown level of no lower than 97.0 feet msl. In addition, Maine DIFW recommends that Black Bear Hydro maintain Graham Lake within 1 foot of 104.2 feet msl from May 20 to June 25 each year. Maine DIFW states that the goal of its recommendation is to enhance bass spawning and reproductive success.

Kathy Cook, DSF,[83] Michelle Dawson, Gretchen Gardner, and Craig Schoppe (Cook *et al.*) recommend that Black Bear Hydro maintain a stable water surface elevation in Graham Lake but did not provide a specific water surface elevation.[84] However, Cook *et al.* did request a water level that would reduce shoreline erosion and improve aquatic

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[80] In the draft EA, staff grouped Mr. Whiting's and DSF's recommendations together because of the similarity of recommended elevations. However, based on comments received after the issuance of the draft EA, staff has separated Mr. Whiting's 2018 recommended elevations and grouped DSF's recommendation with other recommendations involving a 4-foot operating range, such as the range recommended by Gene Flower on February 12, 2019.

[81] In a letter filed February 12, 2018, Ed Damm recommended water surface elevations of 98 and 101.5 to 102 feet msl. In the draft EA, staff assumed that the recommended water surface elevations in the April 6, 2018 letter superseded the elevations in the February 12, 2018 letter.

[82] *See* comments of Friends of Graham Lake (Friends), filed March 26, 2018, and comments of Jane Washburn, filed April 6, 2018. Because Ms. Washburn and Friends did not provide specific water surface elevations in their comments, staff assumes that the elevations submitted by Edward Damm on April 6, 2018 would be acceptable to Ms. Washburn and Friends, given the similarity in the recommended operating ranges.

[83] *See* comments and signed petitions filed by DSF on February 19, 2019.

[84] *See* comments of Kathy Cook, filed March 8, 2018; comments of Michelle R. Dawson, filed April 6, 2018; Gretchen Gardner, filed April 9, 2018.

habitat. Based on Cook *et al*.'s comments regarding shoreline erosion and the requests of several other commenters for the upper water surface elevation to be lowered to protect shoreline property,[85] staff's analysis below includes an alternative water surface elevation range of 102.0 to 103.0 feet msl.

Richard Arnold recommends that Black Bear Hydro lower the maximum water surface elevation to minimize the intensity and duration of high-turbidity events.[86] In addition, he and DSF[87] recommend that Black Bear Hydro protect at least 25 percent of the littoral zone. They did not provide specific water surface elevations. However, based on our turbidity and littoral zone analyses described below, several of the recommendations made by other commenters appear to satisfy Richard Arnold's and DSF's criteria.

In comments on the draft EA, Twyla Bryant and Edward Damm recommend that Black Bear Hydro operate Graham Lake between 98 and 102 feet msl.[88] In a letter filed on February 4, 2019, Mark Whiting and Catherine Fox recommend that Black Bear Hydro maintain the water surface elevation of Graham Lake between 98.4 and 102.4.[89] Given the similarity of the recommendations of Ms. Bryant, Mr. Damm, and Mr. Whiting and Ms. Fox, staff grouped these recommendations and analyzed the effects of operating Graham Lake between 98.0 and 102.0 feet msl. In comments on the draft EA filed February 13, 2019, Gene Flower recommends lower and upper water surface elevations of 99.0 to 103.0 feet msl, which are similar to DSF's recommended elevations.

In response to the Commission's February 9, 2018 notice requesting comments, recommendations, terms and conditions, and prescriptions, 32 commenters recommended

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[85] *See* comments of Thomas P. Dunn, filed April 18, 2018; comments of Michelle R. Dawson, filed April 6, 2018; Friends of Graham Lake, filed March 26, 2018; Richard Arnold, filed March 6, 2018; and Edward A. Damm, filed February 2, 2018.

[86] *See* comments of Richard Arnold, filed March 6, 2018.

[87] *See* comments and signed petitions filed by DSF on February 19, 2019.

[88] *See* comments of Twyla Bryant, filed January 16, 2019 and comments of Edward Damm, filed February 25, 2019.

[89] In a letter filed February 9, 2018, Mark Whiting (Whiting 1) initially recommended that Black Bear Hydro maintain the water surface elevation of Graham Lake between 98.5 and 103 feet msl to reduce turbidity. While staff assumes that his 2019 recommendation supersedes his 2018 recommendation, staff has retained his 2018 recommendation in the analyses below.

a smaller water surface elevation range, but did not provide a specific range (*e.g.*, a 5-foot range) or specific water surface elevations. Consequently, staff assumes that any of the aforementioned alternatives would be acceptable to the commenters because they provide smaller ranges than Black Bear Hydro's current and proposed operation. Similarly, 49 commenters on the draft EA support a 4-foot operating range, but did not provide specific water surface elevations. Therefore, staff assumes that the recommendations by Bryant *et al*. or DSF and Flower would be acceptable.

Our Analysis

<u>Turbidity of Graham Lake and the Union River</u>

Turbidity and suspended sediment can potentially affect all trophic levels of aquatic ecosystems. High turbidity can limit the growth and abundance of phytoplankton, periphyton, and submerged aquatic vegetation (Donohue and Garcia Molinos, 2009). High suspended sediment concentrations can reduce the abundance and growth rates of zooplankton in lakes and reservoirs (Donohue and Garcia Molinos, 2009). Settling sediment reduces the quality of cobble and gravel substrate in lotic and lentic habitats by filling in the interstitial spaces, which reduces the quality of macroinvertebrate habitat (Gammon, 1970; Donohue and Garcia Molinos, 2009). In turn, the reduction in habitat quality can reduce the abundance of macroinvertebrates and alter the species composition of the macroinvertebrate community (Gammon, 1970; Donohue and Garcia Molinos, 2009). Suspended sediment can also have direct negative effects on the health and growth of fish by reducing feeding rates and success (Newcombe and Jensen, 1996). Sedimentation can negatively affect the reproductive success of fish by reducing hatching success, delaying hatching, and directly smothering eggs and larvae (Newcombe and Jensen, 1996). Newcombe and Jensen (1996) reported that extended exposure to low and intermediate levels of suspended sediment (*e.g.*, weeks to months of exposure to suspended sediment levels of less than 20 mg/L) could cause moderate habitat degradation, reduced feeding rates and success for fish, and physiological stress for fish.

Graham Lake is one of the most turbid impoundments in Maine. Of the 900 lakes and impoundments monitored by the Lake Stewards of Maine, only 55 (*i.e.*, 6.1 percent) have a shallower average Secchi depth than Graham Lake based on the Secchi depth data collected by Black Bear Hydro and the Lake Stewards (Black Bear Hydro, 2014; Maine DEP, 2017; see Figure 7). As described in section 3.3.2.1, *Affected Environment, Aquatic Habitat*, the shoreline of Graham Lake is composed of fine, erodible soils in many locations. The length and width of Graham Lake provide long fetches over which persistent winds can generate waves that erode soils and cause suspension of sediment in the water column and increase turbidity. Other weather-related events, such as high precipitation events and ice break-up may contribute to sediment suspension and turbidity in Graham Lake. Furthermore, lowering Graham Lake's water surface elevation exposes additional erodible soil in the form of extensive mudflats between the water and the shoreline. Runoff from rain events can carry sediment from the exposed mudflats into the impoundment (Lawson, 1985; Römkens *et al*., 2001), and sediment can become suspended as water moves over the mudflats when the impoundment is refilled or drawn down (Dirnberger and Weinberger, 2005; Carmignani and Roy, 2017). Sediment eroded from the exposed mudflats likely contributes to the shallower Secchi depths observed in May following the spring drawdown and refill, and in September following the summer drawdown (see Figure 5 and Figure 8).

To estimate the area of the impoundment bottom that would be exposed when Graham Lake is drawn down to the existing and recommended minimum water surface elevations, staff used a regression analysis to quantify the relationship between impoundment surface area and water surface elevation.[90] Staff then estimated the surface area of Graham Lake at the upper and lower water surface elevations for each recommendation. The difference in surface area at the upper and lower recommended elevations is the amount of impoundment bottom that would be exposed at the lower elevation and, therefore, susceptible to erosion from runoff and when the impoundment refills. Lowering the impoundment to 93.4 feet msl, as allowed under the current license, would expose 2,668 acres of impoundment bottom while Black Bear's alternative operating range in its WQC application would expose 1,623 acres. Cook *et al*.'s recommendation would expose 290 acres. The recommendations by Bryant *et al*. and DSF and Flower would expose 1,012 and 1,030 acres, respectively. The remaining recommendations would expose between 1,202 and 1,966 acres. Therefore, Cook *et al*.'s recommendation would provide the greatest protection from erosion caused by runoff from rain events and during refill since less area would be exposed at the lowest elevation.

To assess the potential effects of the seasonal drawdown on turbidity in Graham Lake, staff analyzed the water transparency in Graham Lake at specific water surface elevations using Secchi depth data collected by the Lake Stewards from 2001 to 2017 and water surface elevation data provided by Black Bear Hydro.[91] The Lake Stewards

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[90] The regression analysis was based on the surface area of Graham Lake at five different water surface elevations (Black Bear Hydro, 2015a). The equation resulting from the regression analysis predicted an impoundment surface area within two percent of the surface area that Black Bear provided for each of the five water surface elevations. The equation is as follows: Surface area = $6.4804(\text{elevation})^2 - 1038.7(\text{elevation}) + 47856$, $R^2 = 99.5$ percent, $p = 0.005$.

[91] Staff estimated the midpoint of the monthly water surface elevations to the nearest 0.1 feet based on the 2001 to 2007 annual operating curves filed April 8, 2013 and used those monthly midpoints as the water surface elevation for the day the Lake

recorded Secchi depth in Graham Lake between 2001 and 2017, primarily between May and October (Maine DEP, 2018a). Using Maine DEP's draft Secchi depth criteria of 2 meters as a benchmark for identifying high and low turbidity, 9 out of the 14 monthly average Secchi depth observations that were less than 2 meters occurred between 103.0 and 104.2 feet msl (see Figure 14). This indicates that water elevations between 103.0 and 104.2 feet msl are more commonly associated with lower water transparency than water elevations between 102.0 and 103.0 feet msl (5 out of 11), for example.

Stewards measured Secchi depths from 2001 to 2007. Black Bear Hydro provided daily water surface elevation data for Graham Lake from 2008 to 2015 in a letter filed May 12, 2016. Black Bear Hydro provided hourly water surface elevation data for January to November 2017 in a letter filed November 30, 2017. When Secchi depth was collected multiple times during a month, staff averaged the Secchi depths and daily average water surface elevation for the days when Secchi depth was collected.

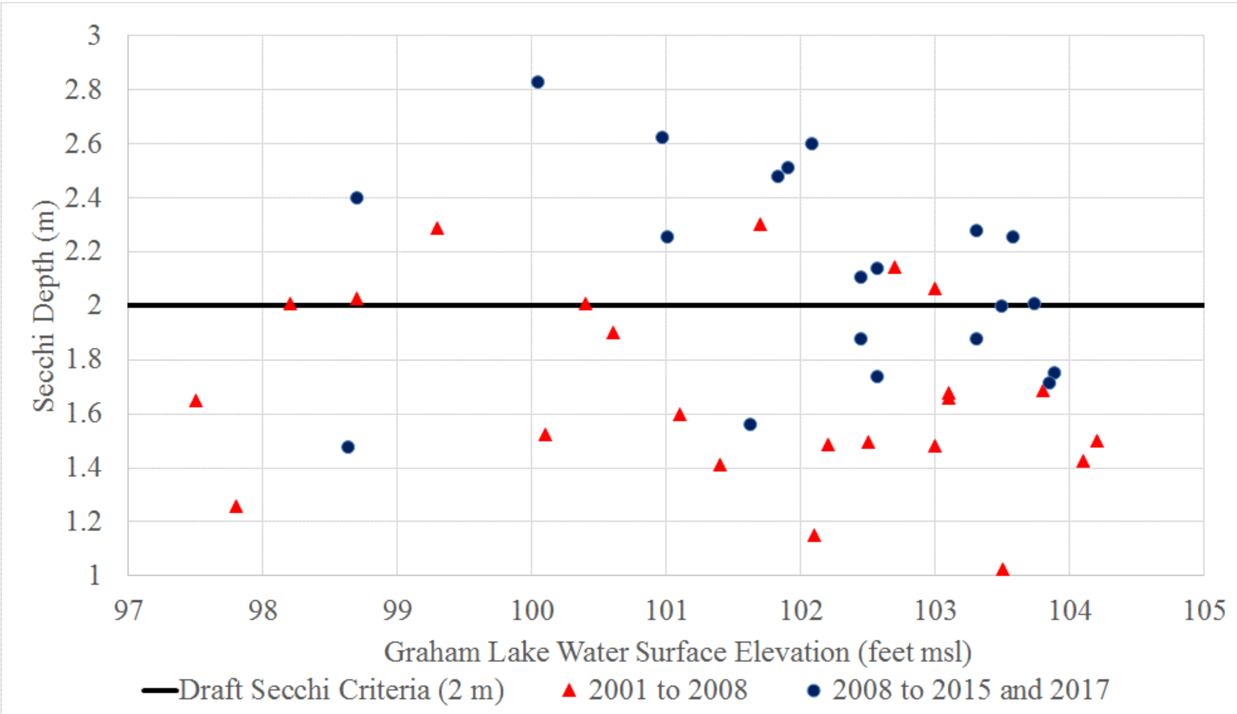

Figure 14. Secchi depth versus Graham Lake's water surface elevation. Maine DEP's draft Secchi depth criteria is shown by the black line. Staff estimated the water surface elevations from the 2001 to 2007 annual operating curves for the data shown by the red triangles. Black Bear Hydro provided the water surface elevation information for the data shown by the blue circles. (Source: Black Bear Hydro[92] and Maine DEP, 2018a).

Using the Secchi depth data from 2001 to 2017 shown in Figure 14, staff calculated the number and percentage of observations with Secchi depths less than 2 meters that occurred at different elevations from 98.0 to 104.2 feet msl (Table 12). While turbid conditions (*i.e.*, Secchi depths greater than or equal to 2 m) occurred at all elevations, turbid conditions occurred most frequently at elevations greater than 103.0 feet msl and at elevations less than 99.0 feet msl.

[92] *See* letters filed by Black Bear Hydro on May 12, 2016 and November 30, 2017.

Table 12. Frequency of turbid conditions in Graham Lake at different water surface elevations.

Elevation Range (feet msl)	Number of Observations	Number of Observations with Secchi Depth Less than 2m	Percent of Observations with Secchi Depth Less than 2m
elevation ≥ 104.0	1	1	100.0
103.0 ≤ elevation < 104.0	13	8	61.5
102.0 ≤ elevation < 103.0	11	5	45.5
101.0 ≤ elevation < 102.0	5	2	40.0
100.0 ≤ elevation < 101.0	4	2	50.0
99.0 ≤ elevation < 100.0	7	3	42.9
98.0 ≤ elevation < 99.0	6	4	66.7

(Source: Staff analysis of data provided by Black Bear Hydro[93] and Maine DEP, 2018a).

Staff also calculated the number and percentage of observations with Secchi depths less than 2 meters during the same time period for each recommendation (see Table 13). Under Black Bear Hydro's current operation and Maine DIFW's recommendation, 25 out of 47 observations had a Secchi depth of less than 2 meters (see Table 13). Between the elevations recommended by Bryant *et al*. (98.0 to 102.0 feet msl), the number of observations with Secchi depths less than 2 m was 11 out of 22, or 50.0 percent (see Table 13). Between the elevations recommended by Cook *et al*. (102.0 to 103.0 feet msl), the number of observations with Secchi depths less than 2 m was 5 out of 11, or 45.5 percent, which was similar to the percentage of observations seen under DSF and Flower's recommendation(see Table 13). Based on the information shown in Table 12, lowering the upper impoundment water surface elevation is associated with a reduction of the frequency of high turbidity conditions. However, the effect of lowering the upper impoundment elevation on the frequency of high turbidity events appears greatest between 103.0 and 104.2 feet msl and appears to diminish for the recommended upper elevations below 103.0 feet msl (Table 12 and Table 14). Therefore, an upper water surface elevation of 103.0 feet msl as recommended by Cook *et al*., DSF and Flower, Dunn, and Whiting 1 would provide greatest reduction of project effects on turbidity in Graham Lake.

[93] *Ibid*.

Table 13. The number of observations of Secchi depth less than 2 meters for the recommended water surface elevations.

Alternative	Recommended Water Surface Elevations (feet msl)	Elevation Range (feet)	Number of Observations with Secchi Depth Less than 2 meters	Percent of Observations with Secchi Depth Less than 2 meters
Black Bear Hydro	93.4 to 104.2	10.8	25 out of 47	53.2
Maine DIFW	97.0 to 104.2	7.2	25 out of 47	53.2
Dunn	96.0 to 103.0	7.0	16 out of 33	48.5
Washburn and Friends	96.4 to 102.2	5.8	11 out of 23	47.8
BBH Alternative	98.5 to 104.2	5.7	23 out of 44	52.3
Whiting 1	98.5 to 103.0	4.5	14 out of 30	46.7
Bryant *et al*.	98.0 to 102.0	4.0	11 out of 22	50
DSF and Flower	99.0 to 103.0	4.0	12 out of 27	44.4
Cook *et al.*	102.0 to 103.0	1.0	5 out of 11	45.5

Source: Staff analysis of data provided by Black Bear Hydro[94] and Maine DEP, 2018a).

As described earlier, Newcombe and Jensen (1996) reported that the effects of suspended sediments on aquatic organisms and their habitat depend upon the duration of exposure. Because Graham Lake's shallow Secchi depth appears to be related to suspended sediments, reducing the number and frequency of shallow Secchi depth events would reduce the duration of exposure to suspended sediments, and thereby reduce the effects of turbidity and sedimentation on aquatic organisms and habitat within and downstream of Graham Lake. Operating Graham Lake with the current upper and lower water surface elevations, as proposed by Black Bear Hydro, would continue the existing seasonal drawdowns in the impoundment, and turbidity levels would likely remain unchanged. The recommendations by DSF and Flower, Washburn and Friends, and Whiting 1 appear to provide similar improvement in both the number and percentage of observations with shallow Secchi depth and the average Secchi depth, relative to the existing minimum and maximum elevation limits at the project (see Table 13).

[94] *Ibid*.

Seasonal Tributary Sediment Loads

In comments on the draft EA, Black Bear Hydro states that reservoir water clarity and turbidity can be impacted by many factors, one of which is higher inflows and increased sediment loading from tributaries or runoff during periods of higher precipitation in the spring and fall. Black Bear Hydro states that any analysis of water clarity that ignores the impacts of run-off and tributary inflows that carry higher sediment content is flawed.

While tributaries can carry suspended sediment into Graham Lake and affect water clarity in the impoundment, there are aspects about the Union River watershed that suggest that tributary inflow in the spring and fall is not the driving force behind the high turbidity of Graham Lake. Over 90 percent of Hancock County is forested (USDA, 2005), and the riparian zone of the tributaries to Graham Lake are largely forested or vegetated. Forested and vegetated riparian zones are highly effective for reducing sediment input into streams (National Research Council, 2002). Moreover, the erosion rate from undisturbed forest is very low (Stolte, 1997), and undisturbed forest soils can absorb water much faster than typical rainfall or snowfall rates (Chamberlin *et al.*, 1991). Therefore, suspended sediment loads from the tributaries of Graham Lake are likely low.

The highly successful spawning of stocked Atlantic salmon broodstock in the West Branch of the Union River in 2011 (see section 3.3.4.1 *Threatened and Endangered Species, Atlantic Salmon*) further indicates that sediment input into the West Branch is low in the fall through the spring. Salmon require gravel and cobble substrate that is free of fine sediment for spawning habitat. Given the proven suitability of the spawning habitat in the West Branch of the Union River, it is unlikely that the West Branch routinely delivers large amounts of suspended sediment to Graham Lake. Because the other tributaries to Graham Lake are similarly forested, it seems unlikely that the other tributaries have high suspended sediment loads. In fact, Alligator Lake, Beech Hill Pond, Floods Pond, Green Lake, Halfmile Pond, Hopkins Pond, and Webb Pond, all of which drain into Graham Lake or its tributaries, have Secchi depths that are consistently deeper than Graham Lake (Maine DEP, 2018c). Because these lakes and ponds are in the forested Union River watershed and have deeper Secchi depths, it is unlikely they are receiving/contributing suspended sediment loads high enough to cause the high turbidity observed in Graham Lake. In addition, since these lakes and ponds are located upstream of Graham Lake, they should act as sediment traps and potentially reduce the amount of sediment entering Graham Lake.

Water Color

In its comments on the draft EA, Black Bear Hydro states that the shallow Secchi depths in Graham Lake are caused by water color rather than suspended sediment.

The color and transparency of water are affected by the amount of phytoplankton, suspended sediments, and dissolved organic material, such as tannins (Menken *et al*., 2006). During the 2014 water quality study, Black Bear Hydro recorded true color[95] values in Graham Lake ranging from 39.0 to 121.0 platinum-cobalt units (PCU), which indicate that Graham Lake is strongly colored. The high color values in Graham Lake likely contribute to the observed shallow Secchi depths to some degree. Black Bear Hydro is also correct that Webb Pond and Great Pond are strongly colored.[96] However, while strongly colored, both ponds have deeper Secchi depths than Graham Lake.[97] In fact, based on true color and Secchi depth measurements from 583 lakes, ponds, and impoundments sampled by the Lake Stewards, Secchi depth in Graham Lake is consistently among the shallowest at a given value of true color (Figure 9). Given that Secchi depths in Graham Lake are shallower than expected based on its true color values and chlorophyll a values are also relatively low, turbidity from suspended sediment appears to be the dominant factor affecting Secchi depth in Graham Lake.

Erosion at Maximum Water Elevations

As discussed in section 3.3.1, *Geology and Soil Resources*, sections of the shoreline along Graham Lake consist of highly erodible soils, including sand and gravel, and erosion is occurring in select areas along the shoreline of Graham Lake, including bank slumps located primarily along the western shore of the impoundment.

The current license provides for a maximum water elevation limit of 104.2 feet msl at Graham Lake. From 1999-2014, the average daily water surface elevation at

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[95] Water color can be measured and reported as "apparent color" and "true color." Apparent color is measured from the water sample as collected and represents the color caused by dissolved and suspended material, including suspended sediment, in the sample. True color is measured after filtering the water sample and represents the color caused by dissolved material only.

[96] Black Bear Hydro stated that Webb Pond had a color value of 90 PCU. However, the Lake Stewards reported that value as apparent color, not true color. Apparent color measurements include the effect of suspended sediment on color, which may result in a higher color value. The Lake Stewards measured true color for Webb Pond on August 20, 2015 and reported a value of 32 PCU.

[97] Webb Pond had a Secchi depth of 2.7 m on September 6, 1979 and a Secchi depth of 4.2 m on August 20, 2015 when true color was also measured. Similarly, Great Pond had a Secchi depth of 3.6 m on September 9, 2014 when true color was also measured. Based on data collected by Black Bear Hydro and the Lake Stewards of Maine, the average Secchi depth for Graham Lake is 1.91 m.

Graham Lake exceeded a water elevation of approximately 102 feet msl between mid-April and mid-July, during the time in which the impoundment was being refilled by snowmelt and prior to the impoundment drawdown in the late summer and early fall (Figure 5). In their comments, landowners recommend that the maximum lake level elevation of 104.2 feet msl be reduced by as much as 2.2 feet to reduce shoreline erosion from high water levels in the spring and the resulting turbidity in the impoundment.[98]

Reducing the maximum shoreline elevation could reduce erosion and turbidity by reducing the extent of inundation and wave action at the upper elevations of Graham Lake. Specifically, lowering the upper water surface elevation would reduce the amount of shoreline (*i.e.*, the perimeter of the impoundment) exposed to wave action and periodic inundation. The length of the impoundment perimeter for each of the recommended upper water surface elevations is shown in Table 14.[99] Based on the relationship between shoreline length and impoundment elevation, the extent of wave action on the Graham Lake shoreline would decrease from a maximum impoundment elevation of 104.2 feet msl to an elevation of 102.0 feet msl.

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[98] *See* comments of Richard Arnold, filed March 6, 2018; intervention request of Friends of Graham Lake Association, filed March 26, 2018; comments of Michelle R. Dawson, filed April 6, 2018; intervention request of the Frenchmen Bay Conservancy, filed April 9, 2018; comments of Jane Washburn, filed April 6, 2018; comments of Thomas P. and Diane Dunn, filed April 18, 2018; comments of Edward A. Damm, filed April 6, 2018; comments of Twyla Bryant, filed January 16, 2019 and January 18, 2019; comments of Mark Whiting and Catherine Fox, filed on February 4, 2019; and comments and signed petitions filed by DSF on February 19, 2019.

[99] Staff estimated the perimeter of Graham Lake at different water surface elevations based on the impoundment area and perimeter data provided by Maine DEP and Maine DIFW (2010) and the surface area versus water surface elevation relationship described above.

Table 14. Impoundment perimeter for the recommended upper water surface elevations.

Alternative	Upper Elevation (feet msl)	Perimeter (miles)	Reduction of Perimeter from Perimeter at 104.2 feet msl (miles)	Percent Reduction of Perimeter from Perimeter at 104.2 feet msl
Black Bear Hydro and Maine DIFW	104.2	92.9	NA	NA
Cook *et al.*, DSF and Flower, Dunn, and Whiting 1	103.0	90.9	2.0	2.2
Washburn and Friends	102.2	89.8	3.1	3.4
Bryant *et al.*	102.0	89.5	3.4	3.8

(Source: Staff analysis of data provided by Black Bear Hydro[100] and Maine DEP and Maine DIFW, 2010).

Bryant, *et al.*'s recommended maximum elevation of 102.0 feet msl is the lowest of the proposed maximum elevations. At 102.0 feet msl, the maximum impoundment elevation would be 2.2 feet lower than the existing maximum impoundment elevation. A reduction of 2.2 feet would reduce the wave action on the edge of the impoundment between the elevation of 102.0 feet msl and the existing maximum elevation limit of 104.2 feet msl, and thereby reduce the potential for erosion to occur at the shoreline. Cook, *et al.*'s, DSF and Flower's, Dunn's, and Whiting 1's recommended maximum elevation of 103.0 feet msl would reduce the maximum elevation of Graham Lake by 1.2 feet relative to existing conditions. Similar to Bryant *et al.*'s recommendation, a maximum elevation of 103.0 feet msl would reduce the wave action at upper elevations, thereby reducing the potential for shoreline erosion and turbidity in Graham Lake. Altogether, relative to the existing maximum elevation limit that Black Bear proposes to continue maintaining, the elevation limits proposed by Bryant *et al.*, Cook *et al.*, DSF and Flower, Dunn, and Whiting 1 would reduce project effects on shoreline erosion and turbidity in Graham Lake.

[100] *See* letters filed by Black Bear Hydro on May 12, 2016 and November 30, 2017.

Protection of Littoral Habitat

Impoundment drawdowns can affect aquatic resources by dewatering littoral habitat used by fish and mussels for cover, foraging, and spawning. In addition, impoundment drawdowns can reduce the abundance, and affect the species composition, of the macroinvertebrate community occupying the littoral zone. Seasonal impoundment drawdowns can also prevent the establishment of submerged aquatic vegetation.

Maine DEP recommends that 75 percent of the littoral zone remain wetted to protect aquatic habitat.[101] Maine DEP defines the depth of the littoral zone as twice the average Secchi depth.[102] Therefore, 75 percent of the area between the maximum water surface elevation and the elevation at twice the Secchi depth should remain wetted for compliance with Maine DEP's recommendation.

The average Secchi depth for Graham Lake during the 2013 study was 1.77 meters, which indicates that the depth of the littoral zone is 3.54 meters, or 11.6 feet. The area of Graham Lake at full pond elevation (*i.e.*, 104.2 feet msl) is 10,042 acres (Black Bear Hydro, 2015b). The littoral zone reaches an elevation of 92.6 feet msl (*i.e.*, 104.2 feet msl – 11.6 feet = 92.6 feet msl), and Black Bear Hydro estimates the area of Graham Lake at this elevation to be approximately 7,232 acres (Black Bear Hydro, 2015b). Therefore, the area of the littoral zone is approximately 2,810 acres. Seventy-five percent of 2,810 acres is 2,107.5 acres, which means a maximum of 702.5 acres (*i.e.*, 2,810 acres – 2,107.5 acres = 702.5 acres) may be exposed at the lowest impoundment elevation in order to maintain consistency with Maine DEP's littoral zone protection recommendation. To be consistent with Maine DEP's guidance, the wetted area of Graham Lake would be no less than 9,339.5 acres (10,042 acres – 702.5 acres), which Black Bear Hydro (2015b) states would be provided at an impoundment elevation of 102.5 feet msl. Because the current license allows Black Bear Hydro to draw Graham Lake down to 93.4 feet msl, Maine DEP states that Graham Lake does not attain the Class C aquatic life requirements associated with the effects of impoundment drawdown on aquatic habitat (Maine DEP, 2016).

To evaluate the project effect on the amount of littoral habitat that remains wetted within the existing 93.4 to 104.2 feet msl elevation operating range for Graham Lake (Black Bear Hydro's proposal), and under each recommended operating range submitted

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[101] *See* Maine DEP's February 21, 2013 letter.

[102] The littoral zone is the shallow area along the shoreline of a lake or impoundment. Littoral habitat often contains aquatic vegetation and woody debris that aquatic organisms use as foraging, spawning, and nursery habitat. The depth of the littoral zone is the maximum depth at which light will reach the bottom, which can be estimated by doubling the Secchi depth.

by stakeholders, staff used the previously described regression equation to quantify the relationship between impoundment surface area and water surface elevation. Staff estimated the surface area of Graham Lake at the upper and lower water surface elevations for each recommendation (see Table 15). Assuming that the depth of the littoral zone would be the same for each proposal or recommendation (*i.e.*, 11.6 feet from the upper water surface elevation, which is twice the average Secchi depth during the 2013 water quality survey), staff estimated the Graham Lake surface area at the elevation corresponding to the bottom of the littoral zone. The difference between the surface area at the recommended lower water surface elevation and the surface area at the bottom of the littoral zone corresponds to the amount of littoral area that would remain wetted for that proposal or recommendation, which ranges from 5.0 to 88.7 percent (see Table 15).

Table 15. Summary of recommended minimum and maximum water surface elevations, resulting littoral area, and amount of littoral zone remaining wetted.

Alternative	Min. Elev. (feet msl)	Max. Elev. (feet msl)	Operating Range (feet)	Area at Max. Elevation (acres)	Area at Min. Elevation (acres)	Lower Elevation of Littoral Zone (feet msl)	Area at Bottom of Littoral Zone (acres)	Total Littoral Area (acres)	Littoral Area Remaining Wetted at Lower Elevation (acres)	Percent of Littoral Area Remaining Wetted at Lower Elevation
Black Bear Hydro Proposal	93.4	104.2	10.8	10,042	7,374	92.6	7,232	2,810	142	5.0
Maine DIFW	97.0	104.2	7.2	10,042	8,076	92.6	7,232	2,810	844	30.0
Dunn	96.0	103.0	7.0	9,620	7,864	91.4	7,056	2,564	808	31.5
Washburn and Friends	96.4	102.2	5.8	9,388	7,947	90.6	6,943	2,445	1,004	41.1
BBH Alternative	98.5	104.2	5.7	10,042	8,419	92.6	7,232	2,810	1,187	42.2
Whiting 1	98.5	103.0	4.5	9,620	8,419	91.4	7,056	2,564	1,363	53.1
Bryant *et al*.	98.0	102.0	4.0	9,331	8,301	90.4	6,916	2,414	1,385	57.4
DSF and Flower	99.0	103.0	4.0	9,620	8,608*	91.4	7,056	2,564	1,552	60.5
Cook *et al.*	102.0	103.0	1.0	9,620	9,331	91.4	7,056	2,564	2,275	88.7

* Black Bear Hydro (2015a) measured the surface area of Graham Lake at an elevation of 99.0 feet msl, and the value shown for the area at minimum elevation is the value Black Bear Hydro (2015a) provided.
(Source: staff)

The current operating range that Black Bear proposes to maintain would leave only 5 percent of the littoral zone wetted if the full operating range is used. However, Black Bear Hydro rarely lowers Graham Lake below 95.0 feet msl (see Figure 5), which leaves approximately 15.4 percent of the littoral zone wetted. Dewatering such a large proportion of the littoral zone adversely affects aquatic habitat and likely reduces the production of fish and macroinvertebrates. The alternative operating range that Black Bear Hydro included in its WQC application would protect 8.4 times the littoral habitat than the existing 10.8-foot operating range. The recommendations submitted by commenters result in at least 30 percent of the littoral zone remaining wetted, increasing the amount of persistent littoral habitat 6.0 to 17.7 times over Black Bear Hydro's current 10.8-foot operating range.

Allowing a greater percentage of the littoral zone to remain permanently wetted would provide three important benefits for fish and other aquatic organisms. First, it would increase the amount of juvenile, adult, and foraging habitat available to fish on a more consistent basis. Second, additional persistent aquatic habitat availability could enhance populations of macroinvertebrates, a valuable food source for fish. Third, a larger and more stable littoral zone would allow existing beds of aquatic vegetation, which are currently rare in Graham Lake (Black Bear Hydro, 2014), to expand over time and also allow new areas to be colonized by aquatic vegetation. Submerged aquatic vegetation provides habitat for aquatic macroinvertebrates and fish (Miller *et al*., 2018), stabilizes sediments, reduces resuspension of sediment, and reduces turbidity (Madsen *et al*., 2001), which could further increase the depth of Graham Lake's littoral zone.

Mussel Stranding

Ed Damm and Mark Whiting reported finding dead mussels on exposed mudflats in Graham Lake during 2016 and 2017.[103] In his February 9, 2018 letter, Mark Whiting stated the dead mussels were found on the dewatered impoundment bottom between elevations of approximately 94 and 96 feet msl in 2017, and the oldest (*i.e.*, largest) mussels occurred near 94 feet msl.

While the current license allows Black Bear Hydro to operate Graham Lake between 93.4 and 104.2 feet msl, the 1999 to 2014 daily average water surface elevation occurred within a much smaller range of approximately 98.2 to 103.5 (Black Bear Hydro, 2015b; see Figure 5). The minimum daily average water surface elevation observed between 1999 and 2014 period was approximately 95.0 feet msl (see Figure 5). However, Graham Lake has approached or dropped below 95.0 feet msl each year since

[103] *See* letters filed by Edward Damm on March 24, 2017 and Mark Whiting on February 9, 2018.

2014.[104] For example, Graham Lake's water surface elevation dropped below the target operating curve to 95.4 feet msl during October 2016 and 93.9 feet msl during October 2017. Black Bear Hydro states that the lower water elevations in 2016 and 2017 are attributable to persistent drought conditions during those years.[105]

The mussel strandings observed in 2016 and 2017 appear to be related to extreme hydrologic conditions that occur relatively infrequently. Based on the water surface elevation information provided by Black Bear Hydro, the water surface elevation of Graham Lake has only dropped below 96.0 feet msl on ten occasions and below 95.0 feet msl on five occasions from 2001 to 2017. The observation that the mussels were found between approximately 94 and 96 feet msl is consistent with fact that Graham Lake's water surface elevation rarely drops below 95.0 feet msl. If Black Bear Hydro used the full extent of the existing 93.4 to 104.2 feet msl operating range every year, mussels would not likely colonize elevations greater than 93.4 feet msl.

In addition, mussel stranding could occur under the other recommended operational ranges if the full elevation ranges are not used each year. Mussels would be expected to colonize areas that are typically inundated by the impoundment on a year-round basis and could become stranded if extreme hydrologic conditions or project maintenance causes the impoundment elevation to be reduced below typical operating conditions. Therefore, Cook *et al.*'s recommendation would be the most protective for mussels because the full operating range likely would be used each year.

Enhancement of Bass Spawning and Reproductive Success

Maine DIFW recommends that Black Bear Hydro maintain Graham Lake within 1 foot of 104.2 feet msl from May 20 to June 25 each year to enhance smallmouth and largemouth bass spawning and reproduction success. Smallmouth and largemouth bass use shallow areas to build nests, deposit and incubate eggs, rear newly hatched fry, and forage. Smallmouth and largemouth bass spawn at water temperatures between 55 ºF and 70 ºF, which occur from around May to July. Male bass construct their nest in water averaging 1 to 3 feet deep and ranging from 0.5 to 23 feet deep (Stuber *et al.*, 1982; Edwards *et al.*, 1983). Males guard the eggs and fry for several days until the fry leave the nest. Water level drawdowns during smallmouth bass spawning and the nest-guarding period could adversely affect bass spawning success by dewatering nests or creating shallow conditions that disrupt spawning and nest-guarding behavior. Maine

[104] *See* letters filed by Black Bear Hydro on May 12, 2015 and November 30, 2017.

[105] *See* the State of Maine Drought Task Force's 2016 and 2017 hydrologic reports included in the letter filed by Black Bear Hydro on November 30, 2017.

DIFW, therefore, states that any drawdowns during the spawning period could be detrimental to bass reproductive success.

Graham Lake has an established fishery for both bass species. Maine DIFW surveyed the smallmouth bass population in 2003 and found that the average length of smallmouth in Graham Lake was 12.7 inches, and the average weight was just under one pound (URFCC, 2004). At the time, Maine DIFW stated that anglers reported that bass between 14 and 16 inches were common (URFCC, 2004). More recently, the average weight of bass (species not specified) for eight anglers in a bass tournament in 2014 ranged from 1.7 to 5.2 pounds (Black Bear Hydro, 2015b). No comments have been filed suggesting a lack of quality-sized bass or that reproductive success has been low.

Based on the Graham Lake water surface elevation Black Bear Hydro provided for 2008 to 2017, the daily average water surface elevations varied by more than 1 foot between May 20 to June 25 in four out of the nine years. During those four years, the changes in water surface elevations ranged from 1.1 to 1.5 feet, which may have dewatered some bass nests or caused nest abandonment. Based on the lack of evidence that project operation is adversely affecting bass reproductive success in Graham Lake, it seems unlikely that water surface elevation drawdowns that exceed Maine DIFW's recommendation by 0.1 to 0.5 feet would have a substantial negative effect on bass reproductive success. Therefore, it does not appear that the existing project operation is causing significant adverse effects to bass spawning and reproductive success.

None of the commenters' recommendations specifically suggest altering the operation of Graham Lake during the bass spawning period. Because bass typically spawn in 1 to 3 feet of water and can spawn at greater depths, a portion of the nests constructed in a given year should remain adequately protected as long as the water surface elevation does not drop more than 2 feet during the spawning period. Therefore, none of the recommended operating ranges would be expected to have significant adverse effects on the bass population.

Flood Control

In comments on the draft EA, Black Bear Hydro states that the analysis should discuss the ancillary flood control benefits provided by the current seasonal drawdown regime of Graham Lake and the effect that changes in impoundment elevation limits may have on flood storage potential. Black Bear Hydro states that reducing the allowable operating range of the reservoir in accordance with the Whiting 1 alternative, as recommended by Commission staff in the draft EA, would result in the loss of 2.42 billion cubic feet of useable storage of the project. Black Bear Hydro states that the loss of this operating capacity would be a critical loss to the management of snowmelt and spring runoff, and may result in increased spillage during significant runoff periods (estimated to be approximately 2.8 billion cubic feet, or 65 percent more spillage than under the existing conditions). Black Bear Hydro states that increasing spillage during spring runoff could increase flooding downstream of the Graham Lake Dam.

The Ellsworth Project operates primarily as a peaking generation facility, with ancillary flood control benefits. The ability to store and release water at Graham Lake allows the project to operate in peaking mode during periods of high electric demand.[106] Reducing the operating range of Graham Lake would reduce the storage potential of the project. The storage capacity associated with the existing operating range of 93.4 to 104.2 feet msl is 108,000 acre-feet; whereas, the operating range of 98.5 to 103.0 feet msl recommended by Whiting 1 would provide a storage capacity of 45,000 acre-feet (see Table 16).

Table 16. Summary of recommended minimum and maximum water surface elevations, and resulting storage capacities.

Alternative	Minimum Elevation (feet msl)	Maximum Elevation (feet msl)	Operating Range (feet)	Storage Capacity (acre-feet)*	Percent Reduction in Storage Potential
Black Bear Hydro current operation	93.4	104.2	10.8	108,000	0
Maine DIFW	97.0	104.2	7.2	72,000	33
Dunn	96.0	103.0	7.0	70,000	35
Washburn and Friends	96.4	102.2	5.8	58,000	46
BBH Alternative	98.5	104.2	5.7	57,000	47
Whiting 1	98.5	103.0	4.5	45,000	58
Bryant *et al.*	98.0	102.0	4.0	40,000	63

[106] Black Bear Hydro's December 30, 2015 Final License Application, Exhibit B at B-1.

Alternative	Minimum Elevation (feet msl)	Maximum Elevation (feet msl)	Operating Range (feet)	Storage Capacity (acre-feet)*	Percent Reduction in Storage Potential
DSF and Flower	99.0	103.0	4.0	40,000	63
Cook *et al.*	102.0	103.0	1.0	10,000	91

***** The storage capacity for each alternative was derived from the Graham Lake stage-storage curve filed by Black Bear Hydro on May 12, 2016.
(Source: staff).

Although the project is primarily operated as a peaking generation facility, Black Bear Hydro also manages water levels in Graham Lake during flood conditions to minimize the risk of flooding downstream of the project.[107] Historically, no complaints or concerns have been filed on the project record to indicate that flooding issues have occurred either upstream or downstream of the project, including during periods of high inflow and spillage from the Ellsworth Dam. For example, from late March to late April, 2009, average daily inflows were above the hydraulic capacity of the Ellsworth powerhouse (*i.e.*, 2,460 cfs) for 20 days and reached a maximum of 10,130 cfs on April 5, 2009. Leading up to this high flow event, Graham Lake's elevation was at 95.2 feet msl. When high flows of 4,262 cfs reached the project on March 30, 2009, Graham Lake's elevation was already at 97.5 feet msl. The elevation increased to 100.0 feet msl by April 4, 2009, after multiple consecutive days of high inflow. At this time, the licensee began spilling flows over the spillway at the Ellsworth Dam on a regular basis until April 13, 2009. The licensee also spilled flows from April 22 to April 27, 2009 during another multi-day high flow event ranging from 2,184 cfs to 7,089 cfs. During this time, the Graham Lake elevation stayed relatively constant between 103.5 and 103.8 feet msl. A similar event occurred in December 2010, when average daily inflows were above the hydraulic capacity of the Ellsworth powerhouse for 11 days and reached a maximum of 13,192 cfs, which is above the 10-year flood flow. During this time, the licensee spilled flows downstream of the project on a regular basis and the elevation of Graham Lake increased from 99.50 to 103.4 feet msl.

As seen in the examples provided above, the full operating range of the project is not always utilized to store high inflows, and Black Bear Hydro utilizes a combination of storage and spillage to manage flood conditions. As shown in Figure 5, the average

[107] Black Bear Hydro's December 30, 2015 Final License Application, Exhibit B at B-3.

water surface elevation in Graham Lake ranged between approximately 98.2 and 103.5 feet msl from 1999 to 2014. The actual storage used in this range is about 53,000 acre-feet. According to daily water surface elevations for Graham Lake between 2008 and 2016, Black Bear Hydro has only occasionally went outside of the historical average range (*i.e.*, 98.2 and 103.5 feet msl), even during high flow conditions.

Black Bear Hydro's "target operating curve" (see Figure 5) shows that Black Bear Hydro targets a minimum elevation of 93.4 feet msl at Graham Lake by March 31. However, Black Bear Hydro regularly deviates from the target curve during the spring season. From January 2008 to December 2012, Black Bear Hydro did not reduce the impoundment elevation below 95.2 feet msl. On March 31, when the target operating curve was at its lowest point of 93.4 feet msl, Black Bear Hydro held Graham Lake at a much higher elevation of 101.8 feet msl, on average from 2008 through 2012. During this time, the minimum elevation on March 31 was 97.6 feet msl in 2008 and the maximum elevation on March 31 was 103.5 feet msl in 2010.

While Black Bear Hydro has not fully utilized the 10.8-foot operating range during the term of the existing license, reducing the storage capacity of the reservoir could still decrease the licensee's ability to store high inflows at Graham Lake and could increase the potential for spillage and flooding during extreme hydrologic conditions. Temporarily modifying the maximum elevation limit during extreme hydrologic conditions,[108] as proposed by Black Bear Hydro, would provide additional storage capacity at Graham Lake that could be utilized for flood control. For example, temporarily modifying the maximum elevation limit from 103.0 (as recommended by Whiting 1) to 104.2 feet msl (the spillway crest elevation) during flood conditions would provide an additional 12,000 acre-feet of storage capacity, which is equivalent to the storage capacity that would be available under the BBH Alternative. The additional storage capacity that would be available during flood conditions could be used to store high inflows and reduce the risk of downstream flooding. Accordingly, Black Bear Hydro's proposal to temporarily modify the elevation limits at Graham Lake during extreme hydrologic conditions would reduce the risk of increased upstream and downstream flooding.

Based on the historical operating data analyzed above and the additional storage capacity that would be available during flood conditions, the risk of upstream and downstream flooding under the alternative recommended by Whiting 1 and the proposal

[108] Black Bear Hydro defines "extreme hydrologic conditions" as "the occurrence of events beyond the Licensee's control such as, but not limited to, abnormal precipitation, extreme runoff, flood conditions, ice conditions or other hydrologic conditions such that the operational restrictions and requirements contained herein are impossible to achieve or are inconsistent with the safe operation of the Project."

submitted by Black Bear Hydro as part of its WQC application (*i.e.*, the BBH Alternative) would not significantly change relative to actual historical operating conditions. In addition, the Commission's regulations and any new license would require measures to ensure the project maintains safe operating conditions. Under the Commission's regulations, licensees are required to develop an emergency action plan to provide early warning to upstream and downstream inhabitants, property owners, operators of water-related facilities, recreational users, and other persons in the vicinity who might be affected by a project emergency.[109]

Minimum Flows

The Ellsworth Project operates as both a water storage facility and as a peaking generation facility, depending on available inflows. The Graham Lake Development is operated as a water storage facility where water is stored for later use in supplementing downstream generation at the Ellsworth Development, which operates as a generation peaking facility.

Black Bear Hydro proposes to maintain the existing, continuous minimum flow release of 105 cfs from Ellsworth Dam and Graham Dam from July 1 through April 30 and a continuous minimum flow release of 250 cfs from May 1 through June 30.

Interior's minimum flow recommendation under section 10(j) of the FPA is consistent with Black Bear Hydro's proposal. However, Interior's prescription under section 18 of the FPA regarding downstream eel passage at Ellsworth Dam states that Black Bear Hydro must modify the existing downstream fish passage facility to have a total hydraulic capacity that is 5 percent of the maximum hydraulic capacity of the project (*i.e.*, 123 cfs).[110] As part of the section 18 downstream eel passage prescription, Interior states that Black Bear Hydro must operate the downstream fish bypass weirs at Ellsworth Dam from August 1 to October 31. Because Interior's section 10(j) recommendation is partially inconsistent with its section 18 prescription, we interpret Interior's minimum flow recommendation and prescription as the following:

1. From May 1 to June 30, release 250 cfs;

2. From July 1 to July 31, release 105 cfs;

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[109] 18 C.F.R. §§ 12.20 and 12.22 (2019).

[110] Black Bear Hydro estimates the project's maximum hydraulic capacity as 2,460 cfs. USFWS (2017) recommends that the attraction flow for downstream passage facilities should be 5 percent of station capacity, or 123 cfs.

3. From August 1 to October 31, release 123 cfs; and

4. From November 1 to April 30, release 105 cfs.

Maine DMR did not provide specific minimum flow recommendations. However, Maine DMR likewise recommends under section 10(j) that Black Bear Hydro modify the existing Ellsworth Dam downstream fish passage facility to have a total hydraulic capacity that is 5 percent of the maximum hydraulic capacity of the project (*i.e.*, 123 cfs). Maine DMR recommends that Black Bear Hydro operate the Ellsworth Dam downstream fish passage facility from June 1 to November 30 for alosines. For Atlantic salmon, Maine DMR recommends that Black Bear Hydro operate the downstream fish passage facility from April 1 to June 15 and from October 17 to December 31. Collectively, Maine DMR's section 10(j) recommendations would require Black Bear Hydro to pass a minimum flow of 123 cfs through the Ellsworth Dam downstream fish passage facility from April 1 to December 31.

Commerce's section 18 prescription would require Black Bear Hydro to modify the existing Ellsworth downstream fish passage facility to have a total hydraulic capacity of 5 percent of the station capacity. Commerce's section 18 prescription would require the same downstream fish passage facility operating schedule that Maine DMR recommends.

DSF recommends that Black Bear Hydro operate the project in run-of-river mode so that instantaneous outflow equals instantaneous inflow. In addition, DSF recommends prohibiting peaking, cycling, or pulsing operation unless necessary for upstream or downstream fish passage.

Our Analysis

To analyze the effects of the proposed and recommended flows on aquatic habitat availability in the Union River between Graham Lake Dam and Lake Leonard, we evaluated the wetted stream width, average depth, and maximum depth for each proposed and recommended flow. We also analyzed the timing of the proposed and recommended flows relative to the amount of flow historically available throughout the year. Because flow in the Union River currently reflects project operation, staff analyzed area-prorated flow estimates from the Narraguagus River to quantify long-term flow variability and availability.[111]

Analysis of 105 CFS Minimum Flow

Aquatic Habitat

According to the instream flow study that Black Bear Hydro conducted in September 2014 between Graham Lake and Lake Leonard, the existing minimum of 105 cfs provides an estimated 68 to 83 percent of the bankfull width, average depths ranging from 1.8 to 6.5 feet, and maximum depths ranging from 2.8 to 11 feet across the three study reaches (see Table 5). Based on the range of wetted widths, a minimum flow release of 105 cfs would continually water the majority of the Union River between Graham Lake and Lake Leonard, thereby providing habitat for fish and aquatic resources between the two impoundments. The maximum depths at 105 cfs would also provide a sufficient zone of passage for adult Atlantic salmon migrating upstream and downstream through the project and adult and juvenile river herring and adult eels migrating downstream through the project.[112]

Black Bear Hydro assessed tributary accessibility at 150 cfs, but not 105 cfs (see Table 8). However, the maximum difference in mean depth in the mainstem Union River at 105 cfs and 150 cfs for the surveyed transects was 0.2 feet (see Table 5), which suggests that the depth at the confluence of each tributary would be approximately 0.2 feet lower at 105 cfs than 150 cfs. Therefore, Moore Brook appears to be inaccessible for all but juvenile river herring at 105 cfs, and adult salmon may have difficulty entering Gilpatrick Brook safely. Grey Brook and Shackford Brook would remain accessible for all life stages of salmon, river herring, and eels.

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[111] Staff calculated flow statistics using data collected from 1971 through 2016 at USGS gage no. 01022500, located on the Narraguagus River in Cherryfield, Maine (approximately 23 miles east of Graham Lake). Staff prorated the Narraguagus River flow data by a factor of 2.14 to compensate for the difference in drainage area at Graham Lake Dam (486 square miles) and the USGS gage (227 square miles).

[112] As a general criterion for fishways, FWS's 2017 Fish Passage Engineering Design Criteria Manual (FWS, 2017) recommends a depth of at least twice the body depth of the largest individual of a species. To apply that criterion to the Union River between Graham Lake Dam and Lake Leonard, staff assumed a maximum body depth of 8 inches for Atlantic salmon, 4 inches for adult river herring, 1 inch for juvenile river herring, and 3 inches for adult American eel. Therefore, a minimum depth of 1.3 feet, 0.7 feet, 0.2 feet, and 0.5 feet would be required for adult salmon, adult river herring, juvenile river herring, and eels, respectively.

Timing and Availability of Flow

The monthly exceedance rates for 105 cfs range from 82.4 percent to 100.0 percent (see Table 17), which suggests 105 cfs should be available except for severe drought conditions. By using water stored in Graham Lake, flow during drought periods could be augmented to maintain a 105-cfs minimum flow. For Interior's prescription, 105 cfs should be available 99.0 percent of the time in July and 99.4 to 100.0 percent of the time from November through April. The generally consistent availability of 105 cfs during the summer and fall ensures that any migrating juvenile river herring, adult river herring, adult salmon, or adult eels will have an unimpeded zone of passage in the mainstem of the Union River between Graham Lake and Lake Leonard.

Table 17. Estimated monthly median daily flow and long-term exceedance values for the proposed and recommended minimum flows based on the area-prorated Narraguagus River flow data from 1971 to 2016.

Month	**Median Flow (cfs)**	**Exceedance for 250 cfs (percent)**	**Exceedance for 123 cfs (percent)**	**Exceedance for 105 cfs (percent)**
January	731	94.9	100.0	100.0
February	666	96.3	100.0	100.0
March	1246	99.2	100.0	100.0
April	2052	100.0	100.0	100.0
May	1111	100.0	100.0	100.0
June	602	94.1	100.0	100.0
July	307	64.0	97.0	99.0
August	221	43.2	82.2	87.8
September	204	41.4	74.0	82.4
October	431	73.2	92.7	94.7
November	942	91.2	98.3	99.4
December	953	97.8	99.4	100.0

(Source: https://waterdata.usgs.gov/usa/nwis/uv/?01022500)

Analysis of 123 CFS Minimum Flow

Aquatic Habitat

Black Bear Hydro did not evaluate depth and wetted width at the 123-cfs minimum flow recommended by Interior, Commerce, and Maine DMR. However, staff estimated the wetted width, mean depth, and maximum depth at 123 cfs based on the on the values at 105 and 150 cfs.[113] Using these estimates, a minimum flow of 123 cfs would provide a slight increase in the wetted width relative to the existing conditions (69 to 84 percent of bankfull width versus 68 to 83 percent, respectively). The average and maximum depths would increase by less than 0.1 feet from the depths at 105 cfs. Given the minor increase in wetted width and depth in the Union River between 105 and 123 cfs, the zone of passage in the mainstem Union River and tributary accessibility at 123 cfs would be similar to the zone of passage and accessibility presented above for the existing minimum flow of 105 cfs. Because increasing flow from 105 to 123 cfs produces only minor increases in wetted width, depth, and tributary accessibility, a minimum flow of 123 cfs would not provide any substantial improvement in aquatic habitat for fish and aquatic resources in the Union River between Graham Lake and Lake Leonard.

Timing and Availability of Flow

The monthly exceedance rates for Interior's prescription of 123 cfs from August 1 to October 31 range from 74.0 percent to 92.7 percent (see Table 17). The monthly exceedance rates for Commerce's prescription and Maine DMR's section 10(j) recommendation of 123 cfs from April 1 to December 31 range from 74.0 percent 100.0 percent. While a minimum flow of 123 cfs would likely be available during the recommended and prescribed time periods, the 74.0 percent exceedance rate for September suggests that inflow may need to be augmented with water stored in Graham Lake during some years.

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[113] Since 123 cfs is 42.2 percent of the way between 105 and 150 cfs, staff estimated the wetted width, mean depth, and maximum depth at 123 cfs by adding 42.2 percent of the difference to the corresponding values for 105 cfs that are presented in Table 5.

Analysis of 250 CFS Minimum Flow

Aquatic Habitat

Black Bear Hydro did not evaluate depth and wetted width at the existing 250-cfs minimum flow that it proposes to continue releasing in May and June. Staff estimated the wetted width, mean depth, and maximum depth at 250 cfs based on the values at 150 and 300 cfs.[114] A minimum flow of 250 would provide an estimated 74 to 88 percent of the bankfull cross-sectional width, mean depths ranging from 2.1 to 6.8 feet, and maximum depths ranging from 3.2 to 11.1 feet. A minimum flow of 250 cfs would therefore continually water the majority of the Union River and expand habitat for fish and aquatic resources relative to the 105-cfs and 123-cfs minimum flows.

Depths at the tributary confluences would likely be near the upper end of the depth ranges shown in Table 8 (ranging from 1.0 feet at Moore Brook to 3.5 feet at Shackford Brook). Therefore, the tributaries between Graham Lake Dam and Lake Leonard, except for Moore Brook, would be accessible during May and June for all life stages of salmon, river herring, and eels.

Timing and Availability of Flow

Interior recommends a minimum flow of 250 cfs during May and June for the protection of migratory fish species moving upstream during these months.[115] The exceedance rates for 250 cfs in May and June are 100.0 and 94.1 percent, respectively (see Table 17). Therefore, it is unlikely that Union River flow would drop lower than 250 cfs during May and June. Maintaining a 250-cfs minimum flow release would ensure that upstream migration of adult salmon and adult river herring through the Union River would not be impeded by the availability of flow and that most of the tributaries between Graham Lake Dam and Lake Leonard could be accessed.

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[114] Since 250 cfs is 66.7 percent of the way between 150 and 300 cfs, staff estimated the wetted width, mean depth, and maximum depth at 250 cfs by adding 66.7 percent of the difference to the corresponding values for 150 cfs that are presented in Table 5.

[115] Interior states that the 250-cfs minimum flow represents the FWS's aquatic base flow guideline of 0.5 cfs per square mile of drainage area for the Ellsworth Project watershed area of 547 square miles (FWS, 1981).

Analysis of Run of River Operation

Aquatic Habitat

Based on the long-term, pro-rated flow data from the Narraguagus River gage, the estimated median monthly flow (*i.e.*, 50 percent exceedance flow) for the Union River at the project would range from 204 cfs in September to 2,052 cfs in April (see Figure 15). The test flows released during the 2014 instream flow study span this range, which allows wetted width, average depth, and maximum depth to be estimated for the range of median monthly flows using the information presented in Table 5. Wetted width would range from 74 to 99 percent of bankfull width, average depth would range from approximately 2.0 to 7.2 feet, and maximum depth would range from approximately 3.0 to 13.3 feet. These parameters would vary seasonally with flow and would be at the lower end of the range during September and at the upper end during April, based on the historical data. However, as discussed above, a sufficient zone of passage for Atlantic salmon, river herring, and eels would be available in the Union River between Graham Lake Dam and Lake Leonard even at the minimum flow of 105 cfs. In addition, the tributaries between Graham Lake Dam and Lake Leonard would remain accessible until flow falls below 250 cfs, at which point accessibility would become increasingly reduced as described above.

Regarding the current peaking operation of the project, rapid drawdowns in streamflow can adversely affect aquatic habitat and organisms downstream of the dam by potentially displacing fish and aquatic macroinvertebrates and disrupting spawning behavior. Operating the project in a run-of-river mode, as recommended by DSF, would minimize unnatural drawdowns to the flow regime of the Union River downstream of Graham Lake Dam and would reduce disruption of spawning behavior and displacement of fish and macroinvertebrates caused by fluctuating flows.

Timing and Availability of Flow

Comparing the pro-rated Narraguagus River flow to actual flow releases from the project from 2007 to 2015 suggests that the natural seasonal flow pattern is being altered by project operation (see Figure 15 and Table 18). Based on the historical data, flow releases have been less variable on a month-to-month basis than natural flows because Black Bear Hydro stores water in Graham Lake during the high-flow period in the spring and releases water from Graham Lake during the low-flow period in late summer and early fall. Under run-of-river operation, flow would have been higher in March, April, November, and December, and lower during the rest of the year. While run-of-river operation would result in a more natural hydrograph for the downstream reach of the Union River, the 90 percent exceedance flows suggest that flow could drop below 105 cfs in August and September (See Table 18). If flows drop below 105 cfs during that time, wetted habitat would decrease relative to existing conditions, which could adversely impact fish and aquatic resources. Shallow areas of the Union River between the project impoundments, particularly in the middle reach, could potentially reduce the availability of safe passage routes for adult salmon during those months.

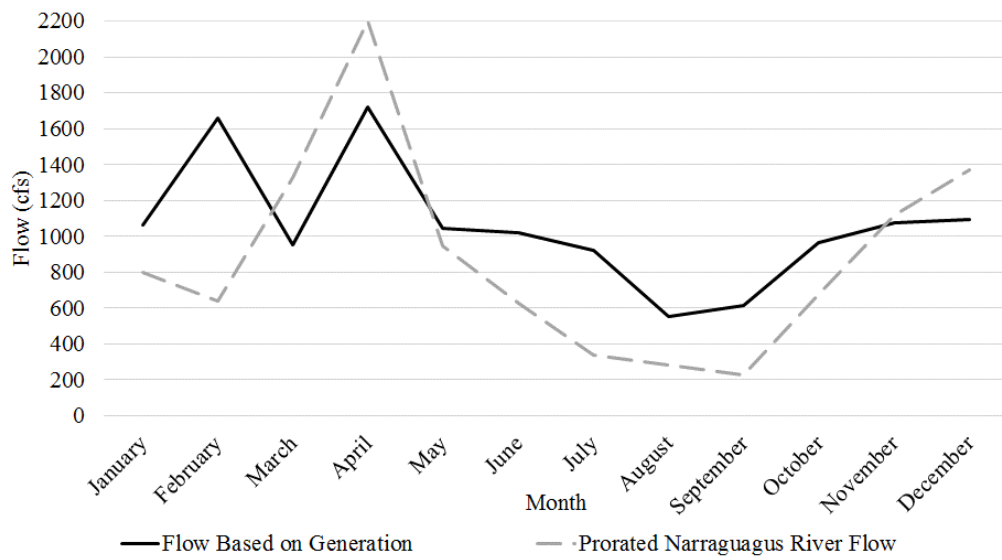

Figure 15. Median flow based on generation and area-prorated Narraguagus River flow from 2007 to 2015 using information from U.S. Geological Survey gage no. 01022500. (Source: Black Bear Hydro;[116] (USGS, 2018, as modified by staff)

[116] *See* Black Bear Hydro's May 12, 2016 letter.

Table 18. Exceedance flow based on generation and area-prorated Narraguagus River flows for 2007 to 2015 using information from U.S. Geological Survey gage no. 01022500. (USGS, 2018, as modified by staff)

Month	50 Percent Exceedance Flow Based on Generation (cfs)	Prorated Narraguagus Flow, 90 Percent Exceedance (cfs)	Prorated Narraguagus Flow, 75 Percent Exceedance (cfs)	Prorated Narraguagus Flow, 50 Percent Exceedance (cfs)	Prorated Narraguagus Flow, 25 Percent Exceedance (cfs)
Jan	1062	550	637	800	1159
Feb	1660	466	516	642	938
Mar	952	426	884	1326	1870
Apr	1722	781	1454	2205	3597
May	1044	490	619	944	1836
June	1020	328	417	626	1030
July	920	166	215	339	662
Aug	556	134	195	285	480
Sept	614	109	140	229	445
Oct	964	227	348	679	1210
Nov	1076	565	770	1122	1764
Dec	1093	582	833	1369	2269

(Source: Black Bear Hydro;[117] USGS, 2018, as modified by staff)

Operation Compliance Monitoring

Black Bear Hydro proposes to maintain Lake Leonard between the elevations of 65.7 and 66.7 feet msl, and maintain Graham Lake between the elevations of 93.4 and 104.2 feet msl during normal operation and to provide a continuous minimum flow of 105 cubic feet per second (cfs) from the Graham Lake Development and the Ellsworth Development from July 1 through April 30, and a continuous minimum flow of 250 cfs from May 1 through June 30, for the protection of fishery resources. Black Bear Hydro also proposes to provide conveyance flows for downstream fish passage at the Ellsworth and Graham Lake developments. Black Bear Hydro proposes to finalize and implement a draft operation compliance monitoring plan that includes measures for monitoring,

[117] *Ibid*.

recording compliance with, and reporting on deviations from the requisite minimum flow releases and reservoir elevations.

Black Bear Hydro proposes no changes to its use of water level sensors to monitor reservoir elevations at the project and a programmable logic controller to control project operation. DSF recommends that Black Bear Hydro install and operate a set of electronic stream gages at the confluence of the West and East branches of the Union River and at the project dams.

Our Analysis

Black Bear Hydro proposes to continue monitoring compliance with project operation and minimum flows with sensors that monitor water levels at the project and control the reservoir levels and discharges from the Ellsworth and Graham Lake developments. Installing and operating stream gages at the confluence of the West and East branches of the Union River within Graham Lake would provide information on the amount of inflow to Graham Lake, which could be used to determine compliance with a run-of-river mode of operation. However, Black Bear Hydro does not currently operate Graham Lake as a run-of-river facility.

Black Bear Hydro proposes to continue to use water level sensors, Tainter gate and turbine gate settings to maintain compliance with minimum flow releases and reservoir elevations at the Graham Lake and Ellsworth developments. Stream gages at the project dams would only provide information on flow releases from each of the developments; however, this information would be duplicative in nature to the existing sensors and operational mechanisms that Black Bear Hydro already has in place. Therefore, stream gages at the project dams would not likely provide additional information for documenting compliance with reservoir level elevations and minimum flows.

Although Black Bear Hydro uses sensors to monitor water levels in the project reservoirs and flows discharged from the Ellsworth powerhouse and Graham Lake Dam, Black Bear Hydro does not currently have formalized monitoring protocols or reporting requirements to verify compliance with, and report on deviations from, operating requirements, including reservoir elevations and minimum flow releases. While compliance measures do not directly affect environmental resources, they do allow the Commission to ensure that a licensee complies with the environmental requirements of a license. Therefore, operation compliance monitoring and reporting are typical requirements in Commission-issued licenses. Black Bear Hydro's formalization of monitoring protocols in an operation compliance monitoring plan would help document its compliance with the operational provisions of any new license, provide a mechanism for reporting operational data and deviations, facilitate administration of the license, ensure the protection of resources that are sensitive to impoundment drawdowns, and ensure that fish passage facilities are conveying minimum flows to the Union River downstream of the project dams.

Upstream Eel Passage

There are no existing upstream fishways for juvenile eels at the Ellsworth Project. Black Bear Hydro proposes to install new upstream eel passage facilities at both the Ellsworth and Graham Lake dams within 2 years of the effective date of a new license. The design and location of the facilities would be determined through consultation with the fisheries agencies.

Interior's fishway prescription would require Black Bear Hydro to design and construct upstream eel passage ramps at both the Ellsworth and Graham Lake dams within 2 years of license issuance. The prescription states that the exact location of the eel ramps and other design criteria is to be determined by the FWS following consultation with Black Bear Hydro and Maine DMR. The prescription would require the eel ramps to be operated from June through August and the design to be consistent with the FWS eel passage design criteria contained in the FWS's 2017 Fish Passage Engineering Design Criteria Manual (Design Criteria Manual; FWS, 2017).

Maine DMR's 10(j) recommendation #2 is the same as Interior's prescription, with the additional specifications that the resource agencies must review the 30, 60, and 90 percent completion drawings and the eel ramps must be operated from June 1 through October 31, two months later in the year than Interior would require.

DSF recommends that the upstream eel ramps be operational within one year of license issuance, rather than within 2 years of license issuance, as specified by Interior and Maine DMR.

Our Analysis

Climbing over and around dams is a well-documented behavior for juvenile eels (GMCME, 2007). Observations of large, dead, adult eels during the fall at Ellsworth and Graham Lake dams indicate that at least a portion of upstream migrating juvenile eels are successful at reaching habitat upstream of both dams and growing to sexual maturity. However, at 57 – 71 feet tall and 45 – 58 feet tall, the respective Ellsworth and Graham Lake dams could delay and potentially block juvenile eels from moving further upstream.

Commercial fisheries data for the Union River elver fishery (see Table 10) show that there is a substantial population of juvenile eels downstream of the project. Between June and August 2014, Black Bear Hydro conducted a qualitative juvenile American eel upstream passage study that documented juvenile eels actively attempting to ascend both project dams. The goals of the study were to evaluate the presence and general abundance of juvenile eel below Graham Lake Dam and Ellsworth Dam, identify concentrations of eel staging in pools or ascending wetted surfaces, and obtain information to assess potential options for upstream eel passage. Black Bear Hydro observed several hundred juvenile eels at both dams, with peak migration occurring in early- to mid-July (see Table 19). At Ellsworth Dam, Black Bear Hydro observed juvenile eels ascending the bedrock outcrop along the eastern side of the dam (see Figure 16). Once at the top of the outcrop, the eels ascended the easternmost corner of the dam and entered Lake Leonard by passing through a gap between the flashboard and concrete abutment of the dam. At Graham Lake Dam, Black Bear Hydro observed juvenile eels in areas of leakage around the gate and in the pool immediately downstream of the westernmost gate (see Figure 17).

Table 19. Estimated numbers and size of juvenile eels that Black Bear Hydro observed at the project dams during the 2014 juvenile eel upstream passage study.

Date	Ellsworth Dam		Graham Lake Dam	
	Number	Size (inches)	Number	Size (inches)
June 10	0	NA	40-50	3 to 6
June 18	0	NA	200+	3 to 6
June 25	10	NA	70+	3 to 6
July 1	100+	2 to 4	100+	3 to 6
July 8	700+	2 to 4	600+	<3 to 10
July 22	400+	2 to 5	150+	3 to 8
August 5	200-300	3 to 4	50	3 to 6

(Source: Black Bear Hydro, 2015b, as modified by staff).

Figure 16. Locations and movement routes of juvenile eels on the eastern side of Ellsworth Dam. Yellow lines indicate the primary movement routes. Orange lines indicate other locations and paths where Black Bear Hydro observed juvenile eels. (Source: Black Bear Hydro, 2014).

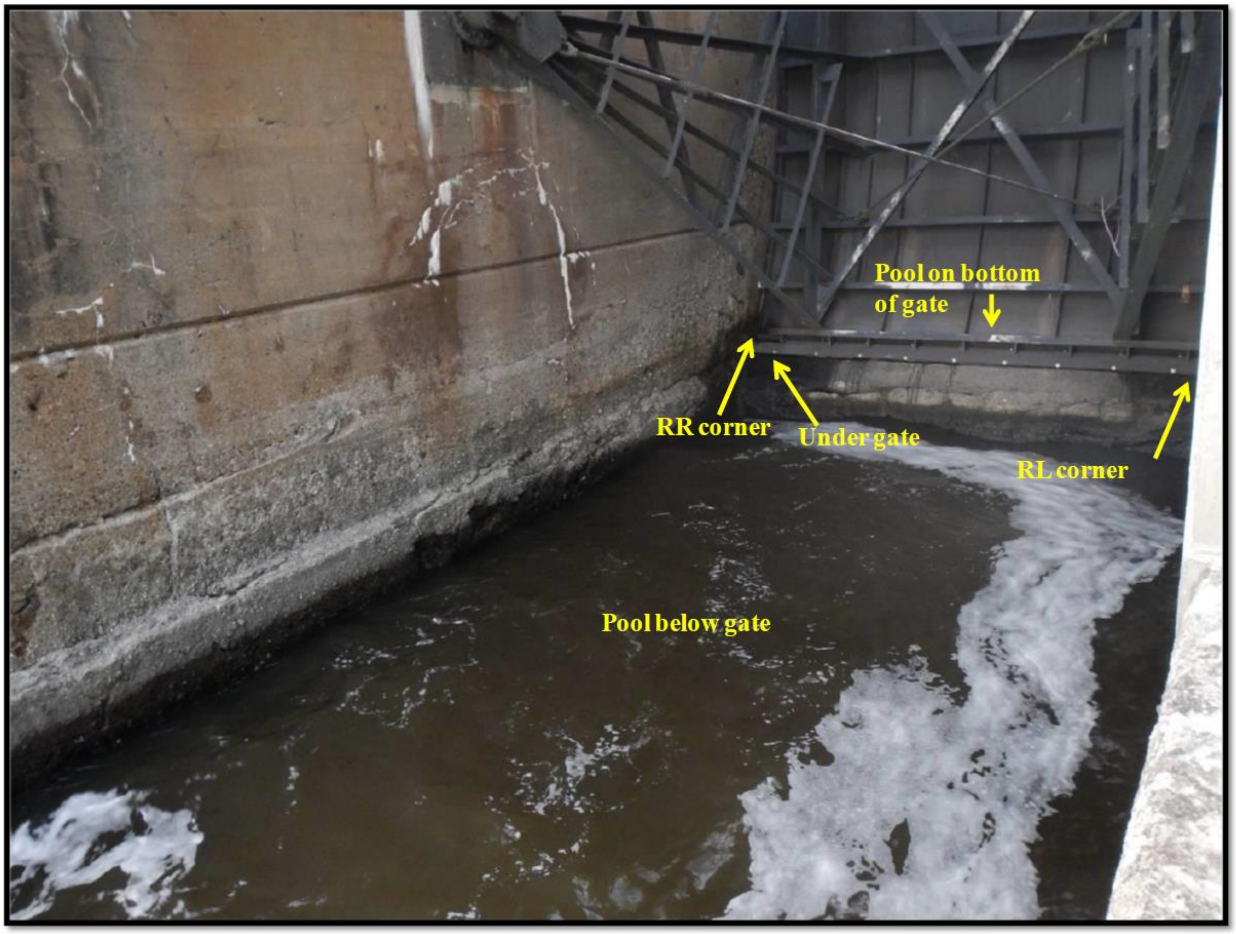

Figure 17. Locations of juvenile eels near Graham Lake Gate 1. “RR” and “RL” correspond to “river right” and “river left, respectively.” (Source: Black Bear Hydro, 2014).

Dedicated upstream eel passage ramps at the project dams would increase upstream passage effectiveness relative to the existing incidental passage over wetted project structures and adjacent bedrock outcrops, potentially decrease predation, and improve access to upstream habitat.

Black Bear Hydro’s 2014 study provides useful information about the locations where the eel ramps could be installed to most effectively reduce adverse project effects. At Ellsworth Dam, the largest number of eels was observed moving over the bedrock outcrop adjacent to the eastern end of the dam, then passing between the flashboards and the concrete abutment (see Figure 16). At Graham Lake Dam, the largest number of eels was observed near an area of leakage through Gate 1 (see Figure 17).

Interior prescribes and Maine DMR recommends that Black Bear Hydro consult with them on the “exact location” of the ramps. Because the 2014 study very clearly identified the appropriate ramp location at the Ellsworth Dam, having Black Bear Hydro consult with Interior and Maine DMR on the exact location of the ramps, as recommended and prescribed, is unlikely to provide any additional benefit.

The most appropriate location for an eel ramp at Graham Lake Dam is more difficult to identify with the information provided in the record because of the location where eels were identified during the 2014 study and because of potential changes that could occur to attraction flows following the issuance of any new license. First, there could be limitations associated with constructing an eel ramp at (or near) a spillway gate, such as Tainter Gate #1 where the majority of eels were located. The gate would need to remain functional over a range of environmental conditions experienced at the project, including during flooding. Second, Interior's prescription would require Black Bear Hydro to pass minimum flows from the modified Alden weir. Minimum flows are currently passed through either the Tainter gates or the surface bypass weir. If the minimum flow release location is changed under a new license such that minimum flows are only released from the surface weir, then it is possible that juvenile eels would be attracted to a different location than they were during the Gate #1 leakage conditions that were present during the 2014 study. Constructing the eel ramp at a location that accounts for project operation and potentially changing attraction flows during the term of any new license, in consultation with resource agencies, would increase the safety and effectiveness of upstream eel passage at the Graham Lake Development.

Juvenile eel catch rates at both dams start declining in late July (see Table 19). Therefore, operating the facility from June 1 to August 31, as recommended by Interior, is consistent with the juvenile eel upstream migration season observed at the project; and, operating the ramps until the end of October, as recommended by Maine DMR, is unlikely to provide much additional benefit.

FWS's Design Criteria Manual[118] could be used to guide the design, operation, and maintenance of the upstream eel ramps, as required by Interior and recommended by Maine DMR, to ensure the safe, timely, and effective movement of eels over the project dams. Specifically, the Design Criteria Manual recommends an upstream eel passage facility consisting of a covered metal or plastic volitional ramp that is lined with a wetted substrate and angled at a maximum slope of 45 degrees, with one-inch-deep resting pools that are sized to the width of the ramp and spaced every 10 feet along the length of the ramp. The Design Criteria Manual further recommends sizing the ramp width to accommodate a maximum capacity 5,000 eels/day (FWS, 2017).

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[118] FWS's Design Criteria Manual was developed by the FWS's Fish Passage Engineering Team to establish, among other things, general guidance on baseline design criteria, operation, and maintenance of fishways throughout the northeastern U.S.

DSF's recommendation to have the eel ramps operational within one year of license issuance could potentially reduce the environmental effects of the project on upstream eel migration sooner than the installation timing specified by Interior and Maine DMR (*i.e.*, within 2 years). However, construction would need to occur outside of the migration season in order to avoid adverse effects on eels that are attempting to migrate upstream. We discuss the practical implications of constructing and operating the upstream passage facilities within one year versus 2 years in section 5.2.2.

Downstream Eel Passage

Graham Lake Development

Black Bear Hydro proposes to continue operating the Graham Lake Development as a water storage reservoir to support downstream generation at the Ellsworth Development and to meet minimum flow requirements of 250 cfs from May 1 to June 30 each year and 105 cfs from July 1 to April 30 each year. Although there are no dedicated downstream eel passage facilities at the Graham Lake Development, Black Bear Hydro does propose to continue operating the temporarily-installed Alden weir[119] and Tainter gates at Graham Lake Development. Black Bear Hydro proposes to modify the Alden weir by May 1 of the third year following issuance of any new license to accommodate a 3-foot depth of flow over the full range of reservoir elevations allowed in any new license issued by the Commission. Black Bear Hydro proposes to operate the modified bypass weir and Tainter gates at Graham Lake Development for downstream fish passage from April 1 through December 31. Black Bear Hydro also proposes to consult with Interior, Commerce, and Maine DMR on the need for and design of downstream eel passage measures, pending the results of downstream eel passage studies that were ongoing at the time the license application was filed in 2015.

Interior's fishway prescription would require Black Bear Hydro to construct and maintain a new downstream fish passage surface weir at the Graham Lake Dam for the safe, timely, and effective passage of American eel and anadromous fish species. Interior's fishway prescription would require Black Bear Hydro to construct and operate the downstream fish passage facility within 2 years of license issuance. The prescription would require the construction and operation of a permanent Alden weir in place of the

[119] In the spring of 2017, Black Bear Hydro modified the existing bypass weir in the log sluice by adding a sloped floor, two side panels, and a bell shaped entrance to create an Alden weir to enhance downstream fish passage based on the results of the 2016 Salmon Smolt Survival Study, which indicated that existing bypass weir had low passage efficiency and high mortality (approximately 40 percent). The Commission has not issued an amendment order requiring permanent installation of the Alden weir and the Union River Comprehensive Management Plan does not provide specific guidance on the installation of the Alden weir to improve downstream fish passage.

existing bypass weir (or a comparable weir design that provides a uniform accelerating flow through the weir). The prescription states that the new downstream fish passage surface weir at the Graham Lake Dam must provide a conveyance flow that is at least 2 feet deep across the full range of reservoir elevations required by any new license issued by the Commission.

Interior's fishway prescription would require Black Bear Hydro to operate the new downstream fish passage facility from August 1 through October 31 and to use the new downstream passage facility to pass the minimum flow required in any new license issued by the Commission. In addition, the prescription would require Black Bear Hydro to design, operate, and maintain the new downstream fish passage facility in a manner that is consistent with FWS's 2017 Fish Passage Engineering Design Criteria Manual (Design Criteria Manual).

Maine DMR's section 10(j) recommendation would require the same downstream eel passage measures at the Graham Lake Development as Interior's section 18 prescription for safe, timely, and effective passage of diadromous fish.[120]

Our Analysis

Adult eels migrating downstream past the development can pass downstream over the surface bypass weir or through any of the development's three Tainter gates when they are releasing flow to provide generation at the Ellsworth Development or minimum flows to the downstream reach. There are no generating facilities at the Graham Lake Development that could adversely affect eels through entrainment on project turbines.

In October 2015, Black Bear Hydro performed tracking surveys as part of the Adult American Eel Downstream Passage Study (Downstream Eel Passage Study) to identify the routes that American eels use to pass downstream at the Graham Lake Dam (and Ellsworth Dam) and to determine whether eels survive passage.

Passage Survival

According to the information collected during the Downstream Eel Passage Study, the bypass weir and Tainter gates provide safe passage for American eel. Although Interior states in its fishway prescription that the water velocity through the Tainter gates is in excess of 20 feet per second (fps) and may cause injury or mortality to migrating

[120] Diadromous is a general category describing fish that spend portions of their life cycles partially in fresh water and partially in salt water. These represent both anadromous and catadromous fish.

eels,[121] the 47 adult eels that were evaluated in the Downstream Eel Passage Study survived passage through all available passage routes at the Graham Lake Development (see Table 20). Based on this information, the project does not appear to be adversely affecting the survival of eels migrating downstream through Graham Lake Dam.

Table 20. Adult eel downstream passage route selection and survival at Graham Lake Dam.

Passage Route	Number	Percent of Total	Percent Passage Survival
Gate 2	14	30	100
Gate 3	14	30	100
Fish Bypass Weir	7	15	100
Unidentified Route	12	26	100
Total	47	100	100

(Source: Black Bear Hydro, 2015d).

In its fishway prescription, Interior references a single incident where adult eels were killed at the Tainter gates. Interior states that adult eels became wedged in the Tainter gates and killed in the fall season of 2017 when the dam was releasing less than the minimum flow. However, the likelihood of this type of mortality is minimal and would not be expected to occur during normal project operation. In its response to deficiencies and additional information requests, Black Bear Hydro provided daily generation flow data from August 2007 to December 2015.[122] A survey of the data showed that Black Bear Hydro has historically released flows in excess of the required minimum flow throughout the eel passage season. Over the course of any new license term, any reduction in flows below the minimum flow would be associated with extreme hydrologic events (*i.e.*, droughts) or project maintenance. Effects to adult eels during these events would be expected to be short term and temporary.

Route Selection

During downstream migration, eels tend to be attracted to deeper routes of passage when they are available (Durif *et.al*., 2003). Opening the Tainter gates at Graham Lake Dam offers a deeper route of egress for migrating eels than the surface-oriented bypass weir located at the crest of the dam. At the normal maximum water surface elevation of 104.2 feet msl, the Tainter gate opening is 21.2 feet deep. At the lowest permitted water

[121] *See* Interior's April 10, 2018 preliminary fishway prescription at 16, *citing* Black Bear Hydro's license application, Appendix E-8 at 18.

[122] *See* Black Bear Hydro's response to deficiencies and additional information requests on the final license application for the Ellsworth Project, filed May 12, 2016.

surface elevation of 93.4 feet msl, the Tainter gate opening is 10.4 feet deep. As a result, migrating eels appear to prefer passage through the Tainter gates rather than passage over the bypass weir, especially when higher flows are being released through the Tainter gates at Graham Lake Dam (Black Bear Hydro, 2015d; see Figure 17). For example, no eels passed over the bypass weir when a flow of 2,386 cfs was being released through the Tainter gates to provide for maximum generation at the Ellsworth Development. However, eels will utilize the surface-oriented bypass when lower flows are being released from the Graham Lake Dam. For example, at a lower flow of 1,001 cfs, 4 of 15 eels passed downstream through the bypass weir (27 percent).

Duration of Passage

Commission staff analyzed the duration of passage and downstream migration speed[123] of eels through the Graham Lake Development to evaluate the effect of the Graham Lake Development on the migratory movements of adult eels through Graham Lake, including how operation of the Graham Lake Development could delay passage for downstream migrating eels.

In the Downstream Eel Passage Study, eels were released 0.5 mile upstream of the Graham Lake Dam under three release scenarios for generation at the Ellsworth Development. Movements were tracked through the reservoir and past the Graham Lake Dam, through the known routes of passage (*i.e.*, Tainter gates or the bypass weir). Eel migration speed was less than 1 fps for all operating scenarios. Under Operating Scenario 1 (flow through Graham Lake Dam to provide for 97 percent generation at Ellsworth), median eel migration speed was 0.14 fps. At this migration speed, eels would expend 5.5 hours moving 0.5 mile downstream through the reservoir and past the Graham Lake Dam into the tailrace. Eel migration speed decreased and the duration of the migration time through the project increased at lower flows. For example, under Operating Scenarios 2 and 3 (64.5 percent and 40.7 percent generation at the Ellsworth development), the median eel migration speed was 0.03 fps. At this migration speed, eels would expend 25 hours to move 0.5 mile downstream through the reservoir and past the Graham Lake Dam into the tailrace. Cumulatively, across all operating scenarios (minimum to maximum generation at the Ellsworth Development), results of the Downstream Eel Passage Study showed that the majority of eels in the study (63 percent)

[123] Commission staff calculated migration speeds based on the time it took eels to travel between two receiver stations. For example the migration speed for eels passing the Graham Lake Development was calculated by measuring the elapsed time in seconds between the study release site (0.5 mile upstream of the dam) and the receiver stations at the Tainter gates and bypass weir. The elapsed time was then divided by the total passage distance (accounting for the release site distance and passage distance through the dam of 2,720 feet and 46 feet, respectively) to obtain the migration speed in feet per second.

passed Graham Lake Dam within 24 hours, with the remainder passing Graham Lake Dam with 48 hours (26 percent) or longer (11 percent). The median migration speed for eels passing through known routes of passage across all operating scenarios was 0.09 fps. At this migration speed, eels would be expected to expend a median of 8.8 hours moving 0.5 mile downstream through the reservoir and past the Graham Lake Dam to the tailrace when the dam is releasing water for generation at the Ellsworth Development.

Eel movements through the Graham Lake Development are influenced by two project features, Graham Lake and Graham Lake Dam. Flow velocity through storage impoundments such as Graham Lake is generally less than flow velocity in free flowing sections of the river. Lower flow velocities reduce the rate of downstream eel movements because eels semi-passively drift with flow when migrating downstream (Piper *et. al*., 2015). In Graham Lake, the median migration speed of eels transiting the 0.5-mile distance between the release site and Graham Lake Dam was 0.08 fps. At this migration speed, eels would be expected to expend a median of 8.6 hours moving 0.5 mile downstream to Graham Lake Dam.

Graham Lake Dam serves as a barrier that eels must navigate to continue moving downstream. However, Graham Lake Dam does not appear to have an adverse effect on downstream eel movements. The median migration speed of eels passing through Graham Lake Dam across all operating scenarios was 0.38 fps. At a migration distance of 80 feet (*i.e.*, the estimated distance between the upstream and downstream sides of the Graham Lake Dam, eels can pass through Graham Lake Dam in two minutes.

Eel migration speed increased in the free-flowing section of the Union River downstream of Graham Lake Dam,[124] relative to passage through the Graham Lake Development. Eel migration speed ranged from 1.03 to 2.16 fps across all three operating scenarios. The migration speeds in the free-flowing section of the Union River are representative of the unimpeded cruising speed[125] for eels in the study because of the free-flowing nature of the Union River in this area of the project. By comparing the highest median migration speed in the free flowing section of the Union River downstream of Graham Lake Dam (2.16 fps) with the eel migration speed of 0.3 fps in

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[124] Staff calculated the migration speed for eels passing downstream in the free flowing section of the Union River from the tailrace of the Graham Lake Development to the upstream extent of the Lake Leonard by measuring the elapsed time, in seconds, from passage detection at Graham Lake Dam and “receiver station 5” (located 1 mile upstream of the Ellsworth Dam). Commission staff divided the elapsed time by the total passage distance in feet (15,734 feet) to obtain the migration speed in feet per second.

[125] Cruising speed is the swim speed a fish can maintain for a long period of time (*i.e.*, hours).

Graham Lake at lower flows, it appears that operation of the Graham Lake Development has the potential to increase the duration of passage by slowing eel migration speed by up to 1.86 fps.

Commission staff estimated passage delay for the Graham Lake Development by using the eel cruising speed from the free-flowing section of the Union River to calculate an unimpeded travel time through Graham Lake and also Graham Lake Dam. At a cruising speed of 2.16 fps, eels would pass through these project features in 0.4 hour. Based on a free-flowing duration time of 0.4 hour for the majority of eels in the Downstream Eel Passage Study, Commission staff estimates that operation of the Graham Lake Dam delays passage for migratory eels for a maximum time of 24.6 hours.[126]

A delay of approximately 25 hours would not adversely affect eels during the migration season. In a typical hydroelectric facility, a passage delay poses a risk of injury in the forebay, where eels would be exposed to harmful project features such as turbines or trashracks. The Graham Lake Development, however, does not have these project features, and therefore a passage delay would not likely subject eels to injury or mortality. The migration season for eels extends from August through November, and a one day delay in passage over a migration season would not likely affect the fitness of spawning adults, as there would be multiple opportunities for eels to pass downstream over the course of the passage season. Eels also normally migrate downstream in pulses (EPRI, 2001), and a delay would be similar to what eels normally experience awaiting environmental passage cues.

Although a delay in passage can also result in increased exposure to predation, predation of adult eels from a passage delay is unlikely. The main source of predation of an adult eel at the Graham Lake Development would likely be fish-eating birds of prey, such as eagles and osprey. These birds rely on sight to catch prey during the day when eels would mostly be found in deeper sections of the forebay. In addition, birds of prey do not hunt at night when eels are typically migrating. Therefore, a passage delay of approximately 25 hours would not likely increase predation of migrating eels.

New Downstream Eel Passage Facility

Black Bear Hydro proposes to modify the temporarily-installed Alden weir to accommodate a 3-foot depth of flow over the full range of reservoir elevations allowed in any new license issued by the Commission. Interior's fishway prescription and Maine DMR's section 10(j) recommendation would require Black Bear Hydro to modify the

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[126] The delay in passage was estimated by subtracting the affected passage duration time (25 hours) from unaffected passage during time (0.4 hour) to arrive at a maximum migratory delay of 24.6 hours for the Graham Lake Development.

Alden weir to provide a conveyance flow that is at least 2 feet deep to provide safe, timely, and effective passage of American eel (and other anadromous fish species) at Graham Lake Dam. Interior's fishway prescription also requires that the modified Alden weir pass the minimum flows required in any new license.

The Alden weir is primarily designed to create a uniform rate of flow acceleration that increases by 1 fps or less, per foot of linear distance from the entrance of the weir toward the exit of the weir. The Alden weir has been shown to reduce avoidance behavior and passage delays for juvenile migratory fish (Johnson *et al*., 1995). However, there is limited information on the efficacy of the Alden weir to reduce avoidance behavior and passage delays for downstream eel passage. Telemetry studies of the surface bypass at the Holyoke Project No. 2004 showed that silver eels preferred the Alden weir over the submerged bypass; however, there is no specific data indicating that the Alden weir design influenced passage efficiency at the Holyoke Project (either by increasing the number of eels that passed or reducing passage delay) (Normandeau, 2018).

Permanent installation of the Alden weir at Graham Lake Dam would not likely improve passage safety for adult eels, based on information from the Downstream Eel Passage Study indicating that downstream migrating eels primarily use the Tainter gates for passage and there was no eel mortality through any of the surface or sub-surface passage routes. Although the passage delay at Graham Lake Dam is estimated to be 25 hours, there is also no indication that a one-day delay in passage negatively affects adult eels or that reducing passage delay is necessary to enhance emigration. As stated above, Graham Lake Dam does not have any harmful project features, such as turbines and trashracks that would harm eels if they were delayed in the forebay. Reducing passage delay would not provide any meaningful benefit to eels, as conditions would be favorable for passage multiple days during passage season. Therefore, it appears that permanently installing an Alden weir at Graham Lake Dam would not reduce any adverse project effects to adult eels, or provide any meaningful benefits to adult eels.

Downstream Passage Operating Schedule

Black Bear Hydro proposes to continue operating the bypass weir on an annual basis from April 1 through December 31. Interior's fishway prescription would require Black Bear Hydro to provide passage through the bypass weir from August 1 through October 31.

As discussed above, the downstream eel migration season begins mid-August and ends mid-November. Results of the Downstream Eel Passage Study show that the majority of eels prefer the Tainter gates as the primary route for downstream passage rather than the bypass weir. Terminating the bypass weir conveyance flow on October 31, prior to the end of the eel migration season in mid-November, could benefit eels by eliminating the hydraulic signal associated with the bypass weir and directing flows through the preferred route of downstream passage (*i.e.*, the Tainter gates). At the same time, the bypass weir could serve as a secondary means of egress that would be lost if the bypass weir conveyance flows were terminated on October 31. For instance, the bypass weir could serve as an alternate means of downstream passage when the primary route of downstream passage is unavailable, such as when the Tainter gates become inoperable due to an emergency or maintenance outage.

Ellsworth Development

Black Bear Hydro proposes to continue operating the Ellsworth Development as a generation peaking facility with two powerhouse intake facilities: one on the eastern end of the dam that contains a 2.5-MW turbine-generator unit (Unit 1) and the other on the western end of the dam that contains two 2.0-MW turbine-generator units and one 2.4-MW turbine-generator unit (Units 2 – 4).

There is no dedicated downstream eel passage facility at the Ellsworth Development. However, Black Bear Hydro operates a downstream fish passage facility for river herring and Atlantic salmon from April 1 through December 31 each year. Black Bear Hydro proposes to continue operating the existing downstream fish passage facility at the Ellsworth Development from April 1 to December 31 of each year and proposes to install the following protective measures by May 1 of the third year following license issuance: (1) a fish guidance system (Worthington boom or similar technology) with rigid panel depths between 10 to 15 feet (where water depths are adequate); and (2) full-depth trashracks or overlays with 1-inch clear spacing at the intakes for Units 2, 3, and 4. Black Bear Hydro also proposes to prioritize operation of Units 1 and 4 over Units 2 and 3 during critical downstream passage seasons, the timing of which would be determined in consultation with the resource agencies. Black Bear Hydro also proposes to make the following modifications to the downstream fish passage facility by May 1 of the third year following license issuance:

1. Modify the eastern surface weir entrance by increasing the depth of the weir to a minimum of 3 feet and installing tapered walls similar to an Alden weir;

2. Increase the capacity of the eastern surface weir to pass up to 5 percent of station hydraulic capacity;

3. Increase the height of the sides of the spillway flume in consultation with resource agencies, to improve containment of fish passing through the flume; and

4. Modify the existing fish downstream migrant pipe to improve its discharge angle into the spillway flume to limit potential injury to fish that are exiting the pipe.

Black Bear Hydro proposes to consult with Interior, Commerce, and Maine DMR on the need for and design of downstream eel passage measures, pending the results of downstream eel passage studies that were ongoing at the time the license application was filed in 2015.

Interior's section 18 fishway prescription would require operational and structural modifications to provide safe, timely, and effective passage for American eel and anadromous fish species. The prescription would require Black Bear Hydro to cease generation at night (8 PM to 4 AM) from September 1 through October 31 and also cease generation in August for a period of three nights following a storm event with rainfall exceeding one inch of rain in 24 hours. The prescription would also require the following structural modifications within 2 years of license issuance:

1. Install 1-inch full-depth trashracks at the intakes of Units 2, 3, and 4, as either permanent structures or season overlays, during the months of August through October;

2. Modify the existing downstream fish passage entrance to increase the total combined flow through the three weirs to 5 percent of maximum station hydraulic capacity (approximately 123 cfs);[127]

3. Realign the end of the 18-inch downstream migrant pipe so water discharges downward to the spillway flume and fish do not impact the spillway when exiting the pipe;

4. Modify the spillway flume to eliminate leakage at the sidewalls of the spillway flume and eliminate discharge to ledges at the toe of the dam.

In its section 10(j) recommendation, Maine DMR recommends the same measures that would be required by Interior's section 18 prescription, and the following additional measures: (1) operate the downstream bypass weirs at night from August 1 through October 31 to pass eels downstream of the Ellsworth Dam; and (2) prioritize operation of Unit 4 over Units 2 and 3 and/or curtail operation of Unit 1 during the critical downstream fish passage seasons.

[127] Interior's section 18 prescription is not consistent with its recommendation under section 10(j) because Interior recommends a minimum flow of 105 cfs from July through April, consistent with Black Bear Hydro's proposal.

DSF recommends installation of permanent downstream passage systems at Ellsworth Dam, including full-depth trashracks with 1-inch clear spacing, a deep gate for out-migrating adult silver eels, an increase in downstream bypass flow to 120 cfs, and a spillway plunge pool within 2 years of license issuance. DSF also recommends turbine shutdowns as described by Maine DMR. In addition, DSF recommends that the Kaplan turbine units (Units 2 and 3) be shut down during downstream migration periods.

Our Analysis

Black Bear Hydro conducted tracking surveys in October 2015 to identify the routes that American eels use to pass downstream at Ellsworth Dam and to determine whether eels survive passage at each dam. All 47 eels that were used in the Downstream Eel Passage Study passed through the Ellsworth Development. All eels that were detected in the study passed through the turbines; none used the surface bypass weirs for passage. Below, we analyze the potential effects of the Ellsworth Development on eels migrating downstream on the Union River, including the potential for entrainment and impingement, survival of eels during passage, duration of passage, and potential alternative means of passage.

Potential for Entrainment and Impingement

Entrainment

Black Bear Hydro screens the intakes with trashracks that have two different sizes of clear spacing. The intakes for Units 2 - 4 have a trashrack with 1-inch clear spacing over the top 6.75 feet of the intake structure, and then 2.37-inch clear spacing over the bottom portion of the intake structure. The Unit 1 intake has a single trashrack with 2.44-inch clear spacing.

The existing trashracks do not prevent eels from entrainment. In the Downstream Eel Passage Study, 43 of the 47 eels in the study passed downstream of the project through Units 2 – 4. When the project is generating, eels seek a low level means of passage, where the clear spacing of the trashrack at the bottom of the intakes for Units 2, 3, and 4 (2.37 inches) was ineffective in excluding eels from the intake. Although no eels passed downstream through the Unit 1 intake during the Downstream Eel Passage Study, eels would be expected to pass through the trashrack at Unit 1 and be entrained by the turbine because the clear spacing is similar.

Entrainment of eels through the intakes is directly related to the width of adult eels. Although the Downstream Eel Passage Study did not document the width of the eels used in the study, previous studies in New England have documented the width of adult eels as ranging from 0.9 to 1.1 inches wide (Great River Hydro, 2016; Melong, 2014). Therefore, trashracks with clear spacing of 2.37 and 2.44 inches would not exclude eels from the intakes, and operating the turbines would entrain eels and subject them to injury or death from the turbine passage. Surface-oriented eels migrating downstream would be afforded some additional protection when swimming near the intakes of Units 2, 3, and 4, as these intakes have trashracks with 1-inch clear spacing from the surface to a depth of 6.75 feet. However, based on the fact that no eels utilized the surface bypass weirs during the Downstream Eel Passage Study, it appears that any surface-oriented eels present during the study likely reverted to lower depths for passage after encountering the upper 1-inch trashrack spacing, at which time they would have been susceptible to entrainment through the turbines.

Black Bear Hydro proposes, Interior prescribes, and Maine DMR recommends that Black Bear Hydro install 1-inch full-depth trashrack overlays at Units 2 – 4 from August 1 through October 31 to protect eels during passage through the Ellsworth Development. Installing full-depth trashrack overlays with 1-inch clear spacing would reduce eel entrainment at Units 2 – 4 when the project is operating, as the width of eels ranges between 0.9 and 1.1- inches. Eels on the lower end of this size range would still be susceptible to some level of entrainment, as would eels passing through Unit 1.

The resource agencies do not recommend, and Black Bear Hydro does not propose to replace the 2.44-inch trashrack at Unit 1, presumably due to Black Bear Hydro's assertion that the trashracks at Unit 1 cannot be 1 inch due to trashrack raking restrictions. In its comments on the draft EA, Black Bear Hydro clarified that there is no deck or rake rails at Unit 1 and the gate house limits the ability to rake either by machine or by hand. As discussed above, a trashrack with clear spacing of 2.44 inches would not exclude eels from the intakes, and operating Unit 1 would entrain eels and subject them to injury or death from turbine passage.

Since adult eel out-migration typically occurs from mid-August through mid-November in New England (Haro *et al*., 2003), installing trashrack overlays from August to October 31, as prescribed by Interior, would potentially expose eels to entrainment at the end of the migration season between November 1 and mid-November. Installing the trashracks through November 15 of each year would reduce the risk of entrainment at the end of the migration season.

Impingement

To assess the potential for impingement of fish at the project, Black Bear Hydro measured velocity across the horizontal faces of the intakes for Units 2, 3, and 4 when all three units were generating at or near maximum generation.[128] At 3 feet in front of the trashracks, the maximum average intake velocity ranged from 2.08 to 2.43 fps. Adult

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[128] Black Bear Hydro did not measure velocity at the intake for Unit 1; however, based on the similarity of the design and operation of Units 1 and 4, the risk of impingement at Unit 1 would likely be the same as the risk of impingement at Unit 4.

eels would not likely be impinged on the trashracks at these velocities because American eels have a burst speed of 3.1 to 4 fps (Bell, 1991), which is sufficient to overcome the maximum approach velocity of 2.43 fps.

Commission staff also calculated the average "through bar velocity" for the existing trashrack overlay for Units 2, 3 and 4. To estimate the flow velocity through the trashrack overlay for Units 2 and 3, Commission staff calculated the effective area in which flow could pass through the trashrack overlay at the project. Specifically, staff accounted for the following parameters: (1) the effective intake width (10.9 feet), as calculated from (a) the clear spacing of the overlay (1.0 inch) and (b) the number of bars necessary to span the 15-foot-wide trashrack (131bars at a standard bar thickness of 0.375 inches); and (2) the trashrack height of 13.75 feet, assumed to be installed at a standard angle of 15 degrees. Staff calculated the velocity through the clear spaces of the trashrack overlay by dividing the maximum hydraulic capacity of the turbine (545 cfs) by the effective area of the trashrack overlay (144.9 ft^2).

The average through bar velocity for the existing trashrack for Units 2 and 3 was 3.5 fps[129] and the average through bar velocity for Unit 4 was 3.8 fps. These "through velocities" are similar to the reported American eel burst speed of 3.1 to 4.4 fps (Bell, 1991). Therefore, while the risk of eel impingement appears to be low at 3 feet in front of the trashracks, it increases as eels swim closer to the trashracks.

To better understand the potential effects of Interior's, Maine DMR's, and DSF's recommendation to install a 1-inch full-depth trashrack overlay on impingement, Commission staff calculated the through velocity at the maximum hydraulic capacity of the turbine units with a full-depth, 1-inch trashrack installed over each intake. If a full-depth, 1-inch trashrack is installed over the intakes for Units 2 and 3, the velocity through the open spaces of the overlay would be approximately 3.8 fps. If a 1-inch, full-depth trashrack overlay is installed over the intake for Unit 4, the velocity through the open spaces of the overlay would be approximately 4.1 fps.[130] These calculated "through

[129] Commission staff used the dimensions in the Figure 3 drawing presented on page 6 of Appendix E-5 of the license application to calculate the through bar velocity for the existing trashracks.

[130] To estimate the flow velocity through the trashrack overlay over the intakes for Unit 4, Commission staff calculated the effective area in which flow could pass through the trashrack overlay at the project. Specifically, staff accounted for the following parameters: (1) the effective intake width (10.9 feet), as calculated from (a) the clear spacing of the overlay (1.0 inch) and (b) the number of bars necessary to span the 15-foot-wide trashrack (131 bars at a standard bar thickness of 0.375 inch); and (2) the intake height of 15.75 feet, with a trashrack assumed to be installed at a standard angle of

velocities" are similar to the reported burst speed of eels and would not likely impinge adult eels, which have a reported burst speed of 3.1 to 4.4 fps (Bell, 1991).

The through bar velocity calculations suggest that screening the intakes for Units 2, 3, and 4 with a trashrack overlay with 1-inch clear spacing would not substantially increase through bar velocity. The through bar velocity with a 1-inch trashrack overlay installed at Units 2 and 3 would be 3.8 fps, which is similar to the existing through bar velocity of 3.5 fps. Similarly, the through bar velocity with a 1-inch trashrack overlay installed at Unit 4 would be 4.1 fps, which is similar to the existing through bar velocity of 3.8 fps.

Passage through the Turbines

During the downstream eel migration season from mid-August to mid-November, river flow is typically less than the flow needed to run the Ellsworth Project at its full hydraulic capacity of 2,460 cfs.[131] Accordingly, Black Bear Hydro generates power at the Ellsworth dam by using a combination of turbine-generator units, depending on river flow and available storage.

According to the results of the Downstream Eel Passage Study, eels passed through Units 2 – 4 at different frequencies depending on the operational scenario. For example, when the project was generating at 97 percent capacity (Operating Scenario 1), eels selected Unit 4 as the preferred route for downstream passage (see Table 21). Cumulatively across all generating scenarios, most of the eels passed downstream through Unit 3 (39.5 percent of test eels, n = 17), slightly less passed through Unit 4 (32.5 percent of test eels, n = 14) and Unit 2 (28 percent of test eels, n = 12). No eels passed through Unit 1, likely due to the higher attraction flow resulting from Units 2 – 4 during Operational Scenario 1, which are grouped together on the western end of the dam with a combined maximum hydraulic capacity of 1,775 cfs, approximately 100 feet away from Unit 1.

15 degrees. Staff calculated the velocity through the clear spaces of the trashrack overlay by dividing the maximum hydraulic capacity of the turbine (685 cfs) by the effective area of the trashrack overlay (166 ft^2).

[131] The maximum hydraulic capacities of the turbine are 685 cfs for Unit 1, 545 cfs for Unit 2, 545 cfs for Unit 3, and 685 cfs for Unit 4.

Table 21. Adult eel downstream passage route selection compared to project operation.

Operational Scenario	Units Operating	Number Passing Through Unit 1	Number Passing Through Unit 2	Number Passing Through Unit 3	Number Passing Through Unit 4	Total
1[132]	1, 2, 3, 4	0	3	1	10	14
2[133]	2, 3, 4	N/A	4	5	3	12
3[134]	2, 3	NA	5	9	N/A	14
Low Flow	3, 4**	N/A	N/A	2	1	3
Total		0	12	17	14	43*

* 4 eels passed downstream undetected.
**Unit 4 also operated on October 31 and November 1.
(Source: Black Bear Hydro, 2015d, as modified by staff).

With regard to passage survival, 51.1 percent (24 out of 47) of the test eels survived downstream passage through the Ellsworth Development. The Ellsworth Development has two different types of turbines. Units 1 and 4 are fixed-propeller turbines that rotate at 200 revolutions per minute (rpm); and Units 2 and 3 are adjustable-propeller Kaplan turbines that rotate at 360 rpm. According to the Downstream Eel Passage Study, Unit 4 has the highest rate of survival with 86 percent of the eels surviving passage (see Table 22). The Kaplan turbines have lower rates of survival with 41 percent of eels surviving passage through Unit 3 and 25 percent of the eels surviving passage through Unit 2. Kaplan turbines are known for high mortality rates due to their relatively high rotational speed (Meuller *et al.*, 2017). The reduced survival rates through the Kaplan turbines at the Ellsworth Development is also related to the length of silver eels (27 – 41 inches). Both the length of an adult eel, and the rotational speed of the Kaplan turbine increases the likelihood of eels striking the turbine blades during passage, which can cause injury (hemorrhage or bruising), or mortality from turbine blades amputating parts of the body.

[132] Operational scenario 1 was conducted at 97 percent of the generation capacity at the Ellsworth development, which is equal to a flow of 2,386 cfs.

[133] Operational scenario 2 was conducted at 64.5 percent of the generation capacity at the Ellsworth development, which is equal to a flow of 1,587 cfs.

[134] Operational scenario 3 was conducted at 40.7 percent of the generation at the Ellsworth Development, which is equal to a flow of 1,001 cfs.

Table 22. Adult eel downstream passage route selection and survival at Ellsworth Dam.

Passage Route	Number	Percent of Total	Number Surviving	Percent Passage Survival
Unit 1	0	0	NA	NA
Unit 2	12	27.9	3	25.0
Unit 3	17	39.5	7	41.2
Unit 4	14	32.5	12	85.7
Unidentified Route*	4	8.5	2	50
Total	47	100	24	51.1

* Four eels passed downstream through undetected routes of passage.
(Source: Black Bear Hydro, 2015d, as modified by staff).

Interior's fishway prescription and Maine DMR's section 10(j) recommendation would require Black Bear Hydro to cease operation at night from September through October 31, and following significant rain events in August. Shutting down all generation at night from September through October 31 would significantly reduce turbine-induced injury and mortality at the project because the peak of eel migration generally occurs between September 1 and October 31 (Haro *et al.*, 2003). In addition, rain events can provide an important environmental cue to encourage downstream movements of out-migrating eels (EPRI, 2001; Haro *et al.*, 2003). Peak movements often occur at night (see Table 23), following periods of increasing river flow (Richkus and Whalen, 1999). In Ellsworth, Maine, the average amount of rainfall for the month of August is 3.5 inches.[135] A storm event in August, with rainfall that exceeds 1 inch would provide one-third of the average monthly rainfall for the entire month of August and would increase flow in the Union River. A storm event of this nature would provide environmental cues that would signal downstream migration, particularly in mid-August when eels begin their migration in Maine. Watene *et al.* (2000) found that a rain event that exceeded 1 inch of rain in 24 hours triggered a migration of adult European eels. Ceasing operation at night, after a significant rainfall event, while continuing to operate the downstream fish passage facility would protect the majority of eels from injury or mortality from the turbines, and would attract eels to a potentially safer means of downstream passage, as the flow from the downstream fish passage facility would be the only hydraulic signal guiding eels downstream. While shutting down Unit 1 during

[135] *See* average rainfall for Maine in August (https://currentresults.com/Weather/Maine/precipitation-august.php), accessed by staff 7/24/2018.

critical periods of the downstream passage season, as recommended by Maine DMR, could also reduce the level of entrainment that occurs at the project, it would not likely significantly reduce entrainment beyond the level of reduction that would be provided by shutting down generation at night from August through October 31. During the period of shutdown, the existing attraction flows provide a means for eels to move downstream and the recommended downstream fish passage enhancements described further below would enhance downstream passage safety and efficiency

Table 23. Timing of adult eel downstream passage at Ellsworth Dam.

Time (24-hour clock)	Number of Eels	Percentage of Eels	Cumulative Percentage
18:00 to 21:00	10	23.3	23.3
21:01 to 00:00	11	25.6	48.9
00:01 to 03:00	12	27.9	76.8
03:01 to 06:00	5	11.6	88.4
Other	5	11.6	100.0
Total	43*	100.0	

*Four eels passed downstream through undetected routes of passage
(Source: Black Bear Hydro, 2015d).

Beginning with the 2017 fish passage season, Black Bear Hydro began prioritizing the operation of turbine Units 1 and 4 over Units 2 and 3 at the Ellsworth Development during the downstream alosine passage season from June 1 to November 30 to address alosine survival based on the results of the 2016 Downstream Atlantic Salmon Passage Survival Study (Survival Study). Results of the Survival Study showed that test fish utilizing Units 1 and 4 for downstream passage survival had greater survival (81.0 percent) than test fish utilizing Units 2 and 3 for downstream passage (62.4 percent survival). Black Bear Hydro concluded that because the turbines at Units 2 and 3 rotate at a faster rate, there is a higher likelihood of alosines being injured or killed by turbine blade strike.

Black Bear Hydro proposes to continue prioritizing operation of turbine Units 1 and 4 over Units 2 and 3 during critical downstream passage seasons that are to be determined in consultation with resource agencies. Black Bear Hydro also proposes to determine the critical passage seasons in consultation with the resource agencies. Commerce’s fishway prescription requires Black Bear Hydro to curtail operation of Unit 1 and prioritize operation of Unit 4 over Units 2 and 3 during the critical downstream fish passage seasons, to be determined in consultation with resource agencies. Maine DMR recommends the same operation schedule required by Commerce. DSF recommends that the Kaplan turbine units (Units 2 and 3) be shut down during downstream migration periods.

Black Bear Hydro's operation prioritization does not appear to effectively reduce adverse effects on downstream migrants, as river herring fish kills were reported after implementing this measure in the months of June, August, and October 2017 and July, August, and September 2018. While unit prioritization has the potential to lower the mortality rate of eels that are entrained at the project during the day when flows in the Union River are equal to or less than the combined maximum hydraulic capacity of Units 1 and 4 (1,370 cfs), the evidence of continued fish kills in the 2017 and 2018 passage seasons demonstrates that turbine passage at the project continues to be unsafe under the existing conditions. Therefore, Black Bear Hydro's proposed turbine operation priority (*i.e.*, Units 1 and 4 prioritized over Units 2 and 3) and Commerce's required and Maine DMR's recommended operation priority (*i.e.*, Unit 4 prioritized over Units 2 and 3) would likely not significantly reduce entrainment without additional protective measures.

DSF's recommendation to cease operation of Units 2 and 3 during the downstream migration period would prevent entrainment of eels that are passing downstream during the day at the units with the lowest survival. However, shutting down Units 2 and 3 would reduce the project's maximum hydraulic capacity from 2,460 cfs to 1,370 cfs for the entire downstream migration period (mid-August to mid-November). According to the flow duration curves based on project generation, flow exceeds 2,460 cfs 5.1 percent of the time and 1,370 cfs approximately 43.9 percent of the time in November. Therefore, shutting down Units 2 and 3 would result in the project spilling for approximately 11.6 days in November. Because of the rocky outcrops present at the base of Ellsworth Dam (see Figure 18), passing via spill may result in eel mortality. Dead alewives were observed in the Union River on June 2 and 3, 2017,[136] before Black Bear Hydro replaced the flashboard that had been removed for the 2017 smolt study, and dead river herring were no longer observed after Black Bear Hydro replaced the flashboards at the conclusion of the 2017 smolt study.[137] In addition, if the proposed and recommended downstream fishway modifications and protective measures discussed above are implemented during the term of any new license, then ceasing turbine operation might not provide any additional significant reductions to turbine impingement and entrainment.

Black Bear Hydro proposes to install a fish guidance system that consists of a rigid hanging curtain or boom that is 10 to 15 feet deep and that leads to the surface weir

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[136] *See* Jane Langley's June 20, 2017 letter.

[137] *See* NMFS' July 5, 2017 letter.

entrance to provide safe, timely, and effective fish passage. DSF also recommends that Black Bear Hydro install a Kevlar diversionary guidance boom at the Ellsworth Development. A diversionary guidance boom[138] could reduce eel entrainment potential at the generating units if the boom extends the full-depth of the forebay, approximately 40 feet. Prior to approaching a forebay, eels generally are benthic-oriented (Piper *et. al*., 2015) and the guidance boom would have to reach to the bottom to direct benthic eels to a safe route of passage at the surface. Therefore, Black Bear Hydro's proposed fish guidance system with a maximum depth of 15 feet would not likely reduce the adverse effects of the project on eels.

Duration of Passage

Commission staff evaluated the duration of passage and downstream migration speed[139] of eels through the Ellsworth Development to determine whether project operation causes passage delay for downstream migrating eels.

During the Downstream Eel Passage Study, eels moved substantially faster under Operating Scenario 1 (97 percent generation) than they did under the other two operating scenarios. Under Operating Scenario 1, the median eel migration speed was 1.2 fps. At this migration speed, eels would expend 11.8 minutes to move 853 feet downstream past the Ellsworth Dam. Eel migration speed decreased and the duration of the migration time through the project increased at lower flows. Under Operating Scenario 2 (64.5 percent generation), the median eel migration speed was 0.37 fps. At this migration speed, eels would expend 38 minutes to move 853 feet downstream past the Ellsworth Dam. Under Operating Scenario 3 (40.7 percent generation), the median eel migration speed was 0.56 fps. At this migration speed, eels would expend 25 minutes to move 853 feet downstream past the Ellsworth Dam.

Cumulatively, across all operating scenarios (minimum to maximum generation at the Ellsworth Development), results of the Downstream Eel Passage Study showed that 71 percent of eels in the study passed the Ellsworth Dam within one hour, 17 percent of eels took between one and eight hours to pass downstream of Ellsworth Dam and 12

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[138] The Kevlar diversionary guidance boom consists of a barrier net with 0.5 inch spacing supported by floats at the water's surface. The net is anchored at a shoreline location that is upstream of the dam and is used to direct fish to the entrance of a surface-oriented downstream fish passage facility at the dam.

[139] Commission staff calculated the migration speed for eels passing the Ellsworth Development by measuring the elapsed time in seconds between the study release site (260 meters upstream) and the receiver station at the turbines and bypass weir. The elapsed time was then divided by the total passage distance in feet (853 feet) to obtain the migration speed in feet per second.

percent of eels took more than eight hours to pass downstream of Ellsworth Dam. The cumulative median migration speed for eels passing through known routes of passage was 0.95 fps. At a migration speed of 0.95 fps, eels would be expected to expend a median of 15 minutes to move 853 feet downstream past the Ellsworth Dam when the dam is releasing generation flows.

As discussed above, the median cruising speed of eels in the free flowing section of the Union River downstream of the Graham Lake Dam ranges from 1.03 to 2.16 fps. By comparing the highest cruising speed for eels in the free flowing section of the Union River downstream of Graham Lake Dam (2.16 fps) with the lowest measured median eel migration speed for the Ellsworth Development during low flow generation (0.37 fps), it appears that the Ellsworth Development reduces eel migration speed by up to 1.8 fps.

Commission staff estimated passage delay from operation of the Ellsworth Development by using the eel cruising speed from the free flowing section of the Union River. At a cruising speed of 2.16 fps, eels would pass Ellsworth Dam in 6.5 minutes. To determine project-affected passage duration, Commission staff used a project operating scenario resulting in the greatest effect on eel migration speed, Operating Scenario 2, which had the lowest median eel migration speed. The median eel migration speed for Operating Scenario 2 is 0.37 fps, and eels would be expected to pass downstream of the Ellsworth dam in 38 minutes. Therefore operation of the Ellsworth Development appears to delay downstream passage of eels by about 31 minutes.

A passage delay of less than one hour would not likely affect eels during migration season. As discussed above, eels typically move downstream at night and the delay in passage does not exceed the number of hours of darkness. Therefore, eels would likely be able to pass downstream during one cycle of darkness during the migration period. In addition, the migration season for eels is several months long, from August through November, and a delay of one hour or less would not likely have an adverse effect on eel populations, as there would be multiple opportunities for eels to pass downstream over the duration of the migration season.

Alternative Means of Downstream Passage

Passage through the Downstream Fish Passage Facility

Migrating eels are not strictly bottom-oriented during migration (Haro *et al*., 2000) and will utilize a surface-oriented downstream fish passage facility (Brown *et al*., 2009) particularly when a hydropower facility is not generating. However, when the project is generating, the 20-cfs attraction flow that is currently provided at each of the surface bypass weirs at the Ellsworth Development does not appear to be adequate for attracting eels to the entrance of the bypass weirs. As evidenced by the results of the Downstream Eel Passage Study, no eels utilized the bypass weirs for downstream passage. A likely cause of the failure of the bypass weir to successfully attract eels is that the flow from downstream bypass facility does not create a hydraulic signal that is strong enough to attract eels to the entrance to the bypass weirs in the presence of competing flows from the turbine intakes.

During the last 10 days of the Downstream Eel Passage Study, Black Bear Hydro was operating the Ellsworth Development at 19.1 percent of station capacity (470 cfs). At 470 cfs, the turbines still created a hydraulic signal that was stronger than the attraction flow for the downstream fish passage facility. The fact that no eels utilized the downstream fish passage facility for downstream passage is therefore not unexpected, as eels are attracted to low level routes of passage during migration. Improving the combined flow through all three weirs to release an attraction flow that is 5 percent of the maximum hydraulic capacity of the Ellsworth Development (as proposed by Black Bear Hydro, required by Interior, and recommended by Maine DMR), would help guide eels away from the turbine intakes, which in turn could increase survival and reduce the chance of injury or mortality eels currently experienced during turbine passage.

As currently designed, however, the downstream fish passage facility has several design features that could pose a safety risk to downstream migrating eels. First, the downstream migrant pipe discharges the conveyance flow in the opposing direction of the flow that is being released from the eastern surface weir (see Figure 18). The conveyance flow from the downstream migrant pipe also discharges the conveyance flow directly into the hard plastic floor of spillway flume. Depending on the amount of flow, eels exiting the downstream migrant pipe could be injured or killed by the shear forces from water flowing in opposing directions or from impacting the plastic floor of the spillway flume. Realigning the end of the downstream migrant pipe so that the discharge from the pipe flows in the same direction as the conveyance flow in the spillway flume, as proposed by Black Bear Hydro and recommended by the resource agencies, would reduce the risk of eels being injured or killed by shear forces and striking the spillway fume.

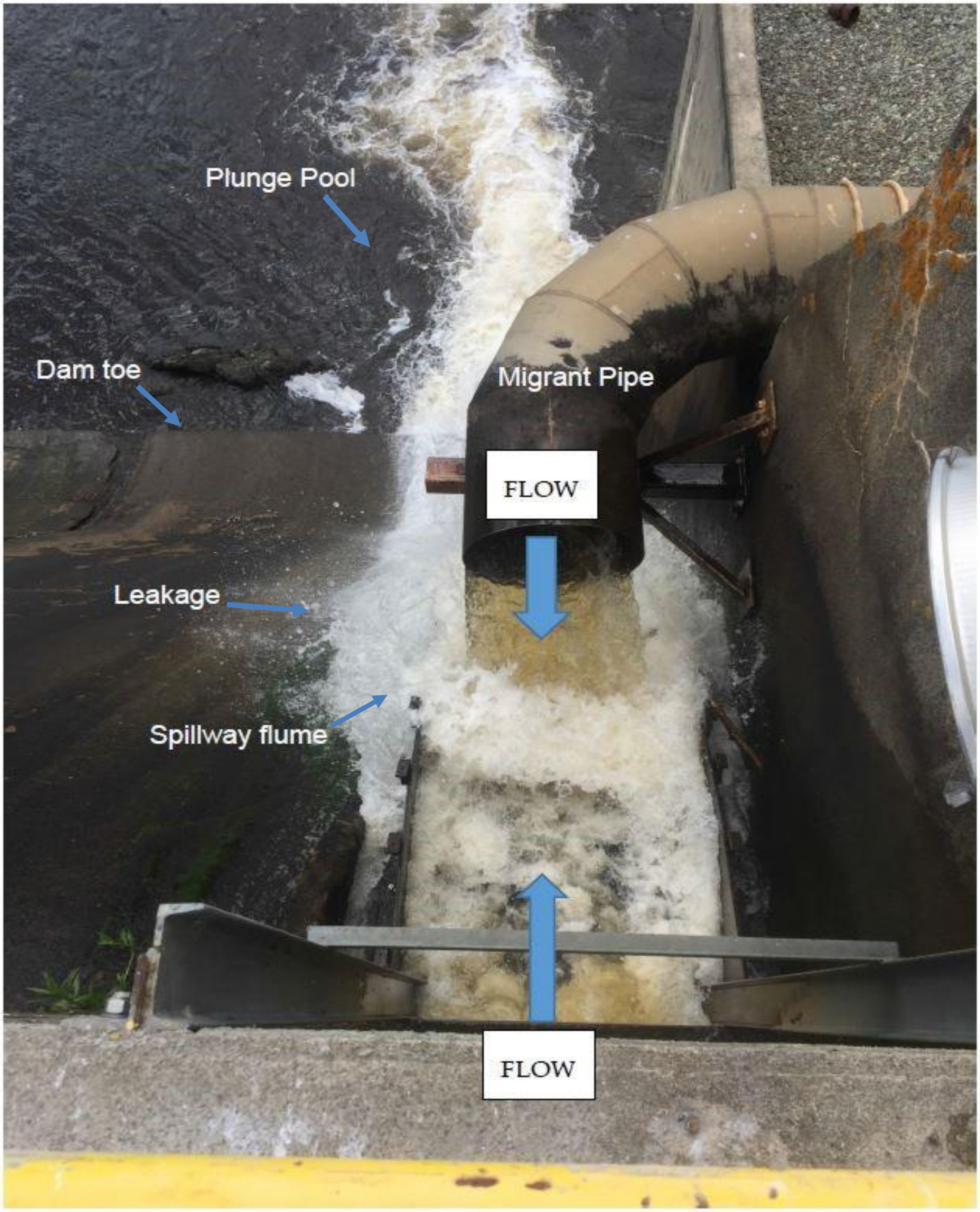

Figure 18. Downstream fish passage facility spillway flume at Ellsworth Dam. (Source: Black Bear Hydro, 2015b, as modified by staff).

The spillway flume itself could also be unsafe for downstream eel passage. The spillway flume leaks along the spillway face and the sidewalls of the spillway flume appear to be insufficient to contain all of the conveyance flow. Leakage outside the spillway flume could reduce the water levels within the flume and create conditions where there is insufficient water to prevent eels from impacting the walls and floor of the spillway flume, which could injure migrants during downstream passage. If the conveyance flow overtops the walls of the flume, eels could also be swept over the walls of the spillway flume and could be injured or killed by impacting the face of the spillway. Eliminating leakage along the walls of the spillway flume by increasing the heights of the sides of the flume to fully contain water and fish within the spillway flume would reduce the risk of injury and mortality associated with impacting the walls and floor of the flume or the face of the spillway.

The discharge from the spillway flume could also pose a safety hazard for eels. Interior's fishway prescription would require Black Bear Hydro to "eliminate discharge to ledges at the toe of the dam." Although Black Bear Hydro states that there is no exposed ledge at the base of the spillway, even at low tide,[140] there are rocky outcrops located immediately adjacent to the spillway flume that could pose a safety risk to eels. Low tide exposes these rocky outcrops (see Figure 18) and discharge from the spillway flume at low tide could impact the rock ledge and injure or kill migrating eels. Modifying the spillway flume exit to eliminate the rock ledge would protect alosines from being injured or killed from impacting the rock ledge during passage.

Although DSF recommends installing a spillway plunge pool downstream of the Ellsworth Dam within 2 years of license issuance, a natural plunge pool already exists at the toe of dam. In its October 10, 2018 response to Commission staff's request for additional information, Black Bear Hydro explains that it does not have drawings of the river bed at the base of the spillway to confirm the depth of the plunge pool, but "the minimum depth of the plunge pool appears to be several feet with a potential depth of approximately 12 feet."

Installation of a Deep Gate

DSF recommends installing a deep gate at Ellsworth dam to provide an additional route of downstream passage for out-migrating eels. As discussed above, passage through the turbines is unsafe and eels are not currently utilizing the surface bypass weirs for passage. Installing a discharge pipe at the base of the dam could provide an alternate means of safe passage, and could increase passage efficiency. When approaching a forebay at a hydroelectric facility, eels will spend a significant period of time near the bottom of the impoundment (Brown *et al.*, 2003), and studies conducted by Durif *et al.* (2003) found that European eels were attracted to and used a submerged bypass more

[140] *See* Black Bear Hydro's October 10, 2018 response to additional information.

readily than a surface-oriented bypass. The Design Criteria Manual recommends that the intake opening should be approximately one half of the maximum body length of an adult silver eel, which would result in an intake opening that is 18 inches or larger in diameter. Installation of a submerged bypass with an 18 inch opening at the Ellsworth development could provide safe and efficient egress for downstream migrants during the passage season, provided that the submerged bypass is not pressurized to levels where the intake velocity elicits avoidance behavior. Based on the results of a study conducted by Piper *et al*. (2015), European eels avoid intakes at a median flow velocity of 1.87 fps. Therefore, an intake velocity of 1.87 fps or less would likely provide suitable velocities for effective downstream eel passage.

Upstream Fish Passage

Black Bear Hydro proposes to continue to maintain and operate the existing upstream fishway trap and truck facilities for alosines,[141] which is consistent with Commerce's section 18 fishway prescription. Black Bear Hydro states that it typically operates the upstream fish passage facilities from early May to early/mid-June based on upstream fishway operation data. In the Species Protection Plan filed on September 28, 2018, Black Bear Hydro proposes to operate the upstream fish passage facilities from May 1 (or when river herring are present in "reasonable quantities") to October 31 for river herring and Atlantic salmon. Commerce's prescription would require Black Bear Hydro to provide upstream fish passage from May 1 to July 31 for alosines.

In its prescription, Commerce states that it is not requiring any changes to the existing fishway trap and truck facility at this time, but if the existing facilities become insufficient (*e.g.*, if the state of Maine increases the number of stocked blueback herring and alewife to the point where the existing facility is no longer sufficient, or if management objectives for American shad change during the term of any new license), then Black Bear Hydro would need to build and operate new facilities at Ellsworth and Graham Lake dams.

DSF recommends that volitional, 24-hour upstream fish passage suitable for adult American shad and river herring be operational at the Ellsworth and Graham Lake dams within 2 years of license issuance.

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[141] Black Bear Hydro also proposes, in the Species Protection Plan filed on September, 28, 2018, to continue to maintain and operate the existing fishway and trap for Atlantic salmon, unless new or modified fish passage measures are provided. That aspect of the proposal and analysis thereof are evaluated in section 3.3.4, *Threatened and Endangered Species*.

Our Analysis

In May and June 2014, Black Bear Hydro quantified upstream passage survival for river herring through the existing fishway trap and truck facility. Black Bear Hydro transported river herring upstream to Graham Lake, released approximately 100 to 200 fish into net pens, and checked the net pens for dead fish at various time intervals following the release, including 30 minutes, 6 hours, 18 hours, and 24 hours after the release. Black Bear Hydro found that there was no fish mortality associated with the trap and truck facilities, and that mortality was limited to factors involving the survival study itself, including entanglement in the cover of the net pen, injuries sustained as the field crews filled net pens with test fish from the transport truck, or injuries or entanglement that occurred as the crews transported the net pens to deeper water after filling (Black Bear Hydro, 2014).

As part of the 2014 upstream passage study, Black Bear Hydro calculated the capacity of the trap and truck facility to determine if the facility could support Maine DMR's target river herring escapement of 315,000 fish (Black Bear Hydro, 2014). In order to provide passage for 315,000 river herring, Black Bear Hydro estimated that the trap's hopper would need to have sufficient volume to safely contain 2,362.5 pounds of river herring (approximately 4,725 fish) and 118.1 pounds of non-target species during the peak hour of the run.[142] Based on the volume of the hopper, Black Bear Hydro estimated that the trap and truck facility could support 1,800 pounds of river herring and non-target species per hour with a 15-minute cycle (4 cycles per hour) or 2,700 pounds of fish with a 10-minute cycle (6 cycles per hour).

Maine DMR's escapement goal of 35 fish per acre has been exceeded since 2015 (see Figure 19). As Figure 13 shows, the existing fishway trap and truck facilities have been effective at passing the number of river herring targeted by Maine DMR for escapement for the 2015 through 2017 migration seasons. Although run size has been adequate to support current escapement goals in most years since 1996, Figure 13, which also shows harvest in addition to run size and escapement, suggest that prior to 2015, management decisions favoring harvest over escapement were the reason that escapement targets were not being met. The fact that the same facilities are used for both the harvested fish and escapement fish indicate that the facilities are operating adequately to meet current management goals. Accordingly, the only apparent benefit to DSF's recommendation for a new volitional passage facility for alosines within 2 years of license issuance would be a theoretical reduction in handling stress associated with the current trap and truck passage method. As described above, however, Black Bear

[142] The number of fish attempting to pass upstream during the peak hour of the run can be estimated as 10 to 20 percent of the number of fish migrating during the peak day of the run (FWS, 2017). Black Bear Hydro estimated that 10 percent of the spawning run would be 10 percent of the total run, or 31,500 river herring (Black Bear Hydro, 2014).

Hydro's 2014 upstream passage survival study provides no evidence that this is currently an issue inhibiting alosine upstream passage.

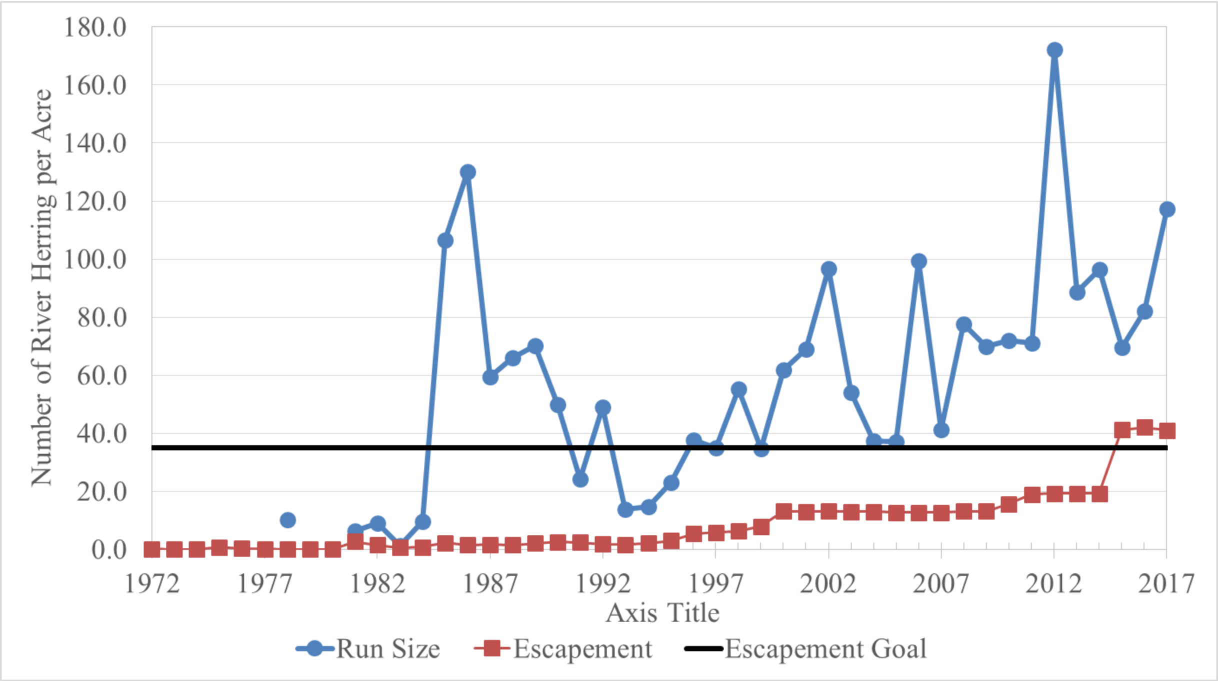

Figure 19. The run size and escapement in fish per acre at the Ellsworth Project. The target run size is 235 fish per acre, and the solid black line shows the escapement goal of 35 fish per acre. (Source: URFCC, 2010-2018, as modified by staff).

Continuing to operate the existing fishway and trap, as proposed by Black Bear Hydro and prescribed by Commerce, should result in no change to the effectiveness of upstream passage for alosines at the project or the survival of river herring that pass through the facilities. Because the current facilities are operating at substantially less than their design capacity, they should also be able to accommodate increased passage in the event that Maine DMR increases the targeted number or river herring escapement.

Providing upstream alosine passage from early May to early/mid-June, as proposed by Black Bear Hydro, would capture most of the alosine spawning runs, but may not be sufficient for blueback herring and American shad, which tend to migrate later in the season. As discussed above in section 3.3.2.1 (*Aquatic Resources, Affected Environment*), spawning runs of alewife can occur from May through June, and spawning runs for blueback herring and American shad can occur from June through July in Maine. Therefore, providing upstream fish passage for alosines from May 1 to July 31, as required in Commerce's prescription, would reduce the potential for adverse project effects on alosine passage, including effects on the timeliness of passage.

Without any definitive information on the scope or magnitude of any changes to management goals in the future, or any specific measures related to new upstream passage facilities for alosines, it is not possible for Commission staff to evaluate the effects of Commerce's requirement for Black Bear Hydro to construct and operate new upstream passage facilities if management goals change or if the escapement target exceeds the existing facilities' design capacity.

Downstream Fish Passage

Graham Lake Development

Black Bear Hydro proposes to continue operating the Graham Lake Development as a water storage reservoir to support downstream generation at the Ellsworth Development and to meet minimum flow requirements of 250 cfs from May 1 to June 30 each year and 105 cfs from July 1 to April 30 each year.

Black Bear Hydro proposes to modify the temporarily-installed Alden weir by May 1 of the third year following issuance of any new license to accommodate a 3-foot depth of flow over the full range of reservoir elevations allowed in any new license issued by the Commission. Black Bear Hydro proposes to operate the modified bypass weir and Tainter gates at Graham Lake Development for downstream fish passage from April 1 through December 31.

Commerce's section 18 fishway prescription would require Black Bear Hydro to modify the Alden weir by May 1 of the third year of any new license to provide a conveyance flow that is at least three feet deep across the full range of reservoir elevations, to provide safe, timely, and effective downstream passage for anadromous fish species. Commerce's fishway prescription also requires Black Bear Hydro to provide downstream passage from April 1 to December 31 of each year.

Interior's fishway prescription would require Black Bear Hydro to modify the existing downstream passage surface weir at the Graham Lake Dam for the safe, timely, and effective passage of American eel and anadromous fish species and to construct and operate the downstream fish passage facility within 2 years of license issuance. The prescription would require the construction and operation of an Alden weir (or a comparable weir design that provides a uniform accelerating flow through the weir). The prescription states that the new downstream fish passage surface weir at the Graham Lake Dam must provide a conveyance flow that is at least two feet deep across the full range of reservoir elevations required by any new license issued by the Commission. Interior's fishway prescription would require Black Bear Hydro to operate the new downstream fish passage facility from August 1 through October 31 and to use the new downstream passage facility to pass the minimum flow required in any new license issued by the Commission. In addition, the prescription would require Black Bear Hydro to design, operate, and maintain the new downstream fish passage facility in a manner that is consistent with FWS's 2017 Design Criteria Manual.

Maine DMR's section 10(j) recommendation would require the same downstream fish passage measures at the Graham Lake Development as Interior's section 18 prescription for safe, timely, and effective passage of diadromous fish.

Our Analysis

Adult fish migrate downstream in the Union River shortly after spawning between May and July of each year. Fish produced from spring spawning events generally remain in river habitats for a few months before out-migrating to the sea as juveniles during late summer and early fall. As discussed above in the minimum flow analysis, the existing minimum flow of 250 cfs that is provided in May and June, and the minimum flow of 105 cfs that is provided for the remainder of the year provide a sufficient zone of passage for adult juvenile and adult river herring that are migrating downstream through the project. Alosines migrating downstream can pass downstream of the Graham Lake Development through the surface bypass weir and Tainter gates when they are releasing flow to provide generation at the Ellsworth Development or minimum flows to the downstream reach. There are no generating facilities at the Graham Lake Development that could adversely affect alosines through entrainment on project turbines.

<u>Passage Survival and Efficiency</u>

There are no project features at the Graham Lake Development that could injure juvenile and adult alosines migrating downstream and no mortalities have been observed in the Union River between the Graham Lake Dam and the Ellsworth Dam.

The Alden weir that Black Bear Hydro temporarily installed in 2017 is primarily designed to create a uniform rate of flow acceleration that increases by 1 fps or less, per foot of linear distance from the entrance of the weir toward the exit of the weir. The steadily increasing flow velocities through the Alden weir help to reduce negative behavioral reactions to the increasing conveyance flow (*e.g.*, avoidance behavior) and may better attract certain migrants to the entrance of the flume compared to other surface-oriented means of fish passage, such as flash board openings or log sluices (Haro *et al.*, 1998). The Alden weir has been shown to reduce avoidance behavior and passage delays for juvenile migratory fish (Johnson *et al.*, 1995). Therefore, maintaining and operating the Alden weir during the term of any new license would reduce potential effects related to passage delays.

Interior's section 18 fishway prescription and Maine DMR's section 10(j) recommendation require the Alden weir to be designed in a manner that is consistent with the baseline design criteria provided in FWS's Design Criteria Manual. FWS's Design Criteria Manual states that surface bypasses should be a minimum of 3 feet wide and 2 feet deep. Black Bear Hydro does not provide any specific information about the width of the Alden weir in its license application and related filings. However, the weir appears to provide a conveyance that is slightly less than 4 feet wide based on photos included in the 2017 Atlantic salmon smolt downstream passage study report and based on the fact that Black Bear Hydro installed the weir in the bay containing the 4-foot-wide downstream bypass weir (Black Bear Hydro, 2017a). Therefore, the width of the Alden weir is likely consistent with the guidance in the Design Criteria Manual.

The Design Criteria Manual recommends a minimum depth of 2 feet for surface bypasses. The Design Criteria Manual also includes a general recommendation for depth of flow in a fish passage facility of at least twice the body depth of the largest individual to provide an adequate zone of passage. The Design Criteria manual provides nominal body depths for adult river herring (4 inches) and shad (6 inches), therefore twice the body depth of the largest individual (adult shad) would be 12 inches. Using the Design Criteria Manual as a guide for the depth of flow over the weir, it appears that Interior and Maine DMR's recommendation to modify the Alden weir to provide a water depth of 2 feet through the Alden weir would provide a sufficient water depth to allow alosines to be fully submerged as they swim through the weir, thereby reducing the potential for adverse behavioral reactions (*e.g.*, avoidance behavior) that would occur at lower depths. Black Bear Hydro's proposal and Commerce's fishway prescription to provide a 3-foot-deep flow through the weir would also eliminate the risk of water being too shallow for river herring to pass through the weir; however, Commerce and Black Bear Hydro do not explain why a 3-foot-depth of flow is needed and it appears that a 2-foot-deep flow would be sufficient for safe, timely, and effective passage through the weir.

The depth of flow that would be provided over the Alden weir depends on the elevation of the Alden weir. In the 2017 salmon smolt passage study, Black Bear Hydro states that the crest elevation of the sluice containing the Alden weir is 96.7 feet msl (Black Bear Hydro, 2017a).[143] At a crest elevation of 96.7 feet msl, water flowing through the weir would be at least 2 feet deep until the water elevation drops to 98.7 feet

[143] Information in the record indicates that the crest elevation of the intake with the Alden weir could be higher than 96.7 feet msl. In the 2017 salmon smolt passage study, Black Bear Hydro states that the depth within the sluice during the 2017 salmon smolt passage study ranged from 4.9 to 5.6 feet. If the crest elevation and reported depths are correct, then the water surface elevation during the 2017 study should have been between 101.6 and 102.3 feet msl. However, in its November 30, 2017 letter regarding water level concerns in Graham Lake, Black Bear Hydro reported that the water surface elevation for Graham Lake ranged from 102.6 to 103.2 feet msl when the study was conducted. Assuming that the water elevation data is correct, it appears that the information included in the 2017 study is inaccurate by about 1 foot, either as it relates to the depth of flow over the weir or the elevation of the weir.

msl. As shown by the long-term operating curve for Graham Lake (see Figure 5), the licensee has historically operated Graham Lake at a water elevation below 98.7 feet msl during the downstream fall migration season for alosines (June 1 – November 30), particularly between September and December, and has dropped the water surface elevation to as low as 93.9 feet msl during October 2017. Modifying the Alden weir to provide a mechanism for vertical adjustment to provide a flow of at least 2 feet of depth within the weir, as prescribed by Interior, would help ensure safe, timely, and effective downstream passage for alosines. In addition, releasing the proposed minimum flows through the modified Alden weir during the downstream fish passage season, as prescribed by Interior and recommended by Maine DMR would ensure consistency between the release of minimum flows and conveyance flows, and would help provide a stronger attraction flow for surface-oriented passage.

The depth of the plunge pool at the base of Graham Lake Dam appears to be adequate to provide safe passage for fish from the surface weir to the water in the Union River downstream of Graham Lake Dam. The Design Criteria Manual recommends a water depth equal to 25 percent of the fall height from the Alden weir to the receiving waters below, or water depth of 4 feet, whichever is greater. The exit of the surface weir is at an elevation of 96.7 feet msl. The tailwater elevation below Graham Lake Dam is 80.5 feet msl, which corresponds to a fall height of 16.2 feet. Therefore, according to the Design Criteria Manual, the recommended depth of the plunge pool should be 4.05 feet. The plunge pool depth of 9.5 feet at the base of Graham Lake Dam exceeds the Design Criteria Manual's recommended depth.

Downstream Passage Operation Schedule

Black Bear Hydro proposes to continue to operate the downstream fish passage facility at the Graham Lake Development from April 1 through December 31 each year, which is consistent with Commerce's prescription. Operating the downstream fish passage facility from April 1 through December 31 would encompass the entire June 1 to November 30 downstream alosine migration period and accounts for downstream passage of Atlantic salmon, as discussed in section 3.3.4.2 (*Threatened and Endangered Species, Environmental Effects*).

Schedule for Completion

With regard to the schedule for completing modifications to the downstream fish passage facility, Interior's fishway prescription and Maine DMR's section 10(j) recommendation would require the modified downstream fish passage facility to be operational within 2 years of license issuance. In contrast, Commerce's fishway prescription would require that the modified downstream passage facility be operational by May 1 of the third year of any new license, consistent with Black Bear Hydro's proposal.

The migratory species would benefit from a construction schedule that reduces the ongoing project effects in a timely manner, while also limiting construction activities to periods outside of the downstream migration season. Adjusting the completion timing for the new downstream fish passage facility around migration seasons would minimize the effects of construction on migrating fish.

Ellsworth Development

Black Bear Hydro proposes to continue operating the existing downstream fish passage facility at the Ellsworth Development from April 1 to December 31 of each year and proposes to install the following protective measures by May 1 of the third year following license issuance: (1) a fish guidance system (Worthington boom or similar technology) with rigid panel depths between 10 to 15 feet (where water depths are adequate); and (2) full-depth trashracks or overlays with 1-inch clear spacing at the intakes for Units 2, 3, and 4. Black Bear Hydro also proposes to prioritize operation of Units 1 and 4 over Units 2 and 3 during critical downstream passage seasons, the timing of which would be determined in consultation with the resource agencies. Black Bear Hydro also proposes to make the following modifications to the downstream fish passage facility by May 1 of the third year following license issuance:

1. Modify the eastern surface weir entrance by increasing the depth of the weir to a minimum of 3 feet and installing tapered walls similar to an Alden weir;

2. Increase the capacity of the eastern surface weir to pass up to 5 percent of station hydraulic capacity;

3. Increase the height of the sides of the spillway flume in consultation with resource agencies, to improve containment of fish passing through the flume; and

4. Modify the existing fish downstream migrant pipe to improve its discharge angle into the spillway flume to limit potential injury to fish that are exiting the pipe.

Interior's section 18 fishway prescription would require the following measures to provide safe, timely, and effective passage for diadromous fish species within 2 years of license issuance:

1. Install full-depth trashrack overlays with 1-inch clear spacing over the intakes of generating Units 2, 3, and 4 at the Ellsworth Development from August 1 to October 31 of each year;

2. Modify the existing downstream fish passage facility at the Ellsworth Development by: (1) increasing the total combined flow through the three existing surface weirs to 5 percent of the maximum station hydraulic capacity (approximately 123 cfs); (2) realigning the end of the downstream fish downstream migrant pipe so that water discharges downward to the spillway flume and fish do not impact the spillway when exiting the pipe; and (3) eliminating leakage at the sidewalls of the spillway flume and eliminate discharge from the flume to the ledges at the toe of the dam; and

3. Operate the modified downstream passage surface weirs at the Graham Lake Dam on an annual basis from August 1 to October 31, and design the downstream passage facility in a manner that is consistent with the FWS's Design Criteria Manual (FWS, 2017).

Commerce's section 18 fishway prescription would require the following measures to provide safe, timely, and effective passage for anadromous fish species by May 1 of the third year of any new license:

1. Modify the downstream fish passage facility at the Ellsworth Development as follows: (1) install a fish guidance system that consists of a rigid hanging curtain or boom that leads to the surface weir entrance(s); (2) increase the total combined flow through the surface weir(s) to 5 percent of station capacity by modifying the fish passage entrance to provide a minimum water depth of 3 feet, with tapered walls similar to an Alden weir; (3) realign the downstream fish downstream migrant pipe to improve the discharge angle to the spillway flume; and (4) increase the height of the sides of the spillway flume to contain the increased conveyance flow and reduce spillage;

2. Operate the modified downstream fish passage facility at the Ellsworth Development from April 1 to December 31 each year;

3. Curtail operation of Unit 1 and prioritize operation of Unit 4 over Units 2 and 3 at the Ellsworth Development during the critical downstream fish passage seasons, to be determined in consultation with the resource agencies; and

4. Install full-depth trashrack overlays with 1-inch clear spacing over the intakes of Units 2, 3, and 4.

In its section 10(j) recommendation, Maine DMR recommends the same modifications to the downstream fish passage facility for alosines and salmon that would be required by Commerce's section 18 prescription, but states that the modifications should be completed within three years of license issuance. Maine DMR's section 10(j) recommendation specifies that the fish boom guidance system should be installed from the eastern end of the intake structure to the west shore of the impoundment, with a maximum depth of 15 feet. Maine DMR also recommends that the downstream fish passage facility modifications be designed in consultation with the resource agencies consistent with the FWS's design criteria manual and that resource agencies review design plans.

DSF recommends installation of permanent downstream passage systems at Ellsworth Dam, including full-depth trashracks with 1-inch clear spacing, a Kevlar diversionary guidance boom, an increase in downstream bypass flow to 120 cfs, and a spillway plunge pool within 2 years of license issuance. DSF also recommends that the Kaplan turbine units (Units 2 and 3) be shut down during downstream migration periods.

Our Analysis

Potential for Entrainment and Impingement

From October 2014 to September 2018, there were 9 fish mortality events at the Ellsworth Development lasting 1 to 2 days in duration (see Table 25).[144] The majority of the fish kills (89 percent, n=8) occurred during the period of July to October, which corresponds to the outmigration period for juvenile alosines. There was only one fish kill reported during the month of June. The June fish kill mostly consisted of outmigrating adults, as Black Bear Hydro would have recently stopped stocking adults upstream in mid-June, and the adults would outmigrate shortly after spawning. Black Bear Hydro stated that repairs to the attraction flow pump contributed to the October 2014 fish kill.[145] In addition, Black Bear Hydro stated that juvenile river herring are occasionally found impinged on a screen for an auxiliary cooling water intake, and impinged fish are discarded into the tailrace.[146] In response, FWS filed a letter stating that it was unlikely that the cooling water intake was the cause of the fish kill and that the lack of adequate attraction flow combined with the high flow running through the turbines after a high precipitation event likely resulted in the entrainment of river herring.[147] Subsequently,

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[144] One fish mortality event (June 3, 2017) was excluded from further analysis as it was attributed to an insufficient experimental spill through the flashboards during the Atlantic Salmon Smolt Downstream Passage Study.

[145] *See* Black Bear Hydro's November 26, 2014 letter.

[146] *Ibid.*

[147] *See* FWS's December 3, 2014 letter.

Black Bear Hydro developed a fish passage operation and maintenance plan[148] and purchased a spare attraction flow pump to minimize the duration of any future outages.[149]

Despite the implementation of the fish passage operation and maintenance plan, additional fish kills involving juvenile river herring occurred in October 2015, October 2016, August 2017, July 2018, August 2018 and September 2018. Black Bear Hydro attributed the October 2015[150] and October 2016[151] fish kills to the failure of the attraction flow pump. Black Bear Hydro determined that the fish kills are related to turbine passage and subsequently developed interim measures to cease operation at the Ellsworth Development until migrating schools of fish pass downstream of the development.

Fish kills involving adult river herring also occurred in June 2017[152] and June 2018.[153] The cause of the June 2017 fish kill was attributed to spill from a flashboard opening discharging to exposed rocky outcrops at the base of dam at low tide. As part of an Atlantic salmon smolt downstream passage study, Black Bear Hydro removed three 7-foot-wide flashboard sections to provide additional downstream passage flow and to evaluate a potential alternative passage route.[154] On June 3, 2017, a river herring harvester observed river herring passing over the dam through the gap in the flashboards and landing on the bedrock ledge at the base of the dam, which had been exposed by a very low tide, resulting in mortality.[155]

Since 2017, Black Bear Hydro has voluntarily implemented measures to attempt to reduce fish mortality associated with turbine passage, including: (1) operating Units 1 and 4 before operating Units 2 and 3; (2) manually inspecting the surface weirs each day

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[148] A discussion of the fish passage operation and maintenance plan is found below.

[149] *See* Black Bear Hydro's March 31, 2015 letter.

[150] *See* DSF's October 7, 2015 letter.

[151] *See* Black Bear Hydro's October 25, 2016 letter.

[152] *See* Black Bear Hydro's July 28, 2017 letter.

[153] https://www.ellsworthamerican.com/maine-news/waterfront/union-rivers-latest-fish-kill-blamed-on-water-flows-at-leonard-lake-dam/ Accessed July 27, 2018.

[154] *See* Black Bear Hydro's June 21, 2017 letter.

[155] *Ibid*.

during the downstream passage season to ensure that the fishway functions correctly; (3) modifying the cooling water intakes at the project with smaller spaced screens; and (4) ceasing operation of the generating units when large numbers of out-migrating river herring are observed at the project or significant mortalities are observed or reported. However, the most recent fish kills in the summer and fall of 2018 indicate that the project is still adversely affecting out-migrating river herring.

Based on these fish kills, turbine entrainment at the project is known to adversely affect out-migrating fish species by causing injury and mortality. The potential for impingement and entrainment to occur at the project is directly related to: (1) whether fish are excluded from the powerhouse intakes by the existing trashracks, according to the size ranges of adult and juvenile alosines relative to the size of the trashrack bar spacing; and (2) whether fish can avoid impingement and entrainment by overcoming the intake velocity and swimming away from the intake to a safer route of passage, such as the surface weirs.

The trashracks at Ellsworth Dam have a variety of spacing sizes between the trashrack bars, ranging from 1 inch to 2.44 inches. The intakes for Units 2 and 3 have a trashrack with 1-inch clear spacing over the top 6.75 feet of the intake structure and 2.37-inch clear spacing over the lower 7 feet of the intake structure. The intake for Unit 4 has 1-inch clear spacing over the top 6.75 feet of the intake and 2.37-inch clear spacing over the lower 9 feet of portion of the trashrack. The Unit 1 intake has a single trashrack with 2.44-inch clear spacing.

In comparison to the minimum clear spacing size of 1 inch at the existing trashracks, an adult alewife has an average width of 0.87 inch (Castro-Santos 2005; Lawler *et al.*, 1991; Bigelow and Schroeder, 1953) and an adult blueback herring has an average width of 0.82 inch (Smith, 1985). Young-of-year alewife have a reported total length of 2.5-3.5 inches (Bell, 1991) and an average width of 0.12 inch (Lawler, 1991); and a juvenile blueback herring has a reported length of 1-3 inches and average width of 0.17 inch (Smith 1985). Therefore, the body widths of juvenile and adult river herring are all less than the minimum 1-inch clear bar spacing at the existing trashracks. Further, the size range of an adult blueback herring (9-10 inches in length) is less than the minimum size of blueback herring that would be excluded from a 1-inch trashrack (11 inches in length); and the size range of an adult alewife (10-12 inches in length) is less than or equal to the minimum size of alewife that would be excluded from a 1-inch trashrack (12 inches). Altogether, based on physical characteristics of width and length, juvenile and adult river herring are currently susceptible to impingement and entrainment at all four project intakes under the existing environmental conditions, and would continue to be susceptible to entrainment with the proposed and recommended bar spacing of 1 inch.

Although Black Bear Hydro asserts that the trashracks at Unit 1 cannot be 1 inch due to trashrack raking restrictions, the 2.44-inch clear spacing size at the Unit 1 intake does not exclude river herring from turbine entrainment and increases the risk of turbine mortality associated with blade strike.

To assess the potential for river herring to overcome the intake velocity and avoid impingement and entrainment, Black Bear Hydro measured flow velocity across the horizontal faces of the intakes for Units 2, 3, and 4 when all three units were generating at or near maximum generation.[156] At a distance of 3 feet in front of the trashracks, the maximum average intake velocity ranged from 2.08 to 2.43 fps. Adult alewife and blueback herring would be able to avoid impingement on the trashracks and entrainment in the turbines at these velocities because alewives and blueback herring have a burst speed of 10.2 to 15.4 fps (Clough et. al., 2004), which is sufficient to overcome the maximum approach velocity of 2.43 fps. However, juvenile alewives and blueback herring would not be able to avoid entrainment at these velocities because juvenile alewife and blueback herring have reported burst speeds 1.4 to 1.6 fps (Griffiths, 1979), which is not sufficient to overcome the maximum approach velocity of 2.43 fps.

Commission staff also calculated the average "through bar velocity" for the existing trashrack overlay for Units 2, 3 and 4. The average through bar velocity for the existing trashrack for Units 2 and 3 was 3.5 fps and the average through bar velocity for Unit 4 was 3.8 fps. These "through bar velocities" are less than the reported burst speeds for adult alewives and blueback herring (see above). Therefore, adult river herring would likely be able to overcome these velocities and escape impingement and entrainment. However, juvenile alewives and blueback herring would not be able to avoid entrainment, as these species of alosines have reported burst speeds that are less than through bar velocity of the existing trashracks.

To better understand the potential effects of installing narrower trashracks at the project on the potential for impingement and entrainment, Commission staff calculated the through velocity of the turbine units with a full-depth 1-inch trashrack installed over each intake. With a 1-inch full-depth trashrack installed over the intakes for Units 2 and 3, the velocity through the open spaces of the overlay would be approximately 3.8 fps. If a 1-inch full-depth trashrack overlay was installed over the intake for Unit 4, the velocity through the open spaces of the overlay would be approximately 4.1 fps. Similar to the existing environmental conditions, adult river herring would be able to overcome these velocities and escape impingement and entrainment; while juvenile river herring would

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[156] Black Bear Hydro did not measure velocity at the intake for Unit 1; however, based on the similarity of the design and operation of Units 1 and 4, the risk of impingement at Unit 1 would likely be the same as the risk of impingement at Unit 4.

not be able to overcome these velocities and would still be susceptible to impingement and entrainment.

Altogether, based on the physical and behavioral characteristics of river herring, it appears that adult river herring are susceptible to impingement and entrainment at all four project intakes, but could overcome the intake velocities of the existing and recommended 1-inch trashracks to avoid impingement and entrainment and successfully pass through an alternative passage route at Ellsworth Dam. On the other hand, based on size and burst speed, juvenile herring would be susceptible to entrainment at all four project intakes and would not be able to overcome the intake velocities of the existing and recommended 1-inch trashracks. Therefore, juvenile river herring are at a greater risk of entrainment at the project than adult river herring.

As discussed, installing trashracks with 1-inch clear spacing over the intakes for Units 2, 3 and 4 as proposed by Black Bear Hydro and recommended by the resource agencies and DSF would not likely reduce the risk of impingement and entrainment of adult and juvenile alewives and blueback herring because their body widths are all less than 1-inch and the burst speed of juvenile alewives is not sufficient to overcome the calculated intake velocities. However, the modifications to the downstream fish passage facility (as discussed in detail below) would enhance overall safety and efficiency of the downstream fish passage facility and could reduce the risk of impingement and entrainment.

Attraction and Conveyance Flows

Black Bear Hydro proposes to modify the existing downstream fish passage facility by increasing the capacity of the eastern surface weir to 5 percent of station hydraulic capacity, which is equal to approximately 123 cfs. Commerce’s and Interior’s prescriptions, Maine DMR’s section 10(j) recommendation, and DSF’s recommendation also include a conveyance flow of 5 percent of station hydraulic capacity.

The total existing attraction flow for the downstream fish passage facility (56 cfs) is only 2.3 percent of the station hydraulic capacity. As evidenced by the fish kills reported annually from 2014 to 2018, the existing attraction flow does not adequately attract fish to the downstream fish passageway entrances and away from the turbine intakes. Providing a higher attraction flow of 5 percent of station hydraulic capacity, as proposed by Black Bear Hydro and recommended by the resource agencies and DSF, would enhance overall safety and efficiency of the downstream fish passage facility by providing a stronger attraction signal that would better direct alosines to the surface weirs rather than the intakes where they are exposed to the harmful effects of the turbines. A higher attraction flow could also benefit alosines by decreasing the overall passage duration past the Ellsworth Dam.

Black Bear Hydro proposes to release the 123-cfs attraction flow through the eastern surface weir; whereas, the resource agencies and DSF do not specifically state how the attraction flow would be allocated among the three existing surface weirs at Ellsworth Dam. Increasing the attraction flow at the eastern surface weir from 16 cfs to 123 cfs would provide a strong attraction signal for downstream migrants at a single location, and would ensure that the attraction signal is not diffused across multiple surface weirs. In addition, the eastern surface weir is located over 120 feet from the competing hydraulic signal that is associated with the three generation units at the western powerhouse intake structure. Finally, as proposed by Black Bear Hydro, each of the two western surface weirs would provide a 20-cfs attraction flow. Overall, a 123-cfs attraction flow at the eastern surface weir and a 40-cfs attraction flow at the western surface weirs would provide a total attraction flow of 163 cfs at the Ellsworth Dam, which would exceed the recommended 5 percent station hydraulic capacity at the project.

Downstream Fish Passage Facility

Modified Passageway Entrance

The existing eastern surface weir is a 3-foot-wide, sharp-crested weir that provides a means for surface-oriented fish species to pass downstream of the development. As discussed above, Black Bear Hydro currently operates the eastern surface weir by opening the weir by approximately 17 inches to provide an attraction and conveyance flow of 16 cfs. Based on the size of the opening, the water depth in the eastern surface weir cannot be greater than 17 inches. Although a water depth of 17 inches provides a minimum zone of passage for the largest species of alosines found in the project area (adult shad), this water depth is less than the minimum depth recommended by FWS's Design Criteria Manual (2 feet) and could make passage less attractive to juvenile and adult alosines which could create passage delay. Although Black Bear Hydro did not evaluate passage safety or the effectiveness of the existing downstream fish passage facility for alosines, flow through a sharp-crested weir typically creates regions of high flow acceleration that can cause migrating fish to avoid the weir for downstream passage (FWS, 2017). Juvenile fish that exhibit avoidance behavior at the weir could be delayed in passing downstream, or could seek an alternate means of downstream passage that could be less safe, such as turbine passage or spill.

Modifying the surface bypass entrance design to be similar to an Alden weir, as proposed by Black Bear Hydro and required by Commerce's prescription, could reduce potential effects associated with passage delay and result in safer and more efficient downstream passage for alosines. As stated above, the Alden weir is primarily designed with tapered walls to create a uniform rate of flow acceleration that increases by 1 fps or less, per foot of linear distance from the entrance of the weir toward the exit of the weir. The steadily increasing flow velocities through an Alden weir help to reduce negative behavioral reactions to the increasing conveyance flow (*e.g.*, avoidance behavior) and may better attract alosines to the entrance of the flume compared to other surface-oriented means of fish passage, such as flashboard openings or log sluices (Haro *et al*., 1998). The Alden weir also has been shown to reduce avoidance behavior and passage delays for juvenile migratory fish (Johnson *et al*., 1995). The large-sized opening of the Alden weir can attract and pass schools intact, which could reduce the risk of predation at the entrance and exit of the downstream fish passage facility. Reducing passage delay could also lessen the chance of alosines encountering harmful project features, such as turbines and trashracks that would harm or kill alosines if they were delayed in the forebay.

FWS's Design Criteria Manual provides guidance for the geometry of surface bypass weirs. The Design Criteria Manual recommends that the surface bypass be a minimum of 3 feet wide and 2 feet deep. The existing weir is already 3 feet wide, but is typically only operated at a depth of 17 inches. As discussed above, the existing attraction flow of 16 cfs associated with a depth of 17 inches is too weak to attract fish away from the intake units and provide for an efficient means of passage. Modifying the eastern surface weir to increase the depth of flow from 17 inches to 2 feet would increase the conveyance flow and reduce the potential for avoidance behavior associated with shallower flow depths. Modifying the entrance to the fish passage facility to provide a water depth of 3 feet, as proposed by Black Bear Hydro and required by Commerce's prescription, would not be likely to provide any additional benefit to alosines because a water depth of 2 feet would be sufficient to convey alosines safely through the downstream fish passage facility, as discussed above.

Spillway Flume and Downstream Migrant Pipe

Consistent with Commerce's and Interior's fishway prescriptions and Maine DMR's section 10(j) recommendation, Black Bear Hydro proposes to modify the existing downstream migrant pipe by realigning the end of the downstream migrant pipe to reduce the risk of injury to fish that are existing from the downstream migrant pipe to the spillway flume. Consistent with Commerce's and Interior's fishway prescriptions and Maine DMR's section 10(j) recommendation, Black Bear Hydro also proposes to increase the height of the sides of the spillway flume to improve containment of fish passing through the flume and reduce spillage, in consultation with the resource agencies.

The downstream migrant pipe poses a safety risk to outmigrating alosines because it discharges the conveyance flow and out-migrating fish in the opposing direction of the flow that is being released from the eastern surface weir (see Figure 20). The conveyance flow from the downstream migrant pipe also discharges directly into the hard plastic floor of the spillway flume. Depending on the amount of flow from the downstream migrant pipe and the eastern surface weir, fish exiting the downstream migrant pipe could be injured or killed by the shear forces from water flowing in opposing directions or from impacting the plastic floor of the spillway flume. Realigning the end of the downstream migrant pipe so that the discharge from the pipe flows in the same direction as the conveyance flow in the spillway flume would reduce the risk of alosines being injured or killed by shear forces and striking the spillway fume.

The existing spillway flume could be unsafe for downstream fish passage. The flume is 48 inches wide with approximately 18-inch-high steel sidewalls and a heavy plastic bottom that extends the entire length of the spillway. Black Bear Hydro did not provide the design flow capacity for the flume; however, operation of the eastern surface weir and the downstream migrant pipe creates conveyance flows that routinely overtop the sides of the spillway flume, such as when the flow through the downstream migrant pipe exceeds 12 cfs. Leakage outside the spillway flume could reduce the water levels within the flume and create conditions where there is insufficient water to prevent fish from impacting the walls and floor of the spillway flume, which could injure migrants during downstream passage. If the conveyance flow overtops the walls of the spillway flume, alosines could also be swept over the sides of the spillway flume, and could fall down the concrete face of the spillway, where they could be injured or killed (see Figure 21).[157] Eliminating leakage along the walls of the spillway flume by increasing the heights of the sides of the flume to fully contain 135 cfs of water[158] and out-migrating fish within the spillway flume would reduce the risk of fish injury and mortality associated with impacting the walls and floor of the flume and eliminate passage down the concrete face of the spillway.

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[157] The migrating fish captured in this picture appears to be contained within a conveyance flow that at least partially overtops the spillway flume.

[158] A conveyance flow of 135 cfs would be associated with a flow of 123 cfs through the eastern surface weir to provide an attraction flow equal to 5 percent of station hydraulic capacity and a flow of 12 cfs through the downstream migrant pipe, as discussed directly above in the analysis of the attraction and conveyance flows.

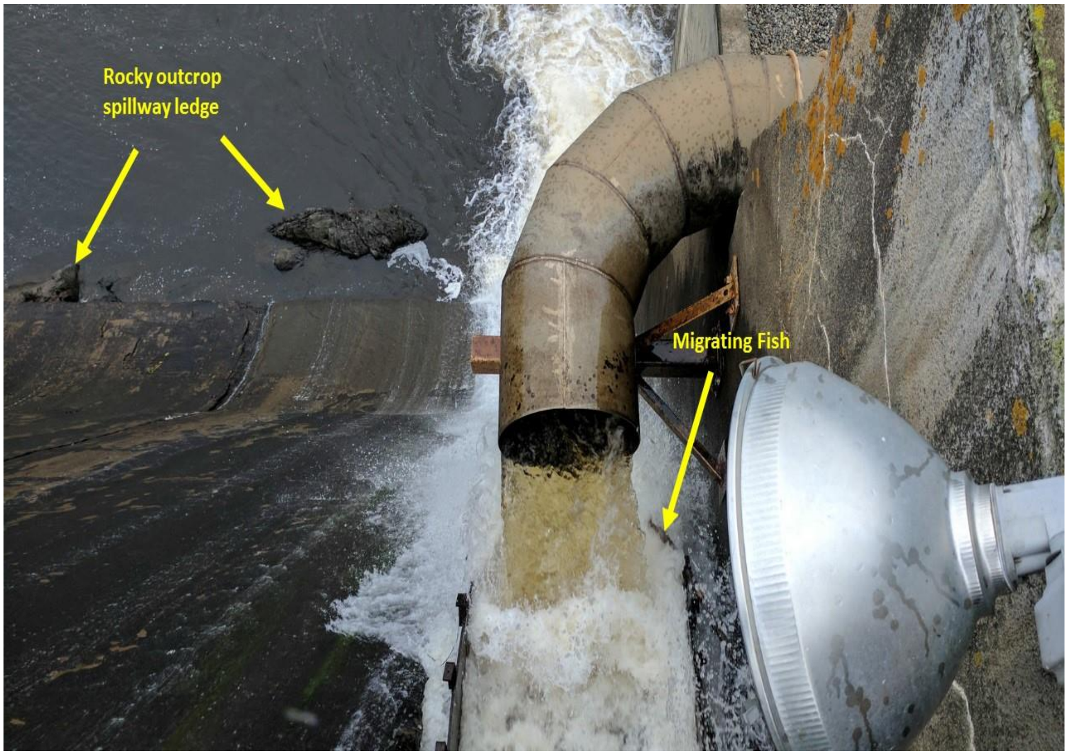

Figure 20. Spillway flume and downstream migrant pipe at Ellsworth Dam. (Source: FERC).

Plunge Pool

Interior's fishway prescription would require Black Bear Hydro to "eliminate discharge to ledges at the toe of the dam." Black Bear Hydro states that there is no exposed ledge at the base of the spillway, even at low tide.[159] In addition, DSF recommends that a spillway plunge pool be operational within 2 years of issuance of any new license. Black Bear Hydro does not propose any modifications to the spillway flume discharge or the existing plunge pool.

Rocky outcrops (*i.e.*, "ledges") located immediately adjacent to the spillway flume could pose a safety risk to alosines. Low tide exposes the rocky outcrops (see Figure 20) and discharge from the spillway flume at low tide could impact the rock ledge and injure or kill migrating alosines. Modifying the spillway flume exit to eliminate the rock ledge would protect alosines from being injured or killed from impacting the rock ledge during passage.

[159] *See* Black Bear Hydro's October 10, 2018 response to additional information.

Although DSF recommends installing a spillway plunge pool downstream of the Ellsworth Dam within 2 years of license issuance, a natural plunge pool already exists at the toe of dam. In its October 10, 2018 response to Commission staff's request for additional information, Black Bear Hydro explains that it does not have drawings of the river bed at the base of the spillway to confirm the depth of the plunge pool, but "the minimum depth of the plunge pool appears to be several feet with a potential depth of approximately 12 feet."

Diversionary Guidance Boom

Consistent with Commerce's fishway prescription and Maine DMR's and DSF's recommendation, Black Bear Hydro proposes to install a fish guidance system consisting of 10- to 15-foot deep rigid panels that are suspended inline from a series of large floats (*i.e.*, "diversionary guidance boom"). Only Maine DMR provides additional details regarding the design and approximate location of the guidance boom, including that the boom should have a maximum depth of 15 feet and that it should "extend from the eastern end of the intake structure to the western shore of the impoundment."

As discussed above, the existing downstream fish passage facilities at the Ellsworth Development do not provide safe, timely, and effective downstream passage. Regularly occurring fish kills involving adult and juvenile herring are evidence that the project is adversely affecting out-migrating fish through turbine entrainment. The existing downstream fish passage facility does not have any means to guide alosines to the downstream fish passage facility entrances and away from the intakes. Alosines migrating downstream have not been able to successfully locate the entrances to the downstream fish passage facility because of weak attraction flows relative to the station hydraulic capacity. Any alosines that do not locate the entrances to the downstream fish passage facility are attracted to the intakes where they have historically been entrained and subsequently injured or killed by turbine passage.

Diversionary guidance booms have been installed at Weston (FERC No. 2325), Hydro-Kennebec (FERC No. 2611), and Lockwood (FERC No. 2574) Projects on the Kennebec River to reduce the entrainment of Atlantic salmon smolts. At the Weston and Hydro-Kennebec Projects, the guidance booms consist of 10-foot-tall metal punch plates with 0.31-inch perforations. The guidance boom at the Lockwood Project consists of a 4-foot-tall, 0.31-inch punch plate and a 6-foot-tall section of 0.31-inch Dyneema® netting[160] (Brookfield, 2013; 2014; 2015; 2016). The licensee of these projects, Brookfield Renewable Energy Group (Brookfield) evaluated the effectiveness of the guidance boom at each project from 2012 to 2015 by releasing radio-tagged smolts upstream of each

[160] Dyneema is an ultra high molecular weight, nontoxic polyethylene fiber.

project.[161] The overall effectiveness of the booms at the three projects ranged from 33.1 to 69.2 percent (see Table 24), with an overall average effectiveness of 57.6 percent. Bypass effectiveness at the Weston Project generally increased as the percentage of flow released through the bypass increased from 2 to 10 percent (Brookfield, 2013; 2014; 2015; 2016).

[161] Brookfield defined "boom effectiveness" as the percent of smolts that arrived at the project and passed downstream via the bypass.

Table 24. Bypass flow, overall bypass effectiveness, and effectiveness range of the diversionary guidance booms for Atlantic salmon smolts migrating downstream at the Weston, Hydro-Kennebec, and Lockwood Projects (projects listed in order from upstream to downstream) on the Kennebec River, Maine. "ND" indicates that no data were collected that year.

Project	Parameter	2012	2013	2014	2015
Weston	Bypass Flow (percent of station capacity)	2, 4, 6	6, 8, 10	10	8
	Overall Boom Effectiveness (percent)	55.2	53.0	65.7	59.2
	Effectiveness Range (percent)	28.6-73.7	40.0-100.0	37.5-100.0	29.4-77.4
Hydro-Kennebec	Bypass Flow (percent of station capacity)	ND	4	4	ND
	Overall Boom Effectiveness (percent)	ND	69.2	33.1	ND
	Effectiveness Range (percent)	ND	43.8-100.0	0.0-66.7	ND
Lockwood	Bypass Flow (percent of station capacity)	6	6	6	6
	Overall Boom Effectiveness (percent)	66.4	67.8	52.6	53.7
	Effectiveness Range (percent)	23.1-91.7	25.0-100.0	0.0-100.0	12.5-70.0

(Source: Brookfield, 2013; 2014; 2015; 2016, as modified by staff).

A diversionary guidance boom could reduce alosine entrainment at the project intakes if the boom curtain is placed at an appropriate location and sufficient depth to divert alosines away from the turbine intakes and guide them to the eastern surface weir. As discussed above, increasing the attraction flow to 5 percent of station capacity at the eastern surface weir would provide a stronger hydraulic signal and increase the safety, timeliness, and effectiveness of passage relative to the existing environment. However, alosines that are migrating downstream on the western side of the Union River would still be susceptible to entrainment due to the strong hydraulic signal associated with Units 2 – 4, which have a total maximum hydraulic capacity of 1,775 cfs. A diversionary guidance boom that extends from the western shore of the impoundment to the eastern end of the Unit 1 intake, as proposed by Maine DMR, could be used to divert out-migrating fish from the generator intakes to the eastern surface weir on the other side of eastern powerhouse intake.

Alosines are pelagic fish and would not likely be found at depths below 10 to 15 feet. A diversionary boom with curtains that extend 10 to 15 feet, as proposed by Black Bear Hydro and recommended by Maine DMR, would likely be effective in diverting alosines away from the intakes. Increasing the attraction flow to the entrance of the eastern surface weir as proposed by Black Bear Hydro and recommended by the resource agencies would enhance the effectiveness of the diversionary boom by creating a stronger attraction signal for fish migrating downstream relative to the existing environment, and potentially by creating sweeping flows along the face of the boom that would help direct alosines to the eastern surface weir.

Black Bear Hydro did not propose a mesh size for the diversionary guidance boom panels; however, if the mesh size of the panels is less than the range of body widths for juvenile alewives (0.12 to 0.18 inch), then the potential for adult and juvenile alosines to be impinged and entrained at the project would be minimized and the alosines should be effectively guided to the downstream fish passage facility. Reducing entrainment and enhancing passage efficiency would directly benefit alosines by enhancing downstream passage safety, timeliness, and efficiency, which could increase the number of adults returning to spawn in following years for the duration of any new license.

Based on the passage effectiveness data above, a diversionary boom may not be completely effective for downstream fish passage and some alosines could potentially escape into the area of the headpond immediately above the generating unit intakes by swimming underneath of the guidance boom curtains. Alosines that escape outside of the boom curtains would essentially be trapped within the downstream side of the boom and would be prevented from utilizing the eastern surface weir for downstream passage. Continuing to operate the Units 2 and 4 bypass weirs, as proposed by Black Bear Hydro, would provide alosines that do escape a means to safely pass downstream of the development.

Black Bear Hydro proposes to operate the downstream fish passage facility from April 1 to December 31. During this period, high flow events can transport debris, which could possibly damage the boom and create gaps that allow fish to escape into the forebay of Units 2 – 4. A diversionary boom with lightweight, yet rigid panels designed to withstand debris loading during high flow events could improve the effectiveness of the boom and reduce the chance of escapement.

Schedule for Completion

As discussed above, modifying the existing downstream fish passage facilities, including the eastern surface weir, spillway flume, and plunge pool, and installing a new diversionary guidance boom at the project would significantly reduce ongoing project effects on downstream migrating fish. Interior's fishway prescription would require the downstream fish passage facility to be operational within 2 years of license issuance, Commerce's fishway prescription would require the modified downstream passage facility to be operational within three fish passage seasons, and Black Bear Hydro proposes and Maine DMR recommends modifying within 3 years license issuance.

The migratory species would benefit from a construction schedule that reduces the ongoing project effects in a timely manner, while also limiting construction activities to periods outside of the downstream migration season. Adjusting the completion timing for the new downstream fish passage facility around migration seasons would minimize the effects of construction on migrating fish.

Schedule for Downstream Fish Passage Operation

Consistent with Commerce's fishway prescription and Maine DMR's section 10(j) recommendation, Black Bear Hydro proposes to operate the modified downstream fish passage facility from April 1 to December 31 annually. Adult river herring migrate downstream shortly after spawning and would be expected to begin arriving at the Ellsworth Dam as early as mid-May of each year. Juvenile alosines begin to migrate downstream from July to as late as December. In addition, the downstream fish passage facilities would be used by Atlantic salmon, which migrate downstream from April 1 to June 15 and October 17 to December 31. Operating the modified downstream passage facility over the entire migration period would provide adult and juvenile alosines and salmon with a dedicated means of safe, effective, and timely downstream passage through the project and reduce passage delay and the risk of injury or death that would be associated with alternative means of passage, including turbine passage or spill.

Turbine Operation Priority and Curtailment

Turbine Operation

Black Bear Hydro proposes to prioritize operation of turbine Units 1 and 4 over Units 2 and 3 during critical downstream passage seasons. Black Bear Hydro also proposes to determine the critical passage seasons in consultation with the resource agencies. Commerce's fishway prescription requires Black Bear Hydro to curtail operation of Unit 1 and prioritize operation of Unit 4 over Units 2 and 3 during the critical downstream fish passage seasons, to be determined in consultation with resource agencies. Maine DMR recommends the same operation schedule required by Commerce. DSF recommends that the Kaplan turbine units (Units 2 and 3) be shut down during downstream migration periods.

Beginning with the 2017 fish passage season, Black Bear Hydro began prioritizing the operation of turbine Units 1 and 4 over Units 2 and 3 at the Ellsworth Development as an interim downstream passage measure to address alosine survival based on the results of the 2016 Downstream Atlantic Salmon Passage Survival Study (Survival Study). Results of the Survival Study showed that test fish utilizing Units 1 and 4 for downstream passage survival had greater survival (81 percent) than test fish utilizing Units 2 and 3 for downstream passage (62.4 percent survival). Black Bear Hydro concluded that because the turbines at Units 2 and 3 rotate at a faster rate, there is a higher likelihood of alosines being injured or killed by turbine blade strike.

Black Bear Hydro's operation prioritization does not appear to effectively reduce adverse effects on out-migrating river herring, as fish kills were reported after implementing this measure in the months of June, August, and October 2017 and July, August, and September 2018. While unit prioritization has the potential to lower the mortality rate of fish that are entrained at the project when flows in the Union River are equal to or less than the combined maximum hydraulic capacity of Units 1 and 4 (1,370 cfs), the evidence of continued fish kills in the 2017 and 2018 passage seasons demonstrates that turbine passage at the project continues to be unsafe under the existing conditions. Therefore, Black Bear Hydro's proposed turbine operation priority (*i.e.*, Units 1 and 4 prioritized over Units 2 and 3) and Commerce's required and Maine DMR's recommended operation priority (*i.e.*, Unit 4 prioritized over Units 2 and 3) would likely not provide much protection from entrainment for alosines without additional protective measures.

DSF's recommendation to cease operation of Units 2 and 3 during the downstream migration period would prevent river herring entrainment into the units with low survival. However, shutting down Units 2 and 3 would reduce the project's maximum hydraulic capacity from 2,460 cfs to 1,370 cfs for the entire downstream migration period (June 1 – November 30). According to the flow duration curves based on project generation, flow exceeds 1,370 cfs approximately 7.4 to 43.9 percent of the time during the downstream migration period. Similarly, flow exceeds the maximum hydraulic capacity of the project (*i.e.*, 2,460 cfs) approximately 1.4 to 5.2 percent of the time. As a result, shutting down Units 2 and 3 would result in the project spilling for approximately 2.2 to 11.6 days in during this period. Because of the rocky outcrops present at the base of Ellsworth Dam (Figure 18), passing via spill may result in river herring mortality. Dead alewives were observed in the Union River on June 2 and 3, 2017,[162] before Black Bear Hydro replaced the flashboard that had been removed for the 2017 smolt study, and dead river herring were no longer observed after Black Bear Hydro replaced the flashboards at the conclusion of the 2017 smolt study.[163] In addition, if the proposed and recommended downstream fishway modifications and protective measures discussed above are implemented during the term of any new license, then ceasing turbine operation might not provide any additional significant reductions to turbine impingement and entrainment.

With regard to curtailing operation of Unit 1 during critical periods of the downstream passage season, Commerce and Maine DMR did not provide a critical time period for downstream alosine passage. Alosines migrate downstream in waves over the course of several months from June to as late as November 30, and there is not a well-defined peak during the migration season when greater numbers of fish would be expected to migrate downstream. However, absent the modifications to the downstream fish passage facility that are analyzed above, operating Unit 1 during the downstream migration season would continue to result in entrainment that would harm or kill alosines. The intake for the Unit 1 turbine is approximately 20 feet from the entrance of the eastern surface weir and operating Unit 1 creates an attraction flow greater than the eastern surface weir entrance flow. As seen by the reported fish kills, alosines are attracted in greater numbers to the project intakes where they are then subject to entrainment, and injury or death from turbine passage. Curtailing operation of the Unit 1 turbine over the entire season would fully protect alosines from entrainment at Unit 1 and would also increase the efficiency of the eastern surface weir, as there would no longer be competing attraction flows in close proximity to the eastern surface weir. As a result, alosines also would be better able to locate the surface bypass weir entrance and find a safe means of passage downstream. In addition, if the proposed and recommended downstream fishway modifications and protective measures discussed above are implemented during the term of any new license, then ceasing turbine operation might not significantly reduce turbine impingement and entrainment.

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[162] *See* Jane Langley's June 20, 2017 letter.

[163] *See* NMFS' July 5, 2017 letter.

Interim Downstream Passage Measures

Black Bear Hydro voluntarily implements several measures to help reduce fish mortality resulting from turbine passage, including: (1) operating Units 4 and 1 before operating Units 2 and 3; (2) inspecting the fishways each day during passage season to ensure that the fishway functions correctly; (3) modified cooling water intakes with smaller spaced screens; and (4) ceasing operation when large numbers of out-migrating river herring are observed at the project or significant mortalities are observed or reported. However, fish kills are still occurring at the project on a regular basis, including three events in 2017 and three more events just recently in 2018. Prioritizing the operation of generation units and modifying the cooling water intakes has not proven to be effective at reducing the frequency of fish kills at the project. While inspecting the fishways each day during the passage season helps to ensure that the fishways remain functional, the fishway design and attraction flows at the Ellsworth Development are not conducive to safe, timely, and effective passage, as discussed above.

Since October 2017, Black Bear Hydro has implemented an operational response procedure for fish mortality events that involves the voluntary shutdown of generation at the Ellsworth Development to encourage fish to pass downstream through spillage at the dam.[164] Black Bear Hydro employs fish passage technicians that monitor the tailrace daily for injured and/or dead fish during the downstream passage season. Black Bear Hydro implements its operational response procedure when the fish passage technicians observe more than an average of 10 fish per minute drifting past a tailrace observation point downstream of Ellsworth Dam, or when it receives a credible report of such fish mortality by the resource agencies or NGOs. Upon reaching the threshold for fish mortality, Black Bear Hydro adjusts the Tainter gates at Graham Lake Dam to target a release of approximately 700 cfs to provide a sufficient amount of flow to Lake Leonard for downstream fish passage over the spillway and for minimum flow compliance at Ellsworth Dam. Once the increased flow from Graham Lake reaches Lake Leonard and begins to spill over the Ellsworth Dam flashboards, Black Bear Hydro ceases generation, normally within 1 to 2 hours following the Graham Lake Dam release. A target flow release from Graham Lake Dam of 700 cfs provides an approximately 8-inch-deep spill flow over the Ellsworth Dam flashboards.

During a shutdown, Black Bear Hydro monitors the tailrace to qualitatively assess the effectiveness of the operating procedures at reducing fish mortalities. After a minimum of 3 hours, and subject to verification from the onsite fish passage technicians that the wave of migrating river herring have cleared the area, Black Bear Hydro brings

[164] *See* Black Bear Hydro's October 23, 2018 letter providing additional information on fish mortality events.

the Ellsworth Development online and resumes turbine unit prioritization and normal operating conditions.

While Black Bear Hydro's operational response procedures help reduce the extent of mortality and injury on downstream migrants once a fish kill has occurred, the benefit of these measures to out-migrating fish heavily depends on timely generator curtailment once a fish kill occurs. The current operational response procedures result in a delayed response because Black Bear Hydro only monitors the tailrace on a daily basis and does not implement generator shut down until up to 2 hours after becoming aware of the fish kill. Consequently, the fish kill could continue until Black Bear Hydro shuts down the generators when the 700 cfs spill arrives at the spillway. In fact, in its October 23, 2018 letter providing additional information on fish mortality events, Black Bear Hydro explained that approximately 1,200 juvenile river herring were killed between September 13 and September 14, 2018 while implementing these operating procedures.

Modifying Black Bear Hydro's operation response procedures to provide for timelier generator curtailment and implementing the modified response procedures would reduce the extent of turbine-induced mortality and injury at the project during the interim between license issuance and operation of the modified downstream fish passage facilities. To increase the effectiveness of the operation response procedures, Black Bear Hydro could: (1) monitor the tailrace for dead and injured fish on an hourly, rather than daily, basis during the alosine downstream fish passage season (June 1 to November 30); and (2) immediately reduce generator output to the minimum hydraulic capacity needed to pass minimum flows at the project, upon observing injured or dead fish in the tailrace. Monitoring the tailrace on an hourly basis for dead and injured fish would increase the likelihood of detecting a fish kill, reduce the amount of time entrainment occurs, and further reduce entrainment mortality compared to the current operation response procedures.

However, taking action to stop effects of project operation on migrating fish after a fish kill has already begun reduces the extent of the ongoing project-related effect but does not protect the first wave of migrating fish from injury and mortality. Ceasing project operation before the wave of migrating fish arrive at Ellsworth Dam would reduce project effects by protecting migrating fish from injury and mortality from turbine passage, provided Black Bear Hydro can take action in a more timely manner.

Alosines emigrate from their natal rivers and ponds in waves of large schools. Factors influencing juvenile alewife seaward migration include heavy rainfall, high water levels, and sharp drops in water temperature (Mullen *et. al.*, 1986). Richkus (1975) offered three observations: (1) waves of downstream migrants lasted two to three days, regardless of the duration of the environmental changes; (2) migrations peaked in late afternoon; and (3) the magnitude of a wave was not related to the magnitude of environmental change. About 70 percent of juvenile alosines complete emigration in only a few days.

From October 2014 to September 2018, there were 9 fish mortality events at the Ellsworth Development lasting 1 to 2 days in duration (see Table 25).[165] The majority of the fish kills (89 percent, n=8) occurred during the period of July to October, which corresponds to the outmigration period for juvenile alosines. There was only one fish kill reported during the month of June. The June fish kill mostly consisted of outmigrating adults, as Black Bear Hydro would have recently stopped stocking adults upstream in mid-June, and the adults would outmigrate shortly after spawning.

To better understand the factors that trigger out-migration, Commission staff used historical weather data from the closest weather station upstream of the Ellsworth Development in Bangor, Maine[166] to determine whether precipitation events regularly occur in the days leading up to fish kills at the Ellsworth Development. Commission staff found that significant rain events appear to trigger outmigration at the Ellsworth Development, as there was a storm event prior to each reported fish kill between October 2014 and September 2018. For all storm events associated with fish kills, the total storm event rainfall ranged from 0.51 to 5.27 inches, with an observed mode of 0.7 inch (see Table 25).

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[165] One fish mortality event (June 3, 2017) was excluded from further analysis as it was attributed to an insufficient experimental spill through the flashboards during the Atlantic Salmon Smolt Downstream Passage Study.

[166] *See* https://www.wunderground.com/history/daily/us/me/bangor.

Table 25. Summary of Ellsworth Fish Kills and Storm Event Precipitation by Month.

Fish Kill Date(s)	Storm Event Date(s)	Storm Event Total (inches)	Average Monthly Rainfall (inches)	Percentage of Monthly Rainfall	Elapsed Time From Storm Event to Fish Kill
10/24/14	10/21/14 10/22/14 10/23/14	0.25 0.45 1.94 *Total = 2.64 inches*	4.21	83%	1-3 days
10/04/15	9/30/15	5.27	4.21	125%	4 days
10/12/16	10/9/16 10/10/16	0.6 0.1 *Total = 0.7*	4.21	17%	3 days
6/21/17	6/17/17 6/20/17	1.5 0.7 *Total = 2.2*	3.66	61%	4 days
8/9 - 8/10/17	8/8/17 8/9/17	0.2 0.6 *Total = 0.8*	2.95	23%	<1 day
10/13/17	10/8/17 10/9/17	0.27 0.66 *Total = 0.93*	4.21	22%	4 days
7/27/18	7/26/18	0.70	3.46	20%	1 day
8/27/18	8/22/18	0.51	2.95	18%	5 days
9/13 – 9/14/18	9/11/18	0.86	4.06	21%	2-3 days

(Source: Official Filings for FERC Docket P-2727)

Commission staff evaluated how storm intensity could affect outmigration by comparing the total storm event rainfall to the total average monthly precipitation. Storm events that trigger an outmigration have significant rainfall. For each storm event, the total storm event rainfall was a minimum of 17 percent of the total monthly average rainfall for a given month. Six of the nine fish kills shown in Table 25 occurred after a rainfall of 17 to 23 percent of the monthly rainfall. Storm intensity can therefore be a useful predictor for outmigration, as any storm event that occurs during alosine migration season with total rainfall that is 17 percent or more of the total average monthly rainfall could trigger an outmigration.

For all mortality events, alosines arrived at the Ellsworth Development between 1 and 5 days after a storm event, with the majority of the fish kills occurring 3 to 4 days after a storm (67 percent, n=6). There was only one fish kill that occurred 5 days after a rain event and there were two fish kills that occurred 1 day or less after a rain event. The two fish kills that happened one day or less after a storm event occurred in July and August during what is normally a dry period. It is possible that alosines are more sensitive to environmental cues such as rainfall during dry periods than they are during other hydrologic periods.

Optimizing Black Bear's operational response procedures for station shut down based on heavy rainfall during the interim period between issuance of any new license and implementation of the staff-recommended modifications to the downstream fish passage facilities could provide a protection measure that precedes the arrival of a wave of out-migrating alosines and decreases injury and mortality associated with turbine passage. Because alosines are surface-oriented, pelagic fish, schools of out-migrating fish should be visible in the forebay of Graham Lake Dam. Monitoring the forebay of Graham Lake Dam for schools of fish on an hourly basis during the day for 3 to 4 days after a storm event that exceeds 17 percent of the total average monthly rainfall during the alosine downstream migration period (*i.e.*, June 1 through November 30), and ceasing generation operation upon observing schools[167] of migrating fish in the forebay of Graham Lake Dam, would reduce the risk of river herring being injured or killed by turbine passage at the Ellsworth Development. As discussed above for the existing operation response procedures, Black Bear Hydro could immediately reduce generator output to the minimum hydraulic capacity needed to pass minimum flows at the project, upon observing a wave of out-migrating fish at Graham Lake. At the same time, Black Bear Hydro could release approximately 700 cfs from Graham Lake Dam to provide a sufficient amount of flow to Lake Leonard for downstream fish passage over the spillway and for minimum flow compliance at Ellsworth Dam. Once the increased flow from Graham Lake reaches Lake Leonard and begins to spill over the Ellsworth Dam flashboards, then Black Bear Hydro could cease generation.

To provide sufficient time for a school of out-migrating fish to pass from Graham Lake to the Union River downstream of Lake Leonard, Black Bear Hydro could cease generation for a 4-hour period following the observation of out-migrating fish, unless additional waves of out-migrating fish are observed in the forebay of Graham Lake during the 4-hour generator shutdown. If additional waves of out-migrating fish are observed in the forebay, then another 4-hour shutdown could be implemented to accommodate fish passage. We suggest a 4-hour duration for the shutdown because it is approximately the time it would take a school of juvenile alosines to travel the 4.1-mile

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[167] Because it is impractical to cease generation for any and all schools, and because accurately estimating school size would require the expense of hydroacoustics, we suggest qualitatively assessing school size by observing fish passing through the Alden weir. This is one suggested method for assessing school size, but we recommend that Black Bear Hydro consult with the agencies to determine the method and school size criteria that would trigger a generation shutdown.

section between Graham Lake and Ellsworth dams, based on an average juvenile alosine migration rate of 1.25 miles per hour (Normandeau Associates, 2017). By observing out-migrating fish before they reach the Ellsworth Development, this modified operational response procedure would allow Black Bear Hydro to proactively initiate protective measures to reduce injury and mortality associated with passage through the turbines.

Fish Passage Design, Operation, and Maintenance

Consistent with the Comprehensive Fishery Management Plan for the Union River Drainage, Black Bear Hydro developed a site specific operation and maintenance plan for its existing upstream and downstream fish passage facilities in 2015. Black Bear Hydro submitted a proposed fish passage operation and maintenance plan with its September 28, 2018 draft biological assessment for Atlantic salmon, Atlantic sturgeon, and shortnose sturgeon. The proposed plan describes how Black Bear Hydro would operation and maintain the existing fish passage facilities, including: the period in which the facilities are to be operated, guidance on the annual start-up and shut-down procedures, routine operating guidelines, debris management, and safety rules and procedures. The plan also includes a daily inspection form and a list of on-site spare parts for the fish passage facilities. Black Bear Hydro also hired staff to operate and oversee the project's fish passage facilities, tend the fish trap, and transport alosines upriver. These staff complete daily checklists and prepare weekly reports on fishway operation, which are provided to the fisheries management agencies throughout the fishway operation season.

Commerce's fishway prescription would require Black Bear Hydro to submit to the resource agencies for review and approval conceptual design plans for: (1) the prescribed new upstream fish passage facilities and modified downstream fish passage facilities not later than 2 years before the anticipated operational date of the facilities; and (2) the prescribed 1-inch full-depth trashrack overlays at least six months prior to the first downstream passage season following issuance of any new license. The prescription would also require Black Bear Hydro to submit the 30, 60, and 90 percent design-stage drawings to the resource agencies for consultation and review. Following resource agency approval, the prescription requires Black Bear Hydro to submit the final design plan to the Commission for approval prior to the commencement of fishway construction activities and to file final as-built drawings with Commerce and FWS following completion of construction. Commerce's prescription also states that the Licensee must meet with the resource agencies annually to discuss fishway operation, study results, and the siting, design, and construction of the new fishways for upstream salmon passage.

Commerce's fishway prescription includes specific provisions for maintaining the upstream and downstream fishways, including: (1) the licensee must keep the downstream passage facilities in proper order and clear of trash, logs, and material that would hinder fish passage; and (2) anticipated maintenance must be performed in sufficient time before a migratory period such that fishways can be tested, inspected, and operational prior to the migratory periods.

Interior's fishway prescription would require Black Bear Hydro to submit 30, 60, and 90 percent drawings for the downstream fish passage facility at the Graham Lake Development to FWS for review and approval prior to construction. Interior's prescription would also require Black Bear Hydro to develop a fishway operation and maintenance plan within 12 months of license issuance that includes measures for operating and maintaining upstream and downstream fish passage facilities. According to the prescription, Black Bear Hydro must submit the fishway operation and maintenance plan to the FWS for review and, and must update the plan annually to reflect any changes in fishway operation and maintenance planned for the year. Black Bear Hydro must amend the plan within 30 days if requested by FWS, and must receive the approval of FWS prior to implementing any other modifications to the plan. Black Bear Hydro would also be required to provide FWS with information on fish passage operation and any project operating conditions that may affect fish passage within 10 days of any such request from FWS.

Maine DMR recommends under section 10(j) of the FPA that Black Bear Hydro design all modifications to the upstream and downstream fish passage facilities at Ellsworth and Graham Lake dams in consultation with the resource agencies, and that the resource agencies review the 30, 60, and 90 percent design drawings of the fishway facilities. Maine DMR also recommends that Black Bear Hydro develop a fishway operation and maintenance plan that includes provisions for operating and maintaining the upstream and downstream fish passage facilities for the project. In addition, Maine DMR recommends that Black Bear Hydro keep the fishways in proper working order and clear of trash, logs, and material that would hinder passage. Maine DMR recommends that Black Bear Hydro perform routine maintenance sufficiently before a migratory period so that fishways can be tested, inspected, and operational during the migratory periods.

Our Analysis

Fish Passage Facility Design

Black Bear Hydro proposes to consult with resource agencies on the need for and design of upstream and downstream fish passage measures for anadromous fish, and to develop plans for upstream eel passage at Ellsworth and Graham Lake dams. However, the license application does not include design specifications for future fishways or specify any proposed improvements to the existing downstream fish passage facilities.

Submitting the conceptual, 30, 60, and 90 percent design drawings to Commerce, Interior, and Maine DMR would provide the resource agencies with a way to review and comment on design issues and provide Black Bear Hydro with an opportunity to adjust the design of any fish passage facility based on comments from the resource agencies to ensure that fishways are constructed to operate efficiently. Submitting the design drawings in this manner would also ensure that fish passage facilities are constructed in a timely manner. However, because it is the responsibility of the Commission to approve and ensure the proper design of fishways, there would be no benefit to providing certified as-built drawings to the resource agencies. As-built drawings could be accessed by the agencies, through the Commission.

Fishway Operation and Maintenance Plan

To maintain the effectiveness downstream fish passage facilities, fishways need to be properly operated and maintained. Most fishways require routine maintenance to ensure the fishways operate effectively. Black Bear Hydro's proposed plan includes procedures for conducting fishway operation and maintenance that would help ensure that routine cleaning and maintenance, including debris removal, are performed so that the fishways operate as intended. After completing modifications to the Graham Lake and Ellsworth development's fish passage facilities, there would likely be new operation and maintenance procedures necessary to ensure that the modified fishways operate as designed. A fishway operation and maintenance plan that includes Maine DMR's recommendations and Interior's and Commerce's requirements for operating and maintaining the fish passage facilities would provide Black Bear Hydro with procedures necessary to ensure that the project fishways are maintained in proper working order before and during the migratory fish season. A fishway operation and maintenance plan would also provide resource agencies a way to review the maintenance and operation history for all fishways at the project and adjust procedures as appropriate.

Shakedown Period

Black Bear Hydro proposes and Interior, Commerce, and Maine DMR recommend modifications to the existing fishways and installation of new fishways at the project. To help ensure that any modifications to the fishways and new fishways are generally operating as designed, Black Bear Hydro could operate each facility for a one-season "shakedown" period and make adjustments to the facilities if they are not operating as designed. Operating the new and modified facilities for a one-season shakedown period, and making adjustments to the facilities that are not operating properly, would ensure that new and modified facilities are operating as designed during the term of any new license and would increase the likelihood of safe, timely, and effective fish passage. To prevent interference with operation of the fish passage facilities during the migration season, any necessary adjustments could be timed so that they are completed prior to the relevant fish passage season.

Fishway Effectiveness Testing

Black Bear Hydro proposes to conduct effectiveness testing for Atlantic salmon at the existing trap and truck facility, the proposed downstream passage facilities at Ellsworth and Graham Lake dams, and the proposed new upstream fish passage facilities at Ellsworth and Graham Lake dams. Specifically, Black Bear Hydro proposes to test the effectiveness of: (1) the proposed modifications to the existing downstream passage weir for Atlantic salmon smolt passage at Graham Lake Dam; (2) the proposed downstream fish passage measures for Atlantic salmon smolt passage at Ellsworth Dam; (3) any adaptive management measures that are implemented for Atlantic salmon smolt passage at Ellsworth and Graham Lake dams; and (4) the new upstream Atlantic salmon passage measures at Ellsworth Dam and Graham Lake Dam. These effectiveness studies would occur for a 1- to 3-year period following implementation of the measures, using a performance standard of 90 percent effectiveness for downstream passage. Black Bear Hydro also proposes to test the effectiveness of the existing fishway trap and truck facility at Ellsworth Dam for passing Atlantic salmon for a 1- to 3-year period using a performance standard of 90 percent effectiveness for upstream passage, to be conducted after downstream passage improvements have been implemented and smolts stocked upstream of Ellsworth Dam have had a chance to return as upstream migrating adults.

Interior's fishway prescription would require Black Bear Hydro to develop fishway effectiveness monitoring plans in consultation with the FWS to test the effectiveness of Interior's recommended new upstream eel passage facilities and modified downstream eel passage facilities. The prescription would require Black Bear Hydro to file the monitoring plans within six months of license issuance.

Interior's fishway prescription specifically requires Black Bear Hydro to test the effectiveness of the new upstream eel fishway using evaluation methods developed by the FWS and Maine DMR for eel ramps at Maine hydroelectric projects on the Kennebec and Presumpscot Rivers, including FERC Project Nos. 2555, 2556, 2364, 2365, 2611, 2574, 2322, 2325, 5073, 2942, 2984, 2931, 2941, and 2932. The prescription would require the upstream fishway effectiveness monitoring plan to consist of two study components: (1) evaluating attraction efficiency to the facility; and (2) evaluating the effectiveness of the facility at passing eels that have entered the structure. Attraction efficiency would be assessed with nighttime observations of migrating eels at the project. The prescription states that a minimum of 100 eels must be used during the upstream effectiveness testing study and 90 percent of those eels must pass the fishway within 24 hours.

For downstream eel passage, Interior's fishway prescription would require Black Bear Hydro to develop a downstream passage effectiveness monitoring plan to demonstrate that downstream passage for adult eels is safe, timely, and effective. The prescription does not define a specific standard for assessing safe, timely, and effective passage for downstream migrating eels, but would require Black Bear Hydro to monitor the effectiveness of silver eel passage at the two project dams using radio telemetry methods in order to determine migratory delay, route of downstream passage, and immediate and latent survival. According to the prescription, if downstream passage is not safe, timely, and effective, then FWS will assess passage enhancements, including but not limited to an extended passage season, time of day restrictions, 0.75-inch trashrack spacing, a deep bypass gate, and/or new downstream eel passage facilities that use angled trash racks. Black Bear Hydro would be required to implement the solution selected by FWS.

Maine DMR recommends the same upstream eel passage effectiveness testing methods and performance standard that are included in Interior's fishway prescription, with additional provisions for consulting with Maine DMR. For downstream eel passage, Maine DMR's recommendation is also the same as Interior's in that it specifies the same methods to be used and does not include a performance standard for defining what would constitute safe, timely, and effective passage.

Commerce's fishway prescription would require Black Bear Hydro to monitor upstream and downstream fishways at both project dams for alosine species and Atlantic salmon, to ensure they are functioning as intended for the safe, timely, and effective passage of migratory fish. The monitoring would begin at the start of the first migration season after each fishway facility is operational and would continue for up to three years, "or as otherwise required through further consultation."[168] Commerce does not provide specific fishway performance standards, but indicates that it is developing standards that will likely require a "total project survival of approximately 90 [percent]." The prescription states that the licensee must develop study design plans for monitoring the effectiveness of fishways for juvenile and adult life stages of alosines and Atlantic salmon in consultation with NMFS and state and federal resource agencies.

Maine DMR recommends that Black Bear Hydro develop a study plan to test the effectiveness of the structural and operational changes to the Ellsworth and Graham Lake downstream passage facilities for Atlantic salmon. Maine DMR recommends that the modified facilities meet the performance standards developed through ESA consultation for Atlantic salmon and that, if those standards are not met, then Black Bear Hydro would implement additional measures to reduce injury or mortality.

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[168] Since the prescription states that the licensee must begin monitoring at the start of the first fish migratory season after each fishway facility is operational, and Commerce's prescription does not require any changes to the existing fish trap and truck facility, Commission staff interprets the prescription to not require monitoring at the existing upstream fishway at the Ellsworth Dam.

Our Analysis

As discussed above, modifying the existing downstream fish passage facilities for Atlantic salmon, alosines, and eels, and constructing new upstream passage facilities for eels would reduce adverse projects effects, such as turbine mortality and passage delay during migration. Commerce's prescription and Maine DMR's section 10(j) recommendation include design specifications for upstream and downstream fish passage facilities. Interior's prescription and Maine DMR's section 10(j) recommendation state that the upstream and downstream eel passage facilities should be constructed in a manner that is consistent with FWS's Design Criteria Manual. Therefore, the passage facilities would be designed, operated, and maintained in accordance with proven fish passage standards and operating procedures.

Maine DMR states that testing the efficiency of the fish passage facilities is critical to evaluating the success of the passage structures and operations, diagnosing problems, and determining when fish passage modifications are needed and what modifications are likely to be effective.

Fishway efficiency evaluations can take many forms, including video observation, sample collection, hydro-acoustics, telemetry, or passive integrated transponder studies. A passage effectiveness study typically evaluates factors such as attraction flows, attraction efficiency, passage efficiency, passage delay, and survival rates. As stated in the FWS Design Criteria Manual, efficiency testing is typically evaluated quantitatively through a site-specific framework and performance standards are generally informed by state and federal agencies with expertise in the life history requirements of the region's fish populations. Factors to consider include the impact of all barriers within the watershed and the minimum number of fish required to sustain a population's long-term health and achieve identified management plan objectives and goals.

Although effectiveness testing can be used to ensure that fish passage facilities are operating as expected, Commerce and Maine DMR did not include any specific methodology or performance standards for testing the effectiveness of the fish passage facilities for Atlantic salmon and alosines. Instead, they would require the development of study plans and performance standards post-licensing, in consultation with resource agencies. Although Commerce suggests that the standard(s) may include a total project survival of approximately 90 percent, Commerce states that it is still developing specific performance standards for Atlantic salmon and alosines. Similarly, Interior's prescription and Maine DMR's recommendation do not include performance standards for assessing the effectiveness of downstream eel passage. Without specific performance standards from the resource agencies that are responsible for establishing management goals and objectives for fisheries resources, there is no basis for assessing the benefits of effectiveness testing for fish passage and determining whether effectiveness testing would or would not provide benefits to Atlantic salmon, alosines, and eels. In the event the resource agencies develop performance standards prior to the issuance of a final environmental assessment for the project, then Commission staff could assess the potential benefits of effectiveness monitoring for the fishways for alosines, Atlantic salmon, and downstream American eel passage. As discussed above, however, operating each new or modified fishway for a one-season "shakedown" period to ensure that the fishways are generally operating as designed, and if not, making adjustments would increase the likelihood of safe, timely, and effective passage.

However, in its September 28, 2018 Atlantic salmon draft biological assessment and Species Protection Plan, Black Bear Hydro proposes effectiveness studies that have performance standards and detailed methodologies that are sufficient for our analysis of potential effects. Specifically, Black Bear Hydro proposes, in the following order, to study: (1) the effectiveness of the downstream passage enhancements using stocked and marked Atlantic salmon smolts at both project dams; (2) the effectiveness of the existing fishway and trap for adult Atlantic salmon that return as a result of the stocked and marked smolts; and (3) if necessary, the effectiveness of new upstream swim-through fishways at both project dams. Black Bear Hydro indicates that the performance measures and methodologies in its proposed Species Protection Plan, including the fishway effectiveness studies, were developed in consultation with fisheries agencies, including the National Marine Fisheries Service and FWS.

The first stage of Black Bear Hydro's proposed fishway effectiveness testing for Atlantic salmon smolt downstream passage would begin in the first year after the downstream passage modifications at both project dams become operational, and would last from 1 to 3 years. Smolts would be marked (presumably with Passive Integrated Transponder (PIT) tags,[169] although this is not specified) and stocked upstream of Graham Lake Dam to ensure that they are imprinted to habitat upstream of the project dams. The number of smolts stocked would be based on estimates of ocean survival and a targeted number or 40 returning adult salmon. The proposed effectiveness performance standard for the proposed downstream passage measures is 90 percent. The 90 percent downstream passage standard is for whole project effectiveness, meaning that it includes the total passage effectiveness across the Graham Lake and Ellsworth development downstream passage facilities. The performance standard would need to be demonstrated for two of the test years following implementation of a given measure.

After the results of the downstream fish passage effectiveness testing are evaluated, then there may be problems identified with the Graham Lake and/or Ellsworth downstream passage measures, which could then be addressed in an adaptive management approach. For example, if the Alden weir at Graham Lake needed to be further modified to improve attraction or guidance efficiency, then those changes could

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[169] Typically, PIT tags are rice-sized tags injected into the pelvic fin area of the body cavity of the fish, effectively providing each individual study fish with its own barcode that can be detected without handling the fish after initial implantation.

be made prior to a second year of marked smolt stocking. Then, in the second year, additional effectiveness evaluations would be conducted to determine if the modified facility meets or exceeds the 90-percent performance standard. On the other hand, if the downstream passage measures meet the performance standard in the first year of effectiveness testing, then there would be reasonable assurance that the downstream passage enhancements were performing as intended to provide safe, effective, and timely downstream passage for Atlantic salmon smolts.

If the marked and stocked salmon smolts survive to return to the Union River, they would be expected to return from 1 to 3 years after they are stocked. As described in section 3.3.4 (*Threatened and Endangered Species*), 80 percent of returning salmon have spent 2 years in the ocean reaching maturity before returning to spawn. At this point, stage 2 of Black Bear Hydro's proposed effectiveness testing could be performed at the existing Ellsworth fishway and trap. Because the returning adults would be marked, they could be differentiated from any aquacultured fish or strays from other rivers. Using PIT tag readers, perhaps in combination with underwater video, it would be possible to identify when fish entered the fishway, or whether they exhibited any milling behavior in the vicinity of the fishway entrance. Any salmon that enters the fishway could be tracked during their progress through the fishway to the hopper and trap. We assume that the 90-percent performance standard for the existing upstream fishway facility applies to successful upstream passage of 90 percent or more of the marked adult salmon that return to the Ellsworth fishway, although this is not specified in Black Bear Hydro's Species Protection Plan. In this way, any specific locations of inefficiency could be identified and consultation with the fisheries agencies could proceed regarding how to correct any identified problems related to attraction or passage efficiency. As with downstream passage effectiveness testing, the initial stage 2 results would provide the basis for an adaptive management approach to modifying the design or operation of the existing fishway. Some modifications that may be appropriate could include, but are not limited to, relocating the entrance of the fishway, modifying the fishway entrance or riverbed in the vicinity of the entrance to improve near-field hydraulics, modifying internal fishway structures, or modifying the flow through the fishway. If, on the other hand, no adult salmon return as a result of the marked smolt stocking, then there would be no way to evaluate the effectiveness of the existing fishway, inform decisions about what, if any, modifications to make to the existing fishway, or determine whether new swim-through fishways are needed or warranted. In that case, historical information from years in which adult salmon did return to the existing fishway and trap would be the only thing in the record on which to base management decisions regarding upstream Atlantic salmon passage at the project.

Finally, if the effectiveness testing provides evidence that the existing fishway and trap cannot be modified to provide safe, timely, and effective upstream passage, then stage 3 of the effectiveness testing could be conducted after construction of the proposed new swim-through fishways. The effectiveness testing of any new swim-through fishways would follow the same timeline and performance standards described in stage 2 above.

Interior's fishway prescription and Maine DMR's section 10(j) recommendation to assess the effectiveness of the upstream eel passage facilities include a specific study design and performance standard that would assess whether 90 percent of eels released at the fishway entrance are able to pass the fishway in 24 hours. The agencies would also require the eel ramps to be designed in accordance with proven design criteria from the FWS's Design Criteria Manual, and to be operated and maintained in accordance with a fish passage operation and maintenance plan that is developed in consultation with the resource agencies and approved by the Commission.

Although the upstream eel passage facilities would already be designed, operated, and maintained in accordance with proven fish passage standards and operating procedures, a performance standard of 90 percent passage within 24 hours could be used to assess whether there are potential site-specific factors that could result in the facilities not operating as well as anticipated. For example, if the base of the ramp, where it is anchored to the substrate, inadvertently creates an eddy or other hydraulic feature that decreases the attraction efficiency of juvenile eels onto the ramp, then this could only be identified through assessment of the 90 percent performance standard during the upstream passage season. Observing the effectiveness of the installed eel ramps would allow verification that no such site-specific anomalies exist and, as necessary, would help identify any modifications that are needed to ensure that the eel ramps operated as intended.

Although the effectiveness study would help identify whether modifications to the upstream eel passage facility are needed, it is not clear what measures would be implemented if one or more eel ramps fail to meet the 90-percent performance standard, despite being designed and operated according to the best available information. Interior recommends that, if the 90 percent criterion is not met, then Black Bear Hydro would need to consult with FWS and modify the fishway by changing the substrate, reducing the slope, increasing the attraction water, or modifying the transport flow. The exact measure that would be implemented in the event of low performance would depend on the observations that are made and the performance issues that are identified during the effectiveness testing. For this reason, staff cannot evaluate at this time whether any subsequent modifications to the fish passage facilities would significantly improve upstream eel passage, especially since the facilities would already be constructed according to design specifications in the FWS Design Criteria Manual. Presumably, whatever level of performance is achieved by the recommended and prescribed eel ramps, even if not in compliance with the standard, would nevertheless represent a substantial improvement to fish passage efficiency compared to existing conditions.

Cumulative Effects

Based our review of the PAD, license application, and Species Protection Plan for the Ellsworth Project, we have identified migratory fish (*i.e.*, alewife, American eel, American shad, Atlantic salmon, Atlantic sturgeon, blueback herring, sea lamprey, shortnose sturgeon, and striped bass), aquatic habitat, and water quality as aquatic resources that could be cumulatively affected by activities in the Union River basin. These include the operation and maintenance of the Ellsworth Project, the harvest of river herring by the City of Ellsworth, and the historic introduction of non-native fish species.

<u>Migratory Fish</u>

The construction of dams in late 18^{th} and 19^{th} Centuries contributed to the disappearance of runs of migratory fish species in the Union River (URSG, 2000). State fisheries agencies began restoring migratory fish runs in the Union River by stocking Atlantic salmon and river herring upstream of the project in 1971 and 1972 (URSG, 2000). Atlantic salmon smolt stocking was successful enough that salmon returning to the Union River provided a source of eggs that were used for salmon restoration in the Penobscot River and other rivers (Baum, 1982). However, the number of adult salmon returning to the Union River has declined greatly since smolt stocking was discontinued in 1991. In contrast, the river herring restoration succeeded in producing a stable, naturally reproducing population with hundreds of thousands of adult river herring returning to the Union River for upstream passage each year.

Fish passage and the presence of non-native fish species in the Union River continue to affect salmon and river herring, the effects of which are discussed below. The City of Ellsworth continues to harvest river herring, and the effects of the harvest are also discussed below. American eel and American shad also historically migrated upstream of Ellsworth and are affected by project operation and other activities within the Union River as discussed below.

The upstream extent of the historical range of Atlantic sturgeon, shortnose sturgeon, and striped bass is believed to have been Ellsworth Falls, which was located in the vicinity of the present-day Ellsworth Dam. The historical and current range of sea lamprey in the Union River is unknown. As described in section 3.3.4.2, *Atlantic and Shortnose Sturgeon*, there are no proposed changes to project facilities or operation that would adversely affect either species of sturgeon, and Black Bear Hydro's proposed sturgeon handling plan would reduce the likelihood of stress or injury to individuals of either species that enter the fish trap or are encountered during maintenance activities.

Our Analysis

Fish Passage

Upstream Passage

The Ellsworth Project is the first hydroelectric project on the Union River and one of two FERC projects in the basin, and as such, represents the primary source of passage-related adverse effects in the basin.[170] Black Bear Hydro currently uses a trap and truck facility to provide upstream passage for adult salmon and river herring, which does not provide volitional passage and causes at least some delay in passage. Furthermore, upstream passage may be delayed for salmon when water temperature exceeds 73.4 °F. In addition, Black Bear Hydro transports salmon to the West Branch of the Union River, which reduces the likelihood that salmon will spawn in other locations with suitable habitat.

Atlantic Salmon

Consistent with Commerce's fishway prescription, Black Bear Hydro proposes to modify the existing trap and truck facility to meet a performance standard of 90 percent for salmon and construct new, volitional upstream passage facilities if that performance standard cannot be met by the existing trap and truck facility or by modifying the facility. Evaluating the effectiveness of the trap and truck facility would allow for the identification of any ongoing adverse effects of the facility on the upstream passage of migratory species and for the modification of the facility or construction of new facilities as needed to ensure the safety, timeliness, and effectiveness of upstream passage. To the extent that a trap and truck facility continues to be used for upstream passage during the term of any new license issued for the project, upstream salmon and river herring passage would continue to be delayed when water temperatures are greater than 73.4 °F. However, based on the staff-recommended effectiveness testing for the upstream trap and truck facility and the potential modifications to the facility that would be made if any adverse effects are identified during the effectiveness testing, staff concludes the project would not add to the cumulative effects on the upstream migration of Atlantic salmon that have occurred or could occur in the future by any new activities in the basin.

River Herring

The target run size of upstream migrating river herring is below the restoration target of 2.3 million fish established by the Union River Coordinating Committee

[170] The Green Lake Project (FERC No. 7189) is located on Reed Brook, a tributary of Graham Lake, and does not currently have upstream fish passage facilities.

(URFCC, 2010), and the size of the river herring run has not increased significantly despite increases in the number of fish collected at the Ellsworth trap and truck facility and stocked in Graham Lake and Lake Leonard. We discuss potential contributing factors below in our analysis of downstream fish passage and river herring harvests. However, the Atlantic States Marine Fisheries Commission (ASMFC) recently assessed the status of river herring populations throughout the Atlantic Coast (ASMFC, 2017) and concluded that the Union River river herring population increased between 1975 to the early 2000s and has exhibited a stable population from 2006 to 2015. While the river herring population in the Union River is below the URFCC's restoration goal of 2.3 million fish, the information presented by ASMFC suggests that the Union River river herring population is stable and not in a depleted condition.

Although upstream passage at the project has been successfully implemented at the project for decades, passage is still lacking at several other lakes, ponds, and impoundments that contain potentially suitable habitat for alewives. The 2015-2017 Union River CFMP identified Lower Webb Pond, Webb Pond, Abrams Pond, Scammon Pond, and Georges Pond as priority alewife restoration ponds (URFCC, 2015). Alewife access to these ponds may be restricted due to beaver dams and constructed dams. Despite being identified as management priorities, these ponds have not been stocked with alewives (URFCC, 2016; 2017; 2018). Doug Watts and DSF state that Maine DIFW stocks trout and landlocked salmon via truck and suggests that access is sufficient at these ponds to allow the stocking of alewives.[171] Access to these ponds is ultimately limited by resource agency management goals, and effects associated with the Ellsworth Project do not appear to be limiting the restoration of river herring within the project boundary or in other locations within Union River Basin. Continuing to operate the existing fishway trap and truck facility would minimize adverse effects of the project on the upstream migration of river herring, and there is no indication that the proposed project would add to the cumulative effects on upstream river herring migration that have occurred in the past or that may occur in the future through any new activities in the basin.

American Shad

As described in section 3.3.2.1, *Aquatic Resources, Affected Environment, Anadromous Fish*, American shad have been observed in the commercial river herring harvest and by anglers in the Union River. The presence of American shad in the commercial river herring harvest (URFCC, 2015) suggests that the harvest is an unquantified source of mortality for what remains of the Union River shad population. The commercial river herring harvest will continue to be source of mortality for shad

[171] *See* letters filed by Doug Watts on March 12, 2018 and additional letters filed by DSF on April 9, 2018 and April 24, 2018.

depending on the degree to which the commercial harvest season overlaps with the shad upstream migration period.

The presence of shad in the river herring harvest suggests that an unknown, but likely small number of shad may be transported to Graham Lake and Lake Leonard, which may support a low level of shad reproduction in the Union River, its tributaries, and the tributaries of the project impoundments. Providing upstream fish passage for alosines from May 1 to July 31 (compared to the existing operation of early May to mid-June), as described in section 3.3.2.2, *Aquatic Resources, Environmental Effects, Upstream Fish Passage*, would provide timely passage for shad, which migrate upstream from June through July in Maine. Continuing to operate the existing fishway trap and truck facility would minimize adverse effects of the project on the upstream migration of shad that migrate upstream in the Union river, and there is no indication that the proposed project would add to the cumulative effects on upstream shad migration that have occurred in the past or that may occur in the future through any new activities in the basin.

American Eel

There are no existing upstream fishways for juvenile eels at the Ellsworth Project. American eels appear to be able to ascend both Ellsworth Dam and Graham Lake Dam under current conditions, but the height of the dams could delay and potentially block juvenile eels from moving further upstream. As discussed in section 3.3.2.2, *Aquatic Resources, Environmental Effects, Upstream Eel Passage*, dedicated upstream eel passage ramps at the project dams would increase upstream passage effectiveness relative to the existing incidental passage over wetted project structures and adjacent bedrock outcrops, potentially decrease predation, and improve access to upstream habitat. Given that the project dams are the tallest known dams in the basin and eels managed to migrate past the project dams with no dedicated passage facilities, eels should be able to ascend any other dam in the basin with a sufficiently wetted surface. Therefore, providing dedicated upstream eels passage ramps at both project dams should reduce the effects of the project on American eel and increase the number of eels available to occupy habitat throughout the Union River basin. The new upstream eel passageways would minimize adverse effects of the project on the upstream migration of American eel, and would have an overall positive impact on the cumulative effects on upstream eel migration.

Downstream Passage

The Ellsworth Project has historically been a source of significant adverse effects on downstream migratory fish passage (*i.e.*, delay, injury, and mortality) in the Union River basin. American eels, Atlantic salmon, and river herring currently experience varying degrees of delay, injury, and mortality while migrating downstream through the project. Installing the proposed Alden weirs at both dams, installing the diversionary guidance boom and narrower trashracks at Ellsworth Dam, and achieving 90 percent passage effectiveness at both dam would reduce delay at both dams and greatly improve whole station survival for salmon smolts. These downstream passage measures would also contribute to safe, timely, and efficient downstream passage for kelts, should a naturally-reproducing salmon population become established in the Union River. The modified surface weirs at Graham Lake and Ellsworth dams and the guidance boom at Ellsworth Dam would reduce entrainment mortality for adult and juvenile river herring. In addition, installing narrower trashracks at the Ellsworth Dam would reduce entrainment of adult eels and river herring. Altogether, these measures would significantly reduce mortality for eels, river herring, and salmon in the Union River basin, and have a positive impact on the cumulative effects on downstream fish passage.

Despite stable upstream river herring runs and successful stocking efforts upstream of the project, the river herring population continues to experience additional adverse effects that are not directly related to project operation. Maine DMR states that an analysis of alewife spawner ages indicates that 93 percent of the alewives spawning in the Union River are 3- or 4-year-old, first-time spawners while other Maine rivers contain higher proportions of older, repeat alewife spawners.[172] Maine DMR and Interior suggest that the lack of older, repeat spawners in the Union River indicates that post-spawning mortality for adults is high.[173]

While the lack of older, repeat alewife spawners could be associated with high downstream passage, as discussed above and described further in section 3.3.2.2 *Downstream Fish Passage*, high exploitation rates (the percentage of population that is harvested) also reduce the number of older, repeat spawners in the population (ASMFC, 2012). As discussed above, the City of Ellsworth harvests river herring from the trap and truck facility for sale as lobster bait to commercial fishers under a cooperative management agreement with Maine DMR. The exploitation rate for alewives in the Union River ranged from 65 to 89 percent from 2000 to 2017 (URFCC, 2000 to 2018). These exploitation rates overlap with the exploitation rates calculated by ASMFC (2012) that could cause population collapse (*i.e.*, 62 to 80 percent, depending on the assumptions used regarding the population growth rate). Therefore, the high exploitation rates combined with potentially low downstream passage survival of adult alewives appear to be contributing to a low number of older, repeat spawners in the Union River at this time. However, the downstream passage measures proposed by Black Bear Hydro and recommended by the resources agencies, including the installation of the diversionary guidance boom, modifications to the downstream migrant pipe and spillway flume, increased attraction flows at Ellsworth Dam, and more narrowly-spaced trashrack would increase the number of adults that survive downstream passage.

[172] *See* Maine DMR's July 1, 2013 letter.

[173] *See* Interior's July 8, 2013 letter.

Non-native Fish Species

Smallmouth bass, largemouth bass, and chain pickerel are non-native fish species that are present in the Union River basin that may prey upon Atlantic salmon smolts, juvenile river herring, and juvenile eels. Based on laboratory and field studies, Van den Ende (1993) estimated that smallmouth bass and chain pickerel in the Penobscot River could consume 119 and 454 smolts, respectively, during the smolt downstream migration season. While Van den Ende (1993) did not estimate smolt consumption rates for largemouth bass, consumption rates would likely be similar to that of smallmouth bass given the similarity of the two species. Black Bear Hydro's proposed and staff's recommended measures for reducing the project's adverse effects on downstream fish migration would reduce injury and mortality of downstream migrants and have an overall positive influence on cumulative effects.

Aquatic Habitat

The majority of the Union River basin is predominately forested and rural; therefore, effects on aquatic habitat related to development are industry are limited. However, drawdowns in the water surface elevation of Graham Lake and the amount of flow released from Graham Lake and Lake Leonard affect the quality and availability of aquatic habitat in the Union River downstream of the confluence of the East and West branches of the Union River to the head of tide at Ellsworth Dam.

Our Analysis

Impoundment Habitat

As discussed in section 3.3.2.2, *Aquatic Resources, Environmental Effects, Impoundment Levels*, current drawdowns of Graham Lake's water surface elevation expose a large percentage of the littoral zone each year, mostly during the fall and winter seasons. Consequently, the amount of spawning, nursery, and feeding habitat is reduced by periodic dewatering. Drawdowns in water surface elevations in Graham Lake also leads to freshwater mussels stranding and likely affects other macroinvertebrates that occupy shallow areas of the impoundment. Other ponds, lakes, and impoundments in the Union River basin may also experience effects similar to Graham Lake depending on the mechanism that regulates their outflow, such as seasonal drawdowns in precipitation, beaver dams, or stoplog-controlled weirs. Reducing the range of elevations permitted at Graham Lake, as recommended by the resource agencies and Commission staff, would reduce adverse effects of the project on impoundment habitat and have an overall positive influence on cumulative effects on aquatic habitat in the Union River basin.

Riverine Habitat

As discussed in section 3.3.2.2, *Aquatic Habitat, Environmental Effects, Minimum Flows*, the current minimum flow from July 1 through April 30 of 105 cfs provides an unobstructed zone of passage in the Union River between Graham Lake Dam and Lake Leonard for migratory fish species and ensures that the majority of the river's width remains wetted. The current minimum flow of 250 cfs from May 1 to June 30 increases the depth of the river, increases the wetted width, and provides unobstructed access to most of the tributaries between the two developments. In addition, current operation provides higher median flows from May to October than would occur under run-of-river operation, which increases the amount of habitat available during those months (see Figure 15).

Downstream of the project, the quantity of aquatic habitat varies based on tidal stage. While fluctuations in flow due to peaking operation affect water velocity downstream of the dam, these effects would dissipate with increasing distance from the tailrace.

Elsewhere in the Union River basin, the outflow from other ponds, lakes, and impoundments determines the quality of downstream riverine habitat. The degree of disturbance this downstream riverine habitat experiences would depend upon how well the outflow preserves normal riverine functions, such as sediment transport, and the proportion of stream width that remains wetted (Tennant, 1975).

Black Bear Hydro's proposal and Commission staff's recommendation to continue providing a minimum flow of 105 cfs from July 1 through April 30 and a minimum flow of 250 cfs from May 1 to June 30 would ensure a sufficient zone of passage for migratory fish species and habitat for resident fish species and other aquatic organisms. There is no indication that the proposed project would add to the cumulative effects on riverine habitat that have occurred or that may occur in the future by any new activities in the basin.

Water Quality

Water quality in the Union River has been affected by multiple point and non-point sources in the Union River basin over time, including the construction and operation of dams, mills, hydroelectric facilities, and their impoundments beginning in the 18th century. In addition, the disposal of untreated wastes from lumber mills, including those present on the Union River during the 17th and 18th Centuries, other factories, and urban populations made some rivers in New England among the most contaminated in the United States (Flanagan *et al*., 1999). Inputs of nitrogen and phosphorus, which can contribute to eutrophication, into rivers can come from many sources, including rocks, soils, vegetation, treated wastewater effluents, stormwater runoff from urban, agricultural and forested lands, poorly functioning septic systems, pet waste, and atmospheric deposition (primarily for nitrogen) (Flanagan *et al*., 1999).

Our Analysis

The presence of self-sustaining populations of brook trout, brown trout, and landlocked salmon in tributaries to Graham Lake and the Union River (URFCC, 2015) suggests that the water in these tributaries is clean, cool, and well-oxygenated. Similarly, Green Lake and Floods Pond contain Arctic charr, which require excellent water quality, and other lakes, ponds, and impoundments in the Union River basin contain populations of naturally-reproducing landlocked salmon. In addition, eutrophication does not appear to be occurring in Graham Lake and Lake Leonard based on the 2013 study results. Therefore, land-use and human activities within the basin appear currently compatible with aquatic life water quality needs.

As described in section 3.3.2.2, *Aquatic Resources, Environmental Effects, Impoundment Levels*, the annual cycle of exposure and inundation in Graham Lake prevents the establishment of terrestrial and aquatic vegetation in a vast expanse of the littoral zone of Graham Lake, and contributes to the erosion of exposed, fine-grained sediments. Consequently, Graham Lake is among the most turbid lakes in Maine. Reducing the amount of exposed littoral zone would reduce the input of fine-grained sediment into the water column, which would improve water clarity in Graham Lake, the Union River downstream of Graham Lake, and Lake Leonard. Stratification occurred in both impoundments, but low DO conditions primarily occurred in the lowermost part of the water column. Since the low DO conditions occurred at depths greater than the Graham Lake Tainter gates and the unit intakes at Ellsworth Dam, water with low DO concentrations is unlikely to be released downstream. Staff's recommendation to reduce the impoundment drawdowns in Graham Lake from the existing operating range of 93.4 – 104.2 feet msl to 98.5 – 103.0 feet msl would have a positive influence on cumulative effects on water quality in the Union River basin.

3.3.3 Terrestrial Resources

3.3.3.1 Affected Environment

<u>Botanical Resources</u>

The project is located in the Acadian Plains and Hills ecoregion (Griffith *et al*., 2009), which is characterized by rolling plains and low hills. This region is primarily forested, with dense concentrations of continental glacial lakes. Forests are composed of spruce-fir on the lowlands, with patches of maple, beech, and birch on the hills. Lands within the project boundary are predominately forested upland (64 percent) and wetland (35 percent), with some maintained lawn and open fields (1 percent).

Approximately 2,144 acres of forested upland are located within the project boundary. Forests in this area are characterized as northern hardwood forests. Typical species include sugar maple, paper birch, and eastern hemlock. In addition, red maple, eastern white pine, northern red oak, birch, beech, red spruce, balsam fir, and northern white cedar are also present within the project boundary.

Three invasive botanical species were identified within the project boundary during 2014 survey efforts: common reed (*Phragmites australis*), Japanese knotweed (*Fallopia japonica*), and purple loosestrife (*Lythrum salicaria*). Three large stands of common reed were documented on an island within Graham Lake, and one large stand of Japanese knotweed was documented on the south side of Graham Lake. No other significant communities were found.

Current vegetation management within the project boundary is limited to 11 acres of open field, 20 acres of residential lawns, and 4 acres of electrical transmission right-of-way. The right-of-way is maintained using a combination of hand-cutting and selective herbicide applications. Mechanical vegetation removal along the right-of-way is performed infrequently.

Wetland Vegetation

About 1,171 acres of wetland habitat are located within the project boundary. Wetlands in the project boundary are found in narrow fringes along the shorelines and tributary streams of Graham Lake, Lake Leonard, and to a lesser extent, the Union River. More extensive wetland areas, including bog habitat,[174] are found on three large islands in Graham Lake and on a large peninsula on the western shore in the southern portion of Graham Lake. Wetland vegetation types present in the project boundary include emergent, scrub-shrub, and forested wetland types.

Emergent and scrub-shrub wetlands are the most common wetland types within the project boundary. Emergent wetlands at Graham Lake are located on the islands and on the peninsula, surrounding bog habitat, and along the shoreline. Emergent species include white beak sedge, cotton-grasses, sedges, cattails, reed canary grass, common button bush, wool-grass, soft rush, and pipeworts. Scrub-shrub wetlands are located on the islands and on the southern side of the peninsula. Shrub species include sheep-laurel, sweetgale, leatherleaf, rusty Labrador-tea, cranberry, silky dogwood, broad-leaf

[174] A bog is a freshwater wetland with a soft, spongy ground consisting mainly of partially decayed plant matter. Bog vegetation in the project vicinity is classified as emergent and scrub-shrub.

meadowsweet, and willows. Forested wetlands are also present along the shoreline and islands in Graham Lake. Forested wetland species include red maple, gray birch, black spruce, American larch, and eastern white pine.

Wetlands along the shoreline of Lake Leonard and the Union River between Graham Lake and Lake Leonard are limited, consisting of emergent and scrub-shrub wetland species. Typical species include pickerelweed, cattails, Canada blue-joint, reed canary grass, alders, and meadowsweet.

Maine Plant Species of Concern

One Maine threatened plant, the Nantucket shadbush (*Amelanchier nantucketensis*), was identified within the project boundary during the 2014 botanical resources survey. This species was identified downstream of Ellsworth Dam on a dry ledge that is elevated above discharges from the dam. In addition, suitable habitat was identified for mudwort (*Limosella australis*), a Maine species of concern, but no plants were found during surveys.

Wildlife Resources

The project vicinity supports various wildlife habitats, including wooded upland and wetland areas. Mammals that are known or likely to occur in the project vicinity include white-tailed deer, moose, black bear, coyote, beaver, muskrat, mink, and river otter. Numerous birds use the riverine and riparian habitats along the Union River for feeding and nesting habitat, including Canada goose, ducks, mergansers, osprey, and common loon (*Gavia immer*).

Three state species of concern are known to occur in the project vicinity, including bald eagle (*Haliaeetus leucocephalus*), great blue heron (*Ardea herodias*), and lesser yellowlegs (*Tringa flavipes*). Suitable habitat may occur in the project vicinity for two state listed endangered species, northern long-eared bat (*Myotis septentrionalis*) and little brown bat (*Myotis lucifugus*); and three state species of concern, the silver haired bat (*Lasionycteris noctivagans*), northern leopard frog (*Lithobates pipiens*), and wood turtle (*Glyptemys insculpta*).

Two intact bald eagle nesting sites were present on islands in Graham Lake in 2015. In addition, five territorial pairs of common loons were observed on Graham Lake during surveys conducted in 2014.

Maine Significant Wildlife Habitat

Two "Significant Wildlife Habitats," as defined by Chapter 335 of the Maine Natural Resource Protection Act, were identified in the project vicinity: inland waterfowl and wading bird habitat (IWWH), and deer wintering areas.

IWWH areas are defined as wetland complexes surrounded by a 250-foot-wide upland zone buffer. Nine IWWH areas were identified within the Ellsworth Project boundary near Graham Lake or tributaries to Graham Lake. Five IWWH areas were found to provide high value habitat,[175] and four were found to provide moderate value habitat. A 2014 desktop survey found that three of these areas were likely to provide suitable habitat for marsh-nesting birds. In 2015, Black Bear Hydro conducted field surveys for three state listed marsh-nesting birds, including least bittern, sedge wren, and common gallinule. However, none were identified during survey efforts.

Deer wintering areas are forested areas that provide shelter for deer when deep snow restricts their mobility and food availability. One potential deer wintering area was identified on the eastern shore of Graham Lake, although on-site verification was not conducted.

3.3.3.2 Environmental Effects

Wetlands

Black Bear Hydro proposes to continue the current, licensed project operation in which Graham Lake is drawn down during the summer and winter, and refilled in the fall and spring. Impoundment levels would continue to fluctuate up to 10.8 feet on an annual basis, between 93.4 and 104.2 feet msl. Lake Leonard water levels would be maintained within 1-foot on an annual basis.

No agency recommendations specifically relating to wetlands were received.

Our Analysis

As currently licensed, the Graham Lake Development is operated as a water storage reservoir to support downstream generation at the Ellsworth Development. At Graham Lake, wetlands are present on three large islands, the large peninsula in the southern half of the lake, and narrow bands along the shoreline and tributary streams.

The extent of wetlands in Graham Lake may be limited by the seasonal water level drawdowns that are permitted under the existing license and that would continue to occur under Black Bear Hydro's proposal. Drawdowns in the impoundment elevation result in the seasonal inundation and dewatering of soils along the project shoreline, which influences the composition and structure of vegetation growing within the drawdown zone. These effects are limited to a littoral band around the impoundment and islands

[175] A high to moderate value inland bird habitat is defined as a complex of freshwater wetland and open water areas plus a 250-foot wide area surrounding the complex itself where inland species of waterfowl and wading birds nest. *See* https://www.maine.gov/dep/land/nrpa/birdhabitat/bird_habitat.html.

between 93.4 and 104.2 feet msl. As discussed in section 3.3.2, *Aquatic Resources, Protection of Littoral Habitat*, the elevation of Graham Lake is typically maintained at or above 95.0 feet msl during normal operating conditions, resulting in at least 15.4 percent of the littoral zone remaining wetted on a year-round basis. At a minimum elevation of 93.4 feet, only 5 percent of the littoral zone would remain wetted. When the impoundment is drawn down below 95.0 feet msl under current operating conditions, shallow marsh areas and large areas of unvegetated mudflats are dewatered and exposed. Although wetlands in the project area have adapted to current project operation, the seasonal drawdowns of water along the project shoreline likely restrict the extent of wetland vegetation that can persist along the shoreline areas.

As discussed in section 3.3.2, stakeholders recommend other operating ranges that would result in 30 to 88.7 percent of the littoral zone remaining wetted on a year-round basis, which would increase the amount of persistent littoral habitat. Increasing the area of the permanently wetted littoral zone could allow existing beds of wetland vegetation to expand over time and allow new areas to be colonized by wetland vegetation. However, some proposed operating ranges would reduce the maximum impoundment level to 102 or 103 feet msl. While a reduction in the maximum impoundment elevation could reduce the potential for shoreline erosion, it could also dewater the upper extent of existing wetlands (*i.e.*, lands up to 104.2 feet msl). This reduction in the maximum impoundment elevation could eventually result in vegetation transitioning from wetland vegetation to upland vegetation on some of the land at higher elevations, if drier conditions persist.

At Lake Leonard, the 1-foot annual elevation drawdown results in relatively stable impoundment levels that support wetland areas on the shoreline of the impoundment. These wetlands have adapted to the existing impoundment elevations, and no changes to project operation are proposed that would adversely affect the existing wetlands.

The Ellsworth Dam is located at head of tide, and wetlands downstream of the dam are wetted by both the flow releases from the dam and tidal flows. There is no proposed change to minimum flow releases from Ellsworth Dam; therefore, no new effects to wetland areas would be expected.

Cumulative Effects

Our environmental analysis did not identify any project-related effects on wetlands that would measurably contribute to cumulative, basin-wide effects. Effects to wetlands resulting from continued operation of the project, as well as proposed changes to the Graham Lake elevation and operating range, would be localized and would not contribute to cumulative effects in the Union River Basin.

Common Loons

During the scoping process, Maine DIFW recommended an analysis of the effects of project operation on common loons. However, Black Bear Hydro has not proposed any specific measures related to common loons and no specific recommendations have been made regarding common loons.

Our Analysis

Five territorial pairs of common loon have been observed at Graham Lake. Common loon habitat includes lakes larger than 60 acres with clear water, abundance of food, numerous small islands, and an irregular shoreline. When present, loons prefer to nest on small islands and floating bog mats. In Maine, nest selection occurs during late May and early June, and incubation subsequently follows during mid-June to mid-July. Fluctuating water levels is a primary cause of nest failure by flooding or stranding nests, reducing nest accessibility, and increasing vulnerability to predation (Evers, 2007).

In 2014, Black Bear Hydro conducted studies to document common loon nesting at Graham Lake. Four common loon pairs attempted to nest in 2014, of which three were found to have successfully nested. Common loon nesting at Graham Lake occurred on floating bog mats, which are able to rise and fall with the change in water level, allowing the nest to remain intact during the incubation period. Therefore, these nesting attempts did not appear to be negatively affected by the seasonal water level drawdowns.[176]

Aquatic Furbearers

During the scoping process, Interior recommended an analysis of the effects of project operation on aquatic furbearers. However, Black Bear Hydro has not proposed any specific measures related to aquatic furbearers and no specific recommendations have been made regarding aquatic furbearers, including mink, beaver, river otter, and muskrat.

Our Analysis

Beaver are known to be present within the project vicinity and were observed during 2014 field surveys. Mink, river otter, and muskrat are also likely to occur at the project. Seasonal water level drawdowns at Graham Lake could reduce the availability of potential habitat for aquatic furbearers by flooding or dewatering dens or lodges. However, the continued presence of these species in the project vicinity indicates that they are not relocating due to dewatering or loss of access to dens. Therefore, it appears

[176] Water level drawdowns are discussed in detail in section 3.3.1, *Aquatic Resources, Water Quantity*.

that the summer and late winter drawdowns and spring and fall refills are not excluding aquatic furbearers from using the project vicinity.

Invasive Species

Black Bear Hydro is not proposing any specific measures to monitor or control invasive plant species at the project.

Our Analysis

Non-native invasive plant species are able to out-compete and displace native species, thereby reducing biodiversity and altering compositions of existing native plant and animal communities. Once established, invasive plant species can be difficult to remove from an area. However, mechanical and chemical methods can be used to restrict the abundance of existing populations, allowing for greater vegetation diversity.

Ground-disturbing activities in the vicinity of the project would be limited to recreation access improvements and construction related to fish passage facilities, neither of which would occur in or near areas with known terrestrial invasive species, including near the stands of common reed that were documented on an island within Graham Lake or near the stand of Japanese knotweed that was documented on the south side of Graham Lake. Further, no aquatic invasive species are known to occur in the project vicinity. Therefore, continued project operation would not be expected to promote the expansion of the invasive species.

Because the invasive species do not appear to be affecting project operation or other environmental resources, there is no indication that an invasive species management plan or other invasive species management measures are needed to protect fish and wildlife resources at this time.

3.3.4 Threatened and Endangered Species

3.3.4.1 Affected Environment

The federally endangered Gulf of Maine DPS of anadromous Atlantic salmon (*Salmo salar*) occupies the Union River as the result of annual fry stocking efforts. In addition, the federally threatened Gulf of Maine DPS of Atlantic sturgeon (*Acipenser oxyrinchus*) and the federally endangered shortnose sturgeon (*Acipenser brevirostrum*) could occur in the Union River downstream of Ellsworth Dam. Lastly, the federally threatened northern long-eared bat (*Myotis septentrionalis*) could occur in Hancock County, Maine.

Atlantic Salmon

Listing Status

The initial listing (issued in 2000) for anadromous Atlantic salmon defined the Gulf of Maine DPS as all naturally reproducing remnant populations of Atlantic salmon from the lower Kennebec River and its tributaries to, but not including, the mouth of the St. Croix River at the U.S.-Canada border.[177] The 2000 listing excluded fish that inhabited the mainstem and tributaries of the Penobscot River upstream of the former Bangor Dam, near Bangor, Maine.[178] In 2009, a final rule was issued for the Gulf of Maine DPS which expanded the listing to encompass the freshwater range of salmon associated with the Penobscot River, the Androscoggin River, and the Union River (see Figure 21).[179] The entire Union River watershed, which is located in the Downeast salmon habitat recovery unit (SHRU)[180] for Atlantic salmon, is designated as critical habitat (see Figure 22).[181]

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[177] 65 Fed. Reg. 69459 (November 17, 2000).

[178] *Id.*

[179] 74 Fed. Reg. 29344 (June 19, 2009).

[180] SHRUs are separate geographic units within the Gulf of Maine DPS. The Gulf of Maine DPS is separated into three SHRUs to ensure that Atlantic salmon are well distributed across the Gulf of Maine DPS range. The separation is based on life history characteristics, as well as demographic and environmental variation. This type of separation is designed to buffer the DPS from adverse demographic and environmental events that could negatively affect recovery of the Gulf of Maine DPS.

[181] 74 Fed. Reg. 29300 (June 19, 2009).

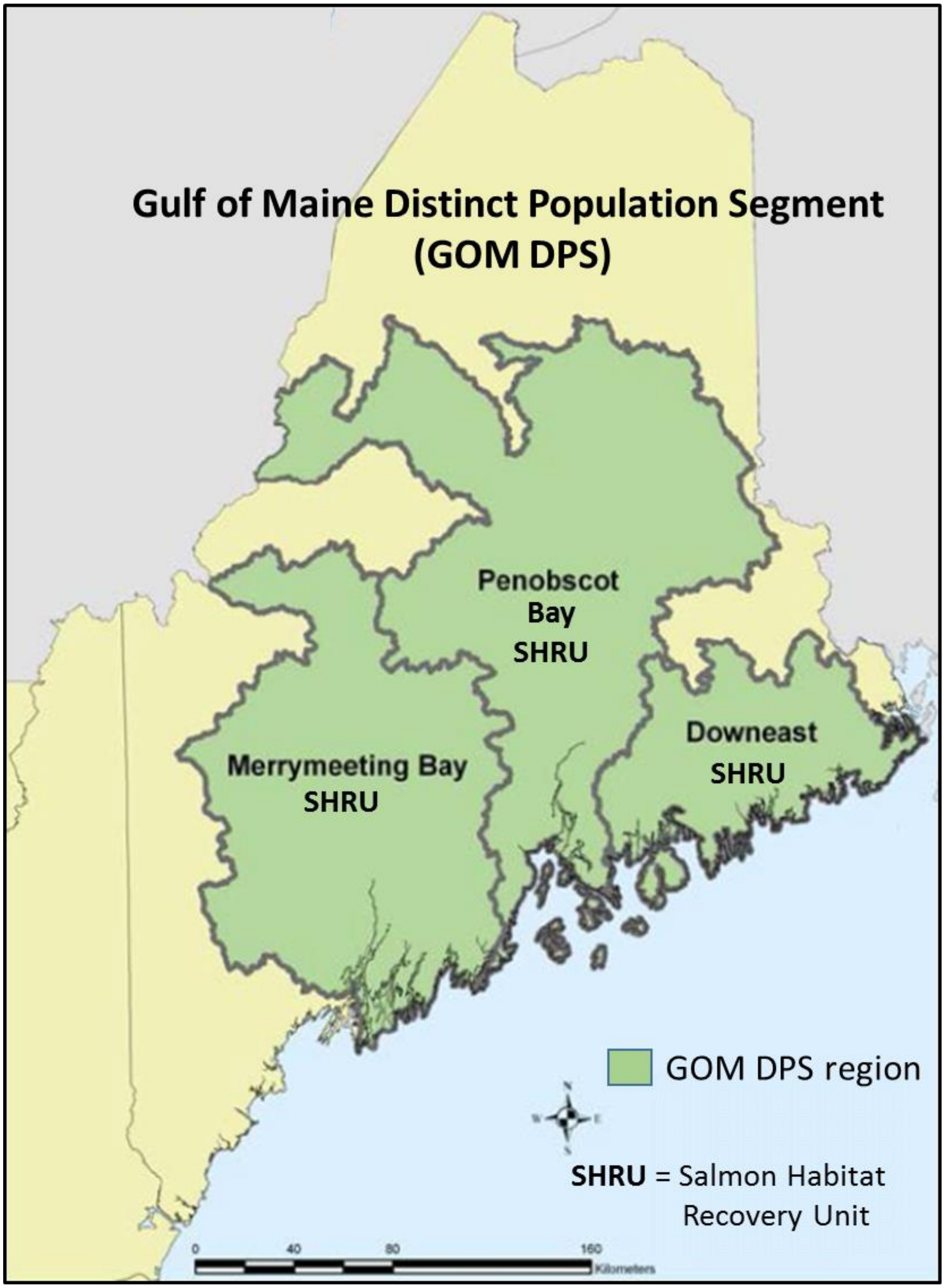

Figure 21. The freshwater population range of the Gulf of Maine DPS of endangered Atlantic salmon. (Source: NMFS and FWS, 2016a, as modified by staff).

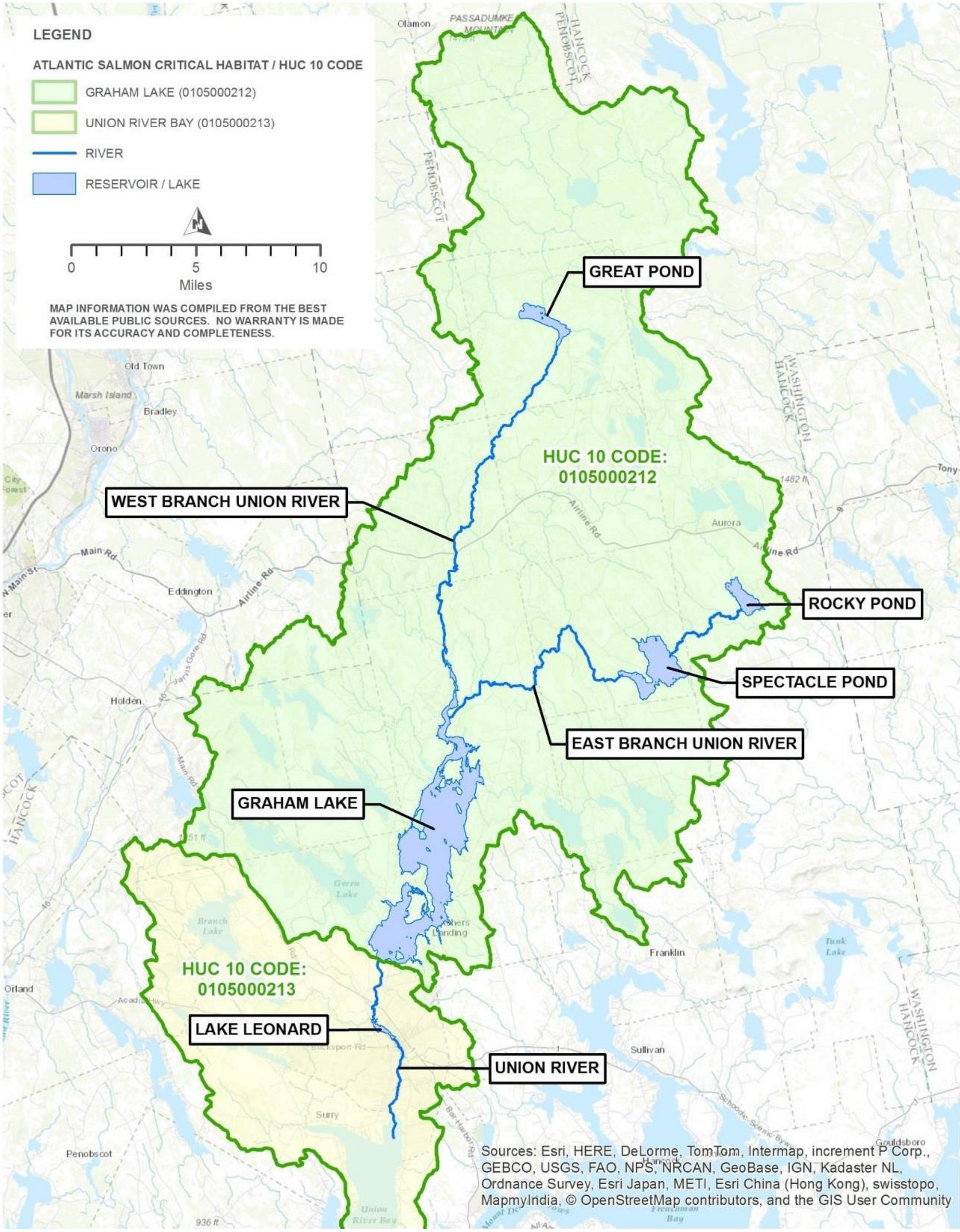

Figure 22. Atlantic salmon critical habitat near the Ellsworth Project. (Source: Black Bear Hydro, 2015e).

Life History

Anadromous Atlantic salmon typically spend two to three years in the ocean before returning to their natal rivers to spawn. Approximately 80 percent of adults return after 2 years, about 17 percent (primarily males) return after one year, and the remaining three percent are repeat spawners or spend three years at sea (USASAC, 2017; NMFS, 2009a). Most adult Atlantic salmon enter Maine rivers during the spring and early summer (May-July), but upstream migrations can occur from April to early November (Baum, 1997). Approximately 65 percent of the adult salmon returning to the Union River each year have returned by June, and nearly 90 percent have returned by August (Baum, 1997).

Upstream migrating adult Atlantic salmon will return to their natal river or stream (*i.e.*, habitat where they were reared as young salmon) to spawn. Adults are able to return to their natal habitat using olfactory cues (*i.e.*, odors) that they imprinted on while rearing in natal habitat, especially during the smolt stage (McCormick *et al.*, 1999). However, one to three percent of returning adults may stray into a different river (Baum, 1997). Returning adults will spawn in clear, coldwater streams and rivers having relatively unobstructed passage to the ocean. Suitable spawning habitat is characterized by coarse gravel or rubble bottom with well-oxygenated, clean water. Anadromous Atlantic salmon spawn in October and November (Fay *et al.*, 2006). After spawning, some adults survive, journey back to the ocean, and return again to spawn after at least one year in the ocean. Surviving adults are referred to as "kelts" during the downstream migration. From 1967 to 2016, approximately 1.9 percent of the wild and naturally reared adult anadromous Atlantic salmon returning to U.S. rivers were repeat spawners (USASAC, 2017), but these fish have become increasingly rare (USASAC, 2017).

Kelts have been observed in the lower Penobscot River in November, while some kelts wait until the following spring (April or May) to migrate back downstream (USASAC, 2007). Five years of data collected at the Mattaceunk Project (FERC No. 2520) demonstrate a spring migration period between April 25 and June 25, and a fall migration in October and November (GNP, 1993, 1994). Kelts tended to move downstream with higher flows in early spring.

The early life stages of Atlantic salmon begin with eggs that hatch during March and April (Fay *et al.*, 2006). The newly hatched alevins (larvae with yolk-sacs) remain in the gravel for about six weeks. Alevins consume their yolk-sacs and emerge from the gravel in mid-May as fry (feeding larvae). The fry develop into juveniles (parr) and remain in rivers for one to three years (until approximately five inches or greater in length), at which point they begin a transformation of color, shape, internal salt balance, and energy storage, and become smolts that migrate downstream to the ocean in the spring (Fay *et al.*, 2006).

Naturally reared smolts in Maine range in size from five to seven inches long, and most smolts enter the sea during May to begin their ocean migration (USASAC, 2004). The peak of movement shifts from year to year in response to environmental conditions (Bakshtansky *et al.*, 1976; Jonsson and Ruud-Hansen, 1985). Smolt migratory movement is a combination of passive entrainment with flow (particularly in areas of high water velocity), and active swimming (Ruggles, 1980). Active swimming speeds may exceed 3.3 fps for prolonged periods (Vanderpool, 1992; Shepard, 1993) and can include directed movement through very large lakes and reservoirs in the absence of rheotactic[182] cues (Bourgeois and O'Connell, 1986). Smolt survival during the downstream migration is generally highest at temperatures between 50° F and 68° F, and at intermediate river flows (Stich *et al.*, 2015a).

Fay et al. (2006) summarized the habitat requirements for the different life stages of Atlantic salmon. Atlantic salmon require clean gravel or cobble, water temperatures ranging from 45 to 50 ºF, an average water velocity of approximately 2 fps, and depths ranging from one to four feet to spawn. Parr occupy habitat with instream cover, such as woody debris, water temperatures between 59 and 66 ºF, water velocity ranging from 1 to 3 fps, and depths of 4 to 24 inches. Optimum water temperatures during the downstream smolt migration in spring range from 45 to 58 ºF, and temperatures over 66 ºF can be lethal. For adult salmon migrating upstream, optimum water temperatures range from 57 to 73 ºF, and temperatures over 73 ºF can be stressful or lethal.

Habitat

Atlantic salmon habitat is quantified in the Gulf of Maine DPS by mapping habitat within hydrologic units.[183] The Union River watershed contains 14,341 historic habitat units, which represents approximately 26 percent of the critical habitat within the Downeast SHRU.[184] Ninety-three percent of the Union River habitat units are upstream of Ellsworth Dam, and 73 percent are upstream of Graham Lake Dam (see Figure 23).[185] The majority of the salmon habitat upstream of Graham Lake is located in the West

[182] For fish, rheotaxis generally refers to the tendency to orient swimming movement in the direction of oncoming current.

[183] Specifically, the Gulf of Maine DPS is mapped for habitat quantity and quality at the hydrologic unit code 10 (HUC 10) scale. The U.S. is divided and sub-divided into successively smaller hydrologic units. The HUC 10 level represents a level of subdivision that usually results in a hydrologic unit of 40,000 to 250,000 acres.

[184] *See* NMFS’s April 10, 2018 letter.

[185] *See* NMFS’s April 10, 2018 letter.

Branch of the Union River (Baum, 1982). Additional habitat is located in the mainstem Union River and its tributaries upstream of Ellsworth dam and the East Branch and Middle Branch of the Union River (Baum, 1982). In addition, Maine DIFW stated that Gilpatrick Brook provides productive brook trout habitat, which suggests that it may also contain suitable salmon spawning and nursery habitat.[186]

[186] *See* the consultation meeting summary in Black Bear Hydro's Tributary Access Study report, filed December 22, 2016.

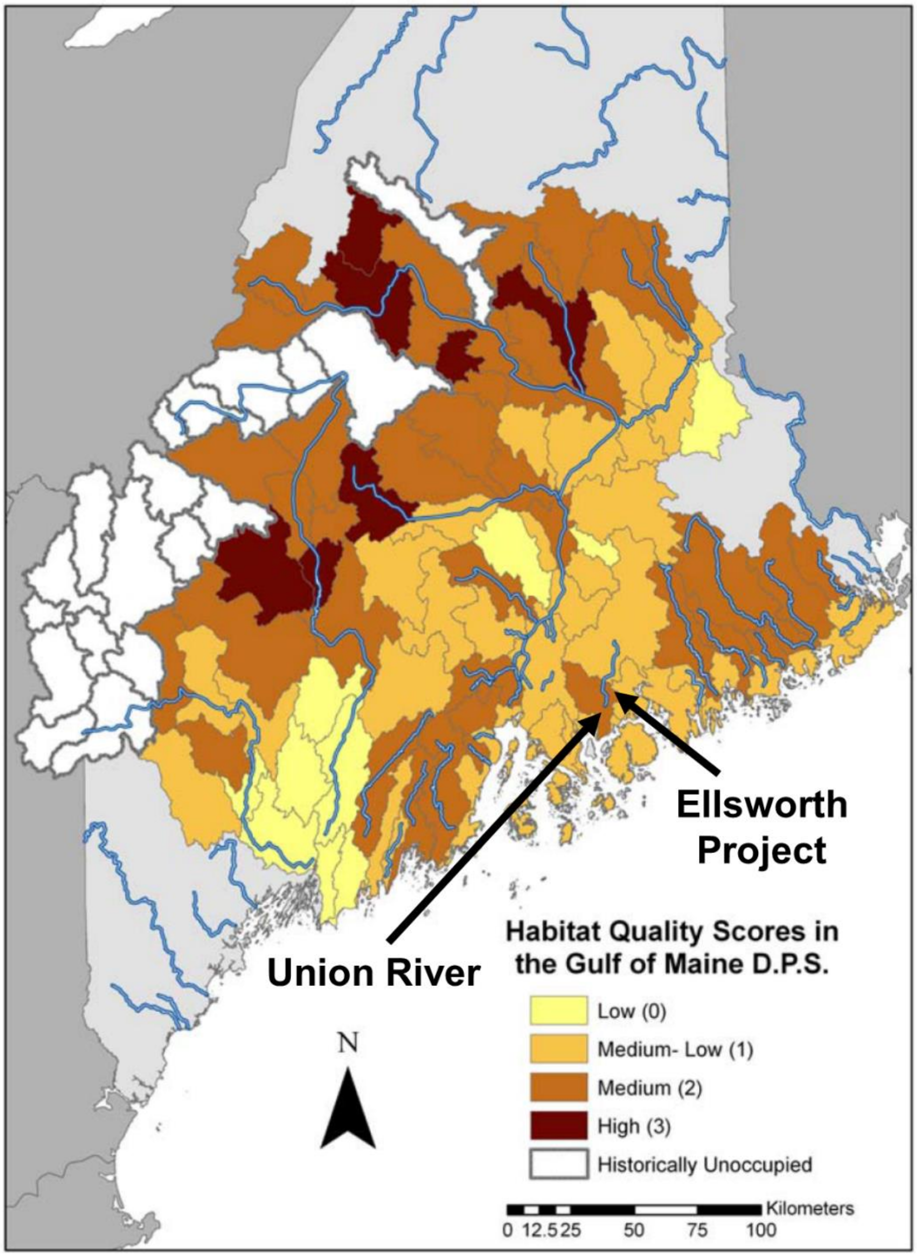

Figure 23. Atlantic salmon habitat quality. (Source: NASCO, 2009).

Atlantic salmon habitat quality is based on the suitability of several parameters, including water temperature, biological communities, water quality, substrate, and cover. Based on input from Maine DIFW, Maine DMR, NMFS, and Kleinschmidt Associates, the North Atlantic Salmon Conservation Organization designated the habitat downstream of Graham Lake Dam as medium quality, and the habitat upstream of the dam has been designated medium-low quality (see Figure 23; NASCO, 2009).[187] The Maine Atlantic Salmon Commission and FWS conducted habitat surveys in the West Branch of the Union River and identified spawning and juvenile rearing habitat (URFCC, 2010; see Figure 24). The suitability of the spawning habitat in the West Branch of the Union River was confirmed in 2011 when Maine DMR stocked 288 surplus Atlantic salmon broodstock into the West Branch of the Union River, and the salmon produced 204 redds (URFCC, 2010; see Figure 25). The habitat in the West Branch of the Union River also proved to be highly productive rearing habitat. Maine DMR conducted electrofishing surveys in the West Branch of the Union River in 2012 and 2013, and collected a median of 0.6 young-of-year salmon per minute in 2012 and 0.6 par per minute in 2013.[188] These catch rates are comparable to catch rates in other productive rivers, such as the Piscataquis River (Penobscot River tributary, 0.7 parr per minute) and the Sandy River (Kennebec River tributary, 0.4 parr per minute).[189]

[187] NASCO is an international organization, established by an inter-governmental convention in 1984. The objective of NASCO is to conserve, restore, enhance and rationally manage Atlantic salmon through international cooperation taking account of the best available scientific information.

[188] *See* NMFS's April 10, 2018 letter.

[189] *Ibid*.

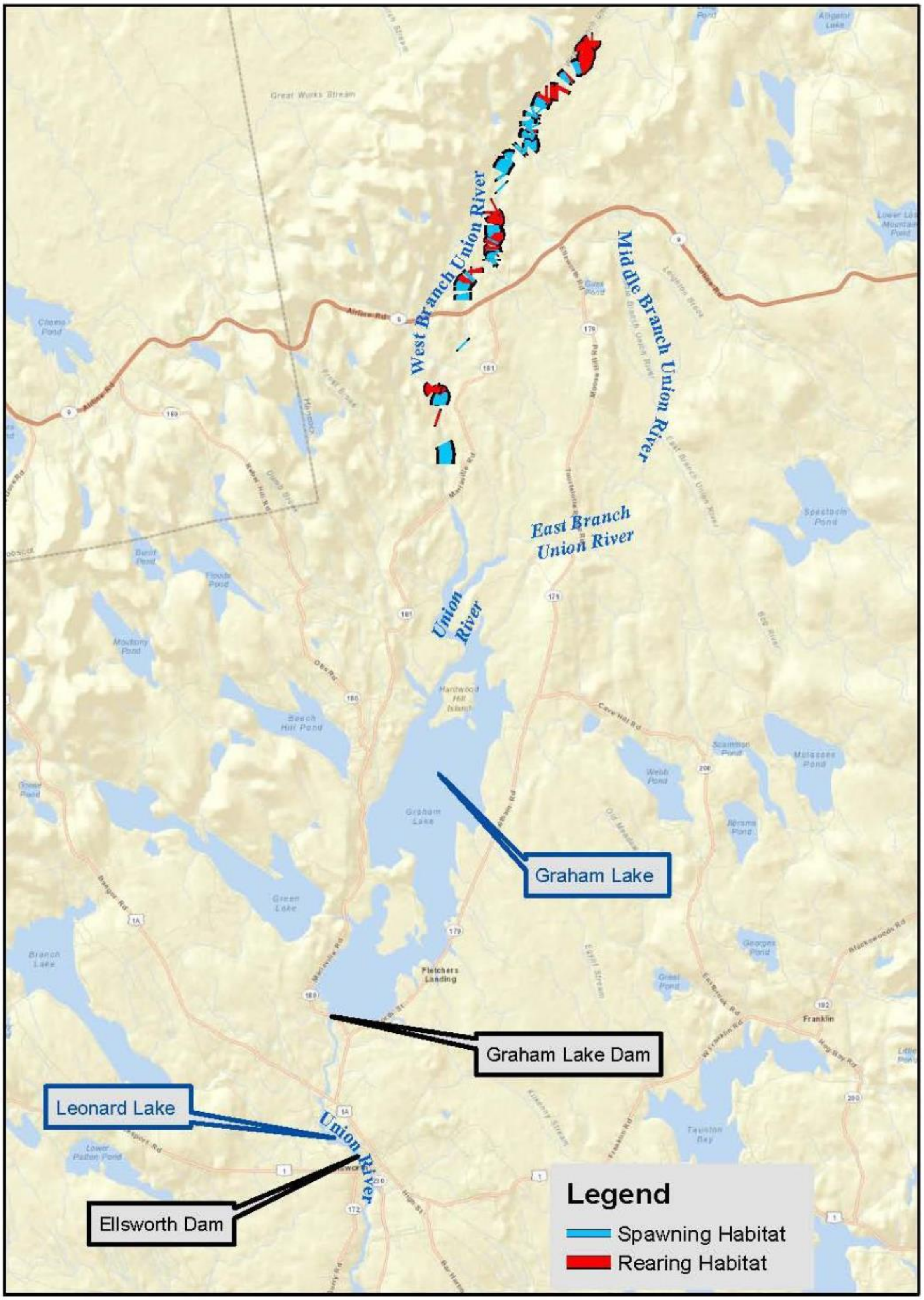

Figure 24. Atlantic salmon spawning and rearing habitat in the West Branch of the Union River. (Source: FWS, 2011).

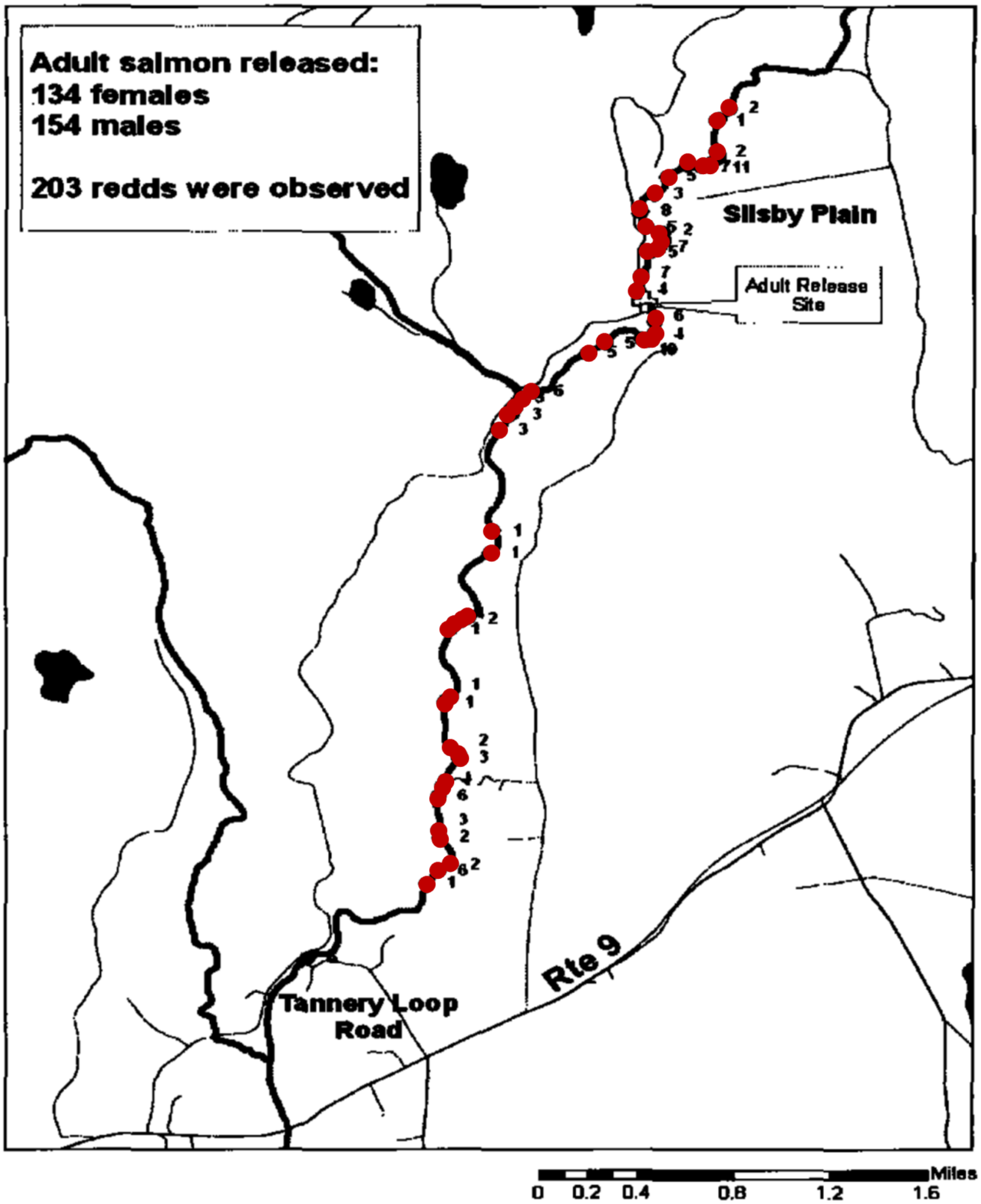

Figure 25. Location of salmon redds observed in the West Branch of the Union River in 2011. The red circles indicate the locations of the redds, and the numbers to the right indicate the number of redds at that location. Not all numbers are visible due to the scale of the map. (Source: URFCC, 2012, as modified by staff).

Atlantic Salmon Critical Habitat

Critical habitat was designated for Atlantic salmon on June 19, 2009.[190] The critical habitat designation includes 45 specific areas occupied by the Gulf of Maine DPS of Atlantic salmon that comprise approximately 12,161 miles of perennial river, stream, and estuary habitat and 197,437 acres of lake habitat. Within the occupied areas, there are known physical and biological features (*i.e.*, primary constituent elements [PCEs]) that are essential to the conservation of the species. Within the occupied range of the Gulf of Maine DPS, Atlantic salmon PCEs include sites for spawning, incubation, and juvenile rearing, (*i.e.*, spawning and rearing PCE) and sites for migration (*i.e.*, migration PCE).

Physical and biological features of the spawning and rearing PCE include:

- PCE 1: deep, oxygenated pools and cover (*e.g.*, boulders, woody debris, and vegetation), near freshwater spawning sites, necessary to support adult migrants during the summer while they await spawning in the fall;
- PCE 2: freshwater spawning sites that contain clean, permeable gravel and cobble substrate with oxygenated water and cool water temperatures to support spawning activity, egg incubation, and larval development;
- PCE 3: freshwater spawning and rearing sites with clean, permeable gravel and cobble substrate with oxygenated water and cool water temperatures to support emergence, territorial development, and feeding activities of Atlantic salmon fry;
- PCE 4: freshwater rearing sites with space to accommodate growth and survival of Atlantic salmon parr;
- PCE 5: freshwater rearing sites with a combination of river, stream, and lake habitats that accommodate parr's ability to occupy many niches and maximize parr production;
- PCE 6: freshwater rearing sites with cool, oxygenated water to support growth and survival of Atlantic salmon parr; and
- PCE 7: freshwater rearing sites with diverse food resources to support growth and survival of Atlantic salmon parr.

Physical and biological features of the migration PCE include:

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[190] 74 Fed. Reg. 29300-29341 (June 19, 2009).

- PCE 8: freshwater and estuary migratory sites free from physical and biological barriers that delay or prevent access of adult salmon seeking spawning grounds needed to support recovered populations;

- PCE 9: freshwater and estuary migration sites with pool, lake, and instream habitat that provide cool, oxygenated water and cover items (*e.g.*, boulders, woody debris, and vegetation) to serve as temporary holding and resting areas during upstream migration of adult salmon;

- PCE 10: freshwater and estuary migration sites with abundant, diverse native fish communities to serve as a protective buffer against predation;

- PCE 11: freshwater and estuary migration sites free from physical and biological barriers that delay or prevent emigration of smolts to the marine environment;

- PCE 12: freshwater and estuary migration sites with sufficiently cool water temperatures and water flows that coincide with diurnal cues to stimulate smolt migration; and

- PCE 13: freshwater migration sites with water chemistry needed to support seawater adaptation of smolts.

Atlantic Salmon Critical Habitat in the Project Area

Critical habitat within the Union River watershed extends from the estuarine habitat of Union River Bay upstream into the watershed headwaters. Therefore, the Ellsworth Project falls within the designated critical habitat of the Downeast SHRU for Atlantic salmon. As mentioned earlier, the Union River watershed contains 14,341 historic habitat units, 93 percent of which is upstream of Ellsworth Dam. Section 3.3.4.1, *Aquatic Resources, Affected Environment* contains a description of aquatic habitat conditions upstream of Ellsworth Dam, which is within designated critical habitat.

<u>Essential Fish Habitat</u>

EFH for Atlantic salmon has been defined as, "all waters currently or historically accessible to Atlantic salmon within the streams, rivers, lakes, ponds, wetlands, and other water bodies of Maine, New Hampshire, Vermont, Massachusetts, Rhode Island and Connecticut," which includes the project area. A description of EFH for each Atlantic salmon life stage can be found in the New England Fishery Management Council (NEFMC) Essential Fish Habitat Amendment 3 (NEFMC, 2016) as follows:[191]

- Eggs: Bottom habitats with a gravel or cobble riffle above or below a pool of rivers. Generally, the following conditions exist in the egg pits (redds): water temperatures below 50° F, and clean, well-oxygenated fresh water. Atlantic salmon eggs are most frequently observed between October and April.

- Larvae: Bottom habitats with a gravel or cobble riffle (redd) above or below a pool of rivers. Generally, the following conditions exist where Atlantic salmon larvae, or alevins/fry, are found: water temperatures below 50 °F, and clean, well-oxygenated fresh water. Atlantic salmon alevins/fry are most frequently observed between March and June.

- Juveniles: Bottom habitats of shallow gravel/cobble riffles interspersed with deeper riffles and pools in rivers and estuaries. Generally, the following conditions exist where Atlantic salmon parr are found: clean, well-oxygenated fresh water, water temperatures below 77 °F, water depths between 3.9 in and 24.0 in, and water velocities between 1.0 and 3.0 fps. As they grow, parr transform into smolts. Atlantic salmon smolts require access downstream to make their way to the ocean. Upon entering the sea, "post-smolts" become pelagic and range from Long Island Sound north to the Labrador Sea.

- Adults: For adult Atlantic salmon returning to spawn, habitats with resting and holding pools in rivers and estuaries. Returning Atlantic salmon require access to their natal streams and access to the spawning grounds. Generally, the following conditions exist where returning Atlantic salmon adults are found migrating to the spawning grounds: water temperatures below 73 °F, and DO above five parts per million (ppm). Oceanic adult Atlantic salmon are primarily pelagic and range from the waters of the continental shelf off southern New England north throughout the Gulf of Maine.

- Spawning Adults: Bottom habitats with a gravel or cobble riffle (redd) above or below a pool of rivers. Generally, the following conditions exist where spawning Atlantic salmon adults are found: water temperatures below 50 °F, water depths between 11.8 in and 24.0 in, water velocities around 2 fps, and clean, well-

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[191] The New England Fishery Management Council, one of eight regional councils established by the Magnuson Fishery Conservation and Management Act of 1976, is charged with conserving and managing fishery resources from three to 200 miles off the coasts of Maine, New Hampshire, Massachusetts, Rhode Island, and Connecticut.

oxygenated fresh water. Spawning Atlantic salmon adults are most frequently observed during October and November.

Atlantic salmon EFH includes all aquatic habitats in the watersheds of the identified rivers, including all tributaries, to the extent that they are currently or were historically accessible for salmon migration. Atlantic salmon EFH excludes areas upstream of longstanding naturally impassable barriers (*i.e.*, natural waterfalls in existence for at least several hundred years).

As discussed above, spawning and rearing habitat has been identified both within and upstream of the project boundary. Further, Commerce has indicated that the historical range of Atlantic salmon in the Union River is designated as EFH by the NEFMC pursuant to the Magnuson-Stevens Fishery Conservation and Management Act.

Abundance

Historically, an estimated 300 to 500 thousand Atlantic salmon returned to U.S. rivers to spawn (Fay *et al.*, 2006). However, from 1967 to 2017, the number of adults returning to U.S. rivers ranged from approximately 450 to 5,311, with the majority returning to the Penobscot River, located approximately 20 miles west of the Union River (USASAC, 2015; 2017; 2018; see Figure 26).[192] Additionally, the majority of returning adults originated from hatcheries as part of restoration programs (USASAC, 2018; see Figure 26).

[192] On average, 75 percent of adult salmon returning to U.S. rivers were stocked as smolts into the Penobscot River

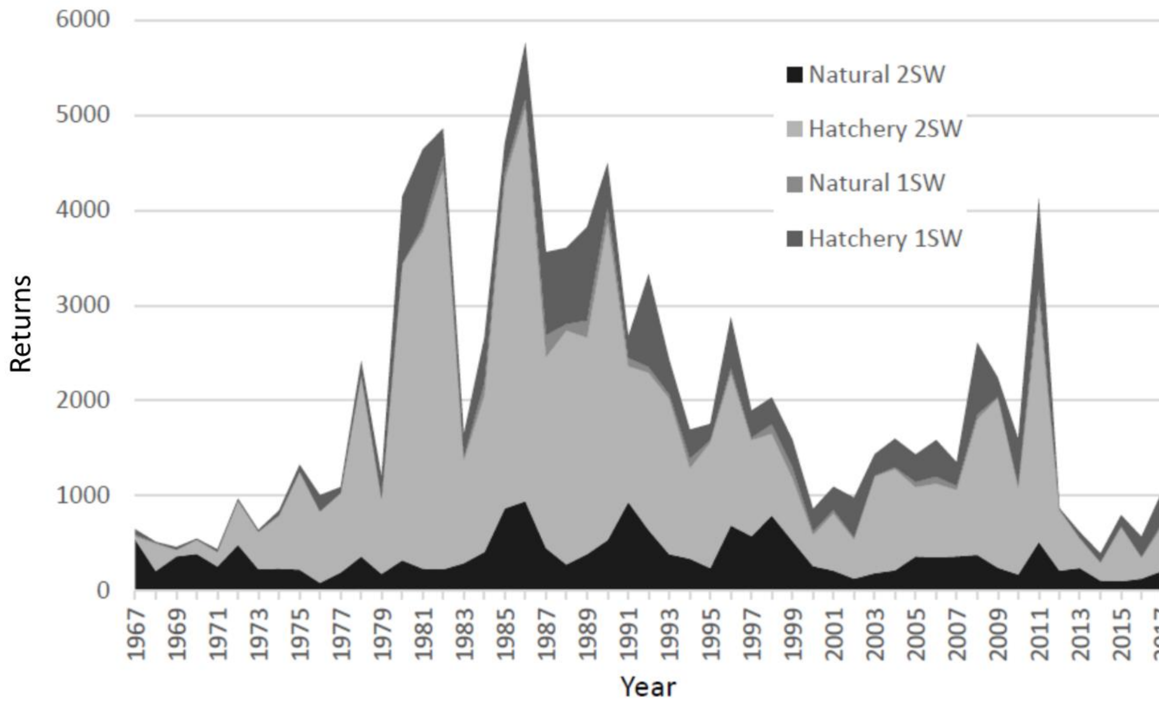

Figure 26. Annual returns of adult Atlantic salmon to U.S. rivers. "Natural" fish were spawned in rivers, and "hatchery" fish were produced in hatcheries and stocked as part of restoration programs. "1SW" and "2SW" indicate how many winters the fish spent in the ocean before returning to spawn (Source: USASAC, 2018).

The URFCC 2015 Comprehensive Fisheries Management Plan states that the potential run size for the Union River is 250 to 750 fish, assuming that the habitat in the Union River watershed produces 3 smolts per 100 m^2 and a smolt-to-adult return rate (SAR) of one to three percent (URFCC, 2015). However, that estimate appears to be based on 8,333 habitat units rather than 14,341. In addition, recent SAR estimates based on naturally reared smolts from the nearby Narraguagus River has ranged from 0.51 to 1.91 percent with a mean of 0.96 percent.[193] Based on 14,341 habitat units and a SAR of 0.51 to 1.91 percent, the Union River salmon run could range from 219 to 822 fish.

The number of adult anadromous Atlantic salmon returning to the Union River since 1987 has ranged from 0 to 72 with a mean of 12 (see Table 26). Adult anadromous Atlantic salmon collected are inspected by Maine DMR personnel to determine their origin. Aquacultured salmon are returned to the river downstream of the dam, and non-aquacultured salmon are trucked upstream and released into the West Branch of the Union River (approximately 17 miles upstream of Ellsworth Dam) and released. Black

[193] The Narraguagus River is approximately 23 miles east of Graham Lake and is part of the Downeast SHRU.

Bear Hydro (2015b) states this process takes one to two hours. In addition, salmon fry, parr, smolts, and adults have been stocked into the West Branch of the Union River at different times since 1970 (URFCC, 2015; see Table 27). FWS discontinued stocking of smolts and parr due to low adult return rates, budget shortfalls, and shifting program priorities (URFCC, 2015).

Table 26. Number of adult Atlantic salmon collected at the Ellsworth Project from 1973 to 2017.

Year	Aquaculture Origin	Hatchery Origin	Wild or Stocked Fry	Total
1973-1986	0	1,892	4	1,896
1987	undetermined	63	0	63
1988	undetermined	45	2	47
1989	undetermined	30	0	30
1990	undetermined	21	0	21
1991	undetermined	2	6	8
1992	undetermined	4	0	4
1993	undetermined	0	0	0
1994	undetermined	0	0	0
1995	undetermined	0	0	0
1996	undetermined	68	1	69
1997	undetermined	8	0	8
1998	undetermined	13	0	13
1999	63	6	3	72
2000	3	2	0	5
2001	2	0	0	2
2002	6	5	0	11
2003	0	1	0	1
2004	0	1	1	2
2005	4	0	0	4
2006	0	0	0	0
2007	0	0	0	0
2008	0	0	0	0
2009	0	0	0	0
2010	0	0	0	0
2011	0	0	0	0
2012	3	0	0	3
2013	0	0	1	1
2014	0	1	1	2
2015	0	0	0	0
2016	0	0	0	0
2017	0	0	0	0

(Source: Black Bear Hydro, 2015b).

Table 27. Numbers of Atlantic salmon fry, parr, smolts, and adults stocked in the Union River watershed.

Year	Fry	Parr	Smolt	Adults*
1970-1974	0	0	65,700	0
1975	0	0	31,300	0
1976	0	0	33,600	0
1977	0	0	35,500	0
1978	0	0	31,900	0
1979	0	0	42,800	0
1980	0	0	30,600	0
1981	0	0	29,400	0
1982	0	0	32,400	484
1983	0	0	41,600	474
1984	0	0	50,200	229
1985	7,000	0	45,800	229
1986	7,000	0	48,400	875
1987	7,000	0	40,100	0
1988	0	0	30,600	0
1989	0	0	20,400	0
1990	0	0	20,400	0
1991	0	0	0	0
1992	0	0	0	0
1993	60,000	111,700	0	0
1994	0	0	0	0
1995	0	54,800	0	0
1996	0	53,500	0	0
1997	12,000	69,300	0	0
1998	165,000	0	0	0
1999	165,000	82,100	0	0
2000	0	0	0	0
2001	2,000	0	0	0
2002	5,000	0	0	0
2003	3,000	0	0	0
2004	3,000	0	0	0
2005	2,000	0	0	0
2006	2,000	0	0	0
2007	22,000	0	0	0
2008	23,000	0	0	0
2009	28,000	0	0	0
2010	19,000	0	0	0
2011	19,000	0	0	288

Year	Fry	Parr	Smolt	Adults*
2012	**	0	0	0
2013	**	0	0	0
2014	23,000	0	0	0
2015	23,865	0	0	0
2016	26,069	0	0	0

*All adults were surplus hatchery broodstock.
**No fry were stocked in 2012 and 2013 because 288 adults stocked in the West Branch of the Union River in 2011 had successfully spawned.
(Source: URSG, 2000; URFCC, 2015; 2016; 2017).

Upstream Passage

The upstream trap and truck facility at the Ellsworth Development was constructed in 1974 to provide a supplemental source of Atlantic salmon broodstock to contribute to the restoration of the Penobscot River and other rivers (Baum, 1982). Broodstock collection was terminated in 1991 (USASAC, 1992). As shown in Table 26, catches of hatchery-origin salmon have shown a sharp decline since 1987.

Black Bear Hydro operates the trap and truck facility for Atlantic salmon from early May to late October (Black Bear Hydro, 2015b). The trap and truck facility consists of an approximately 36-foot-long vertical slot fishway leading to a 420-cubic foot holding pool that contains a 61-cubic foot hopper with metal sides. The hopper is lifted from the trap pool using a hoisting structure and emptied into a 66-cubic foot, rectangular holding tank on a trailer (Black Bear Hydro, 2015c). The tank is then towed to the release site in the West Branch of the Union River.

The operation of the trap and truck facility during the Atlantic salmon upstream migration period has varied since 1974 in terms of the period of operation and the frequency of operation. Operation has typically begun in May with the beginning of the river herring upstream migration period, and has continued until October or mid-November for Atlantic salmon. From 1976 to 1981, the trap was operated for one to two days per week for approximately two to six hours per day (Baum, 1982). No operation data are available for 1982 to 2000.[194] Based on the annual URFCC reports, Black Bear Hydro has consistently operated the trap and truck facility primarily during the morning and early afternoon during each day of operation since 2000, but the duration of operation has ranged from 6.5 hours during each day of operation from 2000 to 2004 to four hours from 2007 to 2009. From 2010 to 2012, the trap and truck facility operated

[194] In its revised study plan (Black Bear Hydro, 2013b), Black Bear Hydro stated that no information about the operation of the trap and truck facility prior to 2000 is available.

approximately five hours each day. Furthermore, the total number of days Black Bear Hydro operated the facility during the salmon upstream migration period has varied from 7 to 62 days.

In addition, the operation of the trap and truck facility can be limited by water temperature. To reduce the stress experienced by salmon during the trap and truck process, Maine DMR prohibits the handling and upstream transport of salmon when the water temperature exceeds 73.4 °F.[195] The trap may not be operated when water temperature exceeds 77 °F. The operating protocol can greatly reduce the number of days the facility operates during the Atlantic salmon upstream passage season. For example, water temperatures exceeded 73.4 °F for most of August and September of 2015 (Black Bear Hydro, 2015c). Furthermore, an average of 24.6 percent of the salmon collected at the trap and truck facility at the former Veazie Project on the Penobscot River between 1978 and 2012 were collected when the water temperature exceeded 73.4 °F.[196] Therefore, the upstream migration for salmon in the Union River would be delayed under these conditions.

Downstream Passage

Black Bear Hydro operates downstream fish passage facilities at both Graham Lake Dam and Ellsworth Dam. Downstream fish passage at Graham Lake Dam is currently provided by the normal operation of: (1) three 20-foot-wide Tainter gates; and (2) a 4-foot-wide by 7.5-foot-deep surface-oriented bypass weir (Alden weir)[197] located on the west-end of the spillway, 16.2 feet above the tailwater, capable of releasing flows up of at least 50 cfs. Black Bear Hydro operates the Alden weir from April 1 through December 31 each year to provide a surface-oriented means for migrating fish to pass downstream of the dam. Flows from the Alden weir and Tainter gates discharge into an

[195] *See* Maine DMR's Union River Atlantic salmon trap operating and fish-handling protocols, filed with the 2006 URFCC report on March 7, 2007.

[196] *See* Maine DMR's July 1, 2013 letter.

[197] *See* description of an Alden weir in the "Downstream Eel Passage" section above. In the spring of 2017, Black Bear Hydro modified the existing bypass weir in the log sluice by adding a sloped floor, two side panels, and a bell shaped entrance to create an Alden weir to enhance downstream fish passage based on the results of the 2016 Salmon Smolt Survival Study, which indicated that existing bypass weir had low passage efficiency and high mortality (41 percent). The Commission has not issued an amendment order requiring permanent installation of the Alden weir and the Union River Comprehensive Management Plan does not provide specific guidance on the installation of the Alden weir to improve downstream fish passage.

approximately 9.5-foot-deep natural plunge pool in the Union River below the dam. The 4-foot-wide overflow weir discharges approximately 150 to 200 cfs into the plunge pool.

Black Bear Hydro operates a downstream fish passage facility[198] at Ellsworth Dam for river herring and Atlantic salmon from April 1 through December 31 of each year. The existing downstream fish passage facility consists of three, 3-foot-wide surface weirs that are located on either side of the west powerhouse intake to Units 2, 3, and 4, and between the east powerhouse intake for Unit 1 and the overflow spillway of the Ellsworth Dam. Fish pass from the eastern surface weir directly to a flume that transports the fish down the face of the spillway into a natural plunge pool at the toe of the dam in the tailrace. Fish that enter the two weirs at the west powerhouse intake are conveyed through a 30-inch-diameter downstream migrant pipe that crosses the downstream face of the non-overflow section of the dam and discharges directly into the flow from the eastern surface weir and the spillway flume, just below the dam crest elevation. The weirs at the western powerhouse intake are 53 feet apart and the weir at the eastern powerhouse intake is approximately 120 feet apart from nearest weir at the western powerhouse intake. Black Bear Hydro opens the western surface weirs approximately 21 inches to pass approximately 20 cfs from each weir. Black Bear Hydro opens the eastern surface weir approximately 17 inches to provide an attraction and conveyance flow of 16 cfs. The downstream fish passage facility also includes a recirculating pump that is capable of returning up to 35 cfs of the 40 cfs conveyance flow from the two western surface weirs to the headpond. Under normal operation, Black Bear Hydro maintains a 12-cfs conveyance flow through the 30-inch downstream migrant pipe. The conveyance flow from the eastern surface weir (16 cfs) and conveyance flow from the downstream migrant pipe (12 cfs) combine just below the crest elevation of the dam to transport migrants down the spillway flume. The spillway flume is 48-inches wide with 18-inch high steel sidewalls and a hard plastic bottom. The spillway flume empties into a plunge pool at the base of the spillway.[199]

The intakes for Units 2 through 4 have trashracks with 1-inch clear spacing for the top approximately 6.75 feet of the trashrack, and 2.37-inch clear spacing for the bottom 7 feet for Units 2 and 3 and for the bottom 9 feet for Unit 4. Unit 1 has 2.44-inch clear

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[198] The downstream fish passage facility was constructed in 1989 and became operational in 1990. *See Bangor Hydro-Electric Company*, 66 FERC ¶ 62,079 (1994).

[199] In its October 10, 2018 response to Commission staff’s request for additional information, Black Bear Hydro explains that it does not have drawings of the river bed at the base of the spillway to confirm the depth of the plunge pool, but “the minimum depth of the plunge pool appears to be several feet with a potential depth of approximately 12 feet.”

spacing for the full depth of the trashrack. Black Bear Hydro operates the downstream fish passage facilities at both dam from April 1 to December 31.

Recovery Plans

The 2005 Final Recovery Plan for the Atlantic Salmon Gulf of Maine DPS (NMFS and FWS, 2005) presents a strategy for recovering Atlantic salmon listed as endangered under ESA in 2000. A 2018 final recovery plan addresses recovery within the expanded range of the Gulf of Maine DPS of Atlantic salmon described in the 2009 final rule (FWS and NMFS, 2018).

The 2018 Final Recovery Plan for the Gulf of Maine DPS of Atlantic salmon reflects a new recovery planning approach (termed the Recovery Planning and Implementation) that focuses on the three statutory requirements in the ESA, including site-specific recovery actions; objective, measurable criteria for delisting; and time and cost estimates to achieve recovery and intermediate steps. The Final Recovery Plan is based on two premises: (1) recovery must focus on rivers and estuaries located in the Gulf of Maine DPS until threats in the marine environment are better understood; and (2) survival of Atlantic salmon in the Gulf of Maine DPS depends on conservation hatcheries through much of the recovery process (FWS and NMFS, 2018). The main objective of the final recovery plan is to maintain self-sustaining, wild populations with access to sufficient suitable habitat in each salmon habitat recovery unit (SHRU), and ensure that necessary management options for marine survival are in place. In addition, the plan seeks to reduce or eliminate all threats that either individually or in combination might endanger the Gulf of Maine DPS (FWS and NMFS, 2018).

The final recovery plan includes a table that generally identifies the priority, timing, and involved parties for the various actions, and states that annual decisions made about recovery priorities will be formulated in SHRU-level workplans (FWS and NMFS, 2018). SHRU-level workplans provide the basis for determining activities that should be implemented in the short term for each of the plan’s recovery actions. The eight categories of recovery actions include:

- *Habitat Connectivity*, intended to enhance connectivity between the ocean and freshwater habitats important for salmon recovery;

- *Freshwater Conservation*, intended to increase adult spawners through the freshwater production of smolts;

- *Marine and Estuary*, intended to increase survival in these habitats by increasing understanding of these salmon ecosystems and identifying the location and timing of constraints to the marine productivity of salmon in support of management actions to improve survival;

- *Outreach, Education, and Engagement*, intended to collaborate with partners and engage interested parties in recovery efforts for the Gulf of Maine DPS

- *Federal/Tribal Coordination*, intended to facilitate consultation with all involved Tribes on a government-to-government basis;

- *Conservation Hatchery*, intended to increase adult spawners through the conservation hatchery program;

- *Genetic Diversity*, intended to maintain the genetic diversity of Atlantic salmon populations over time; and

- *Funding Program Actions,* intended to identify funding programs that support State, local, and NGO conservation efforts that benefit Atlantic salmon recovery (FWS and NMFS, 2018).

Recovery actions outlined in the Downeast SHRU workplan (NMFS and FWS, 2016b) that are potentially relevant to the Ellsworth Project include:

- Continue to provide fry to the Union River Salmon Association to support stock rebuilding efforts in the Union River.

- Ensure hydropower operation at the Ellsworth Dam minimizes harm to Atlantic salmon and adverse effects to their Critical Habitat.

- Ensure operation of the Graham Lake Development minimizes harm to Atlantic salmon and adverse effects to their Critical Habitat.

- Develop a stock rebuilding and management plan for the Union River.

Atlantic and Shortnose Sturgeon

The threatened Gulf of Maine DPS of Atlantic sturgeon and the endangered New York Bight DPS of Atlantic sturgeon (both listed in February 2012) have the potential to occur in the Union River downstream of Ellsworth Dam. The endangered shortnose sturgeon (listed in March 1967) also has the potential to occur in the Union River downstream of the Ellsworth Dam. There is no critical habitat for either sturgeon species in the Union River.[200] Both species are anadromous and their range of distribution includes (but is not limited to) the portion of Maine where the Union River meets the Atlantic Ocean. The main difference in the life histories of the two species is that shortnose sturgeon often remain in rivers or near river mouths for their entire lives,

[200] *See* NMFS's April 10, 2018 letter.

whereas Atlantic sturgeon usually migrate long distances north and south along the Atlantic coast after spending several years in estuarine habitat reaching maturity.

According to Black Bear Hydro, NMFS and the University of Maine have maintained an array of acoustic telemetry receivers along the coast of Maine since 2008 to detect passing fish that have been tagged by the University of Maine with acoustic tags. No acoustically tagged Atlantic sturgeon have been detected in the Union River, but the species has been observed in the river by state fishery personnel. One acoustically tagged shortnose sturgeon was detected in the Union River in 2014 downstream of the City of Ellsworth. NMFS states that neither Atlantic nor shortnose sturgeon are believed to have had access historically to habitat upstream of Ellsworth Falls, which was located in the vicinity of the Ellsworth Dam. NMFS also notes that the project fishtrap has been operated since 1974 without any records of the Atlantic or shortnose sturgeon being trapped.

Northern Long-eared Bat

The northern long-eared bat (NLEB) was listed as a federally threatened species under the ESA on May 4, 2015. Maine has also designated the NLEB as an endangered species. In January 2016, the FWS finalized the 4(d) rule for this species, which focuses on preventing effects on bats in hibernacula associated with the spread of white-nose syndrome[201] and effects of tree removal on roosting bats or maternity colonies (FWS, 2016b). As part of the 4(d) rule, FWS proposes that take incidental to certain activities conducted in accordance with the following habitat conservation measures, as applicable, would not be prohibited: (1) occurs more than 0.25 mile from a known, occupied hibernacula; (2) avoids cutting or destroying known, occupied maternity roost trees during the pup season (June 1 – July 31);[202] and (3) avoids cutting or destroying any tree within a 150-foot radius of a known, occupied maternity tree during the pup season. The 4(d) rule provides flexibility to landowners, land managers, government agencies, and others as they conduct activities in areas that could be NLEB habitat.

Traditional ranges for the NLEB include most of the central and eastern U.S., as well as the southern and central provinces of Canada, coinciding with the greatest abundance of forested areas. The NLEB, whose habitat includes large tracts of mature, upland forests, typically feeds on moths, flies, and other insects. These bats are flexible

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[201] A hibernaculum is where a bat hibernates over the winter, such as in a cave. White-nose syndrome is a fungal infection that agitates hibernating bats, causing them to rouse prematurely and burn fat supplies. Mortality results from starvation or, in some cases, exposure.

[202] Pup season refers to the period when bats birth their young.

in selecting roost sites, choosing roost trees that provide cavities and crevices, and trees with a diameter of 3 inches or greater at breast height.[203] Winter hibernation typically occurs in caves and areas around them that can be used for fall swarming[204] and spring staging.[205] No critical habitat has been designated for this species.

The project is located within the white-nose syndrome buffer zone for this species.[206] Although there is no documentation of NLEB at the project, NLEB have been identified approximately 20 miles from the project at Acadia National Park in recent years (Divoll, 2013), and the project vicinity contains mature, upland forest that could provide suitable habitat for NLEB summer roosting and foraging activities.

3.3.4.2 Environmental Effects

Atlantic Salmon

Operational Effects on Atlantic Salmon Habitat

Atlantic salmon habitat could be affected by minimum flow releases from the project and the range of water elevations within the project impoundments. Black Bear Hydro proposes to continue releasing a minimum flow of 105 cfs from July 1 to April 30 and 250 cfs from May 1 to June 30 during the term of any new license. Commerce's section 18 prescription and Maine DMR's section 10(j) recommendation would require a total downstream fishway flow of 5 percent of the project's maximum station hydraulic capacity (123 cfs) from April 1 to December 31 of each year. Interior also prescribes a flow of 123 cfs from the downstream fish passage facility, but recommends a minimum

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[203] Diameter at breast height refers to the tree diameter as measured about 4 to 4.5 feet above the ground.

[204] Fall swarming fills the time between summer and winter hibernation. The purpose of swarming behavior may include: introduction of juveniles to potential hibernacula; copulation; and gathering at stop-over sites on migratory pathways between summer and winter regions.

[205] Spring staging is the time period between winter hibernation and migration to summer habitat. During this time, bats begin to gradually emerge from hibernation and exit the hibernacula to feed, but re-enter the same or alternative hibernacula to resume daily bouts of torpor (*i.e.*, a state of mental or physical inactivity).

[206] The white-nose syndrome buffer zone encompasses counties within 150 miles of a U.S. county or Canadian district in which white-nose syndrome or the fungus that causes white-nose syndrome is known to have infected bat hibernacula.

flow of 250 cfs from May 1 to June 30 and 105 cfs from July 1 to April 30, consistent with Black Bear Hydro's proposal.

Agency and stakeholder recommendations regarding impoundment drawdown limits for Graham Lake and minimum flows are discussed fully in section 3.3.2.2, *Aquatic Resources*, *Environmental Effects*.

Our Analysis

Atlantic Salmon Critical Habitat

The majority of salmon critical habitat in the project area is in the West Branch of the Union River (Baum, 1992), but other Graham Lake tributaries may contain suitable spawning and rearing habitat for salmon. As discussed in section 3.3.2.1, *Impoundment Habitat*, the tributaries to Graham Lake, including the West Branch of the Union River, are accessible for adult salmon as long as the water surface elevation remains above 97 feet msl (*i.e.*, PCE 8 as discussed in section 3.3.4.1, *Critical Habitat*) (see Table 7). Water surface elevation of Graham Lake is typically above 97 feet msl from May through August, at which point nearly 90 percent of the adult salmon returning to the Union River have returned (Baum, 1997). However, as discussed in section 3.3.2.2 *Impoundment Levels*, water surface elevations may drop below 97 feet msl during the upstream migration period in some years, which may negatively affect tributary access.

As discussed in section 3.3.2.2, *Minimum Flows*, the existing license requires Black Bear Hydro to provide a minimum flow of 105 cfs from July 1 to April 30 and 250 cfs from May 1 to June 30. Under current operation, flow exceeds 105 and 123 cfs 100.0 percent of the time, and 250 cfs about 87.5 percent of the time, based on data from generation releases. Based on the annual flow duration curve calculated from area-prorated flows from the Narraguagus River, flow entering Graham Lake exceeds 105 cfs about 96.9 percent of the time, 123 cfs about 95.3 percent of the time, and 250 cfs about 82.9 percent of the time.[207] Therefore, flow will be higher than these required and recommended minimum flows most of the time under current operation.

DSF recommends that Black Bear Hydro operate the project in run-of-river mode. However, under a year-round run-of-river operational mode, flows could drop below 105 cfs in August and September (see Table 17). If flows drop below 105 cfs during that

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[207] There are no stream gages on the Union River. Therefore, staff calculated flow statistics using data collected from 1971 through 2016 at U.S. Geological Survey gage no. 01022500, located on the Narraguagus River in Cherryfield, Maine (approximately 23 miles east of Graham Lake). Staff prorated the Narraguagus River flow data by a factor of 2.14 to compensate for the difference in drainage area at Graham Lake Dam (486 square miles) and the USGS gage (227 square miles).

time, wetted habitat in downstream areas would decrease relative to existing conditions, and shallow areas of the Union River between the project impoundments could potentially reduce the availability of safe passage routes for adult salmon during those months.

As discussed in section 3.3.2.1, *Water Quality*, the water quality study conducted by Black Bear Hydro demonstrates that stratification occurs in both Lake Leonard and Graham Lake, but dissolved oxygen concentrations are typically greater than 7 mg/L in most of the water column and should not impede upstream or downstream migration (*i.e.*, PCE 8 and PCE 11, as discussed above). Water temperatures in Lake Leonard, the Union River between Lake Leonard and Graham Lake, and Graham Lake do exceed 73.4 °F for periods in July and August, which can be stressful or lethal for salmon migrating upstream (PCE 9). However, Baum (1997) reported that 65 percent of adult salmon returning to the Union River returned to the project area prior to July, which suggests exposure to stressful temperatures should be limited for most of the returning adult salmon.

As discussed in detail below, Black Bear Hydro proposes to develop and maintain upstream fishways and modify existing downstream fishways for Atlantic salmon, and ensure the fishways meet performance standards of 90 percent effectiveness for upstream migrating adults and 90 percent survival for downstream migrating smolts and kelts. Maintaining an upstream and downstream rate of passage at the level of the proposed performance standards would provide timely passage for the GOM DPS, and improve migration habitat for Atlantic salmon migrating through the project area (*i.e.*, PCE 8 and PCE 11, as discussed above).

Atlantic Salmon Essential Fish Habitat

Essential fish habitat for Atlantic salmon is present both upstream and downstream of the Ellsworth Project, and Atlantic salmon use habitat in the immediate vicinity of the project for migration and potentially for spawning and rearing upstream of Ellsworth and Graham Lake dams. As the discussion above on critical habitat indicates, proposed project operation would maintain the water quality, flow, and habitat conditions generally capable of supporting spawning and rearing upstream of the project dams. The proposed enhancements to the upstream and downstream fish passage facilities, including meeting 90 percent effectiveness standards, would provide safe, timely, and efficient passage of all life stages of Atlantic salmon. Furthermore, maintaining passage at the proposed performance standards would provide necessary passage requirements for the GOM DPS and would improve migration habitat for Atlantic salmon migrating through the project area. Therefore, over the term of the license, aquatic habitat and EFH would be enhanced under the applicant's proposal. The additional staff modifications and measures discussed in section 5.2, *Comprehensive Development and Recommended Alternative*, which are supported in section 3.3.2.2, *Aquatic Resources,* and in sections above, would further support EFH.

Upstream Passage

Black Bear Hydro proposes to continue to maintain and operate the existing fishway trap and truck facilities at Ellsworth Dam until 15 years after license issuance, at which time it proposes to install new upstream passage measures for Atlantic salmon at both the Ellsworth and Graham Lake dams. Black Bear Hydro proposes to operate the upstream fish passage facilities from May 1 to October 31 of each year.

In its fishway prescription, Commerce requires that Black Bear Hydro design and install a "state of the art swim-through fishway" to replace the trap and truck facility at the Ellsworth Dam, such as a vertical slot, Denil, or Ice Harbor fishway, or a fish lift. The prescription requires installation and operation of effective upstream swim-through passage structures for Atlantic salmon at the Graham Lake Dam and Ellsworth Dam no later than year 15 of any new license. Commerce states that Black Bear Hydro must continue to operate the existing fishway trap and truck facility until the new fishways are operational. The prescription requires that the upstream fishways be operational from May 1 to November 15 of each year.

DSF recommends that volitional, 24-hour upstream fish passage suitable for adult Atlantic salmon be operational at the Ellsworth and Graham Lake dams within 2 years of license issuance.

Our Analysis

Access to the Union River for migratory fish species, including Atlantic salmon, has been restricted since the first dams were constructed on the river in the late 1700s (NMFS, 2009a). The existing upstream passage facility at the Ellsworth Development was completed in 1974 to, among other things, trap and transport Atlantic salmon to critical habitat located upstream of Ellsworth Dam.

Effects of Existing Fishway Facility

Despite decades of stocking efforts (see Table 27) and efforts to provide upstream passage, only 10 adult Atlantic salmon have been collected at the fishway trap and truck facility since 2005. Out of these 10 individuals, seven originated from aquaculture and one originated from a hatchery. Only two individuals were wild or previously stocked upstream of the project, and no individuals were collected for nine of the years between 2005 and 2017. Commerce states that poor returns have been attributed to inadequate upstream and downstream passage at the Ellsworth Dam. Below, we discuss potential ongoing project effects on the upstream migration of Atlantic salmon. These include possible issues with the existing fishway's ability to attract and efficiently move salmon, periods when the fish trap is not operated due to water temperature restrictions or unavailability of trap and truck operators, and the possible occurrence of fallback behavior for salmon that are trapped and trucked.

Commerce indicates that the upstream fishway might not be effective at detecting and passing salmon upstream of the project. Commerce states that data from the Ellsworth Dam fish trap may underestimate the number of adult salmon returning to the Union River and that a larger salmon run may actually be present in the Union River. Given the number of fry stocked upstream of the project in the Union River, and an estimated 3 percent straying rate of salmon from other rivers (such as the nearby Narraguagus and Penobscot Rivers), Commerce estimates that the salmon run should consist of approximately 5 returns and 36 strays.

Commerce states that salmon might not be entering the fishway trap for passage, as intended. Although Commerce does not provide recent evidence for its statement, Baum (1982) stated that "salmon appear to be reluctant to enter [the] trap or stay in it very long due to flow patterns through it." Baum (1982) stated that salmon tended to hold in the pool below the trap and not enter the trap, so that fish had to be removed manually by draining the fishway. In 1978, at least 67 of the 147 salmon captured at the facility were netted out of the fishway pools below the trap.[208] From this report, it appears that there could be an issue with salmon not being successfully attracted to the trap, perhaps due to near-field flows experienced by salmon as they enter the fishway. However, the hopper has been replaced since the problems Baum (1982) reported, and no data is available to verify that there is an existing problem with the fishway trap. Prior to the replacement of the hopper, there was a known capture rate of 50 percent for salmon that approached the Ellsworth Dam (USASAC 1991). Although the new hopper may have better performance, there is no way to determine that because there are not enough salmon in the river to study the hopper's performance. At the same time, the upstream fish passage facility is successfully attracting and being used to pass hundreds of thousands of river herring each year (see Figure 13).

In the rationale for its prescription, Commerce states that effectiveness studies at the Ellsworth Dam will be required to test the efficiency of the existing fishway entrance to attract adult salmon. In its September 28, 2018 Atlantic salmon draft biological assessment and Species Protection Plan, Black Bear Hydro proposes effectiveness studies for the existing fishway that it recently developed in consultation with resource agencies, including Commerce's National Marine Fisheries Service (see section 3.3.2.2, *Aquatic Resources, Environmental Effects*). As discussed in section 3.3.2.2, the effectiveness studies would provide the basis for an adaptive management approach to modifying the design or operation of the existing fishway in the event that problems related to attraction or passage efficiency are identified. Some modifications that may be appropriate could

[208] *See* NMFS's April 10, 2018 letter.

include, but are not limited to, relocating the entrance of the fishway, modifying the fishway entrance or riverbed in the vicinity of the entrance to improve near-field hydraulics, modifying internal fishway structures, or modifying the flow through the fishway.

Apart from potential issues involving salmon attraction to the fishway trap, Commerce references the fact that the existing fishway is not operated when water temperatures are above 73.4 degrees Fahrenheit. While this may successfully avoid handling stress, as intended, it is also an additional potential source of migratory delay during periods when the fishway and trap are not being operated. Separately, a known issue with trap and truck type fish passage is the fallback rate. Studies have shown that some adult Atlantic salmon drop back downstream from their upstream release site after being trapped and trucked. On the Penobscot River, Sigourney et al. (2015) reported a 2.4 to 2.6-percent fallback rate for trucked salmon and on the Piscataquis River, nearly half of the study fish moved downstream rather than upstream following their release (Spencer et al., 2011). Although some of the Piscataquis salmon eventually moved back upstream, both of these studies demonstrate that trapped and trucked salmon may experience migration delays due to fallback behavior.

Although migration delay associated with the existing fishway trap facility could affect the success of upstream passage, the delay would be at least partially offset when the salmon are trucked upstream and released into the West Branch of the Union River (approximately 17 miles upstream of Ellsworth Dam). As discussed above, transporting river herring from the fishway trap to the Graham Lake release site only takes an average of 12.5 minutes (see Table 9). The transportation time for salmon, which are released upstream of Graham Lake at Goodwin's Bridge on the West Branch of the Union River, is also expected to be less than half an hour. In comparison, at an average migration speed of .62 miles per hour (Izzo et al. 2016), it would take 27 hours for salmon to travel approximately 17 miles upstream.

Effects of New Swim-Through Fishways

For the reasons described above, Commerce's prescription states that the existing facility is insufficient at passing salmon and needs to be replaced with new swim-through fishways at each project dam. However, Commerce states the following in the rationale for its prescription:

> "effectiveness studies at the Ellsworth Dam will be required to test the efficiency of the existing fishway entrance to attract adult salmon. If the existing entrance cannot attract and successfully pass the required proportion of adults than [*sic*] a new fishway should be sited based on the results of the telemetry studies and constructed as required."

In the draft EA, staff interpreted Commerce's prescription to mean that a new fishway would only be required if the existing trap and truck facility was shown to be inefficient at attracting and passing adult salmon. However, in comments filed by Commerce on February 15, 2019, it clarified that this interpretation of its section 18 prescription was incorrect. Commerce stated that even if the existing trap and truck facility entrance is determined to be highly effective at attracting salmon, only the entrance of the existing facility could be incorporated into the new fishway design. The existing trap and truck facility would not be permitted by Commerce to continue operating in lieu of the new fishway prescribed.

On the other hand, to the extent that the effectiveness study demonstrates that the existing trap and truck facility does not currently attract and successfully pass adult salmon, and that the facility could not be modified to effectively pass salmon, then new swim-through fishways could be used to increase the effectiveness of upstream passage for Atlantic salmon returning to the Union River. Vertical slot, Denil, and Ice Harbor fishways have been proven to be successful at providing safe, effective, and timely passage for Atlantic salmon at hydroelectric projects, and would not require a fishway operator to be present. Although a fish lift would require an operator to be present, this type of fishway has also been successfully used for Atlantic salmon, most notably at the Milford Project No. 2534 on the Penobscot River, which has the largest Atlantic salmon run in the United States.

The effect of any new fish passage facility on the GOM DPS of endangered Atlantic salmon is highly dependent on the success of Atlantic salmon restoration efforts in the Union River during the term of any new license. Salmon returns in the Union River have been minimal in recent years despite stocking efforts upstream of the project (see Table 26 and Table 27). As discussed above, modifying the downstream fish passage facilities and adding protective measures to reduce turbine mortality at the Ellsworth Dam would reduce project effects on out-migrating salmon smolts, which would likely increase the number of adult salmon returning to the Union River to spawn in future years. However, given the low abundance of Atlantic salmon in the Union River, and the interactive nature of the fry stocking program, downstream passage success at the project, run size, and upstream passage, Commission staff cannot predict the magnitude of the impact that new upstream fish passage facilities would have on improving populations of GOM DPS of endangered Atlantic salmon in future years.

One aspect of the new swim-through fishways that is not clear is whether operation of the existing fishway trap and truck facilities would be discontinued when the new facilities become operational. This could have implications for the management of both Atlantic salmon and alosines. If the existing fishway and trap remain operational, but the new swim-through fishways are better at attracting Atlantic salmon and alosines, then there could be a problem with overcrowding of the new fishways with alosines during May, June, and July. This potential problem could be overcome either by designing the fishway so that only the stronger-swimming salmon (but not the alosines) could navigate the new swim-through fishways, or by sizing the new swim-through fishways so that they can accommodate both salmon and alosines during the months when their runs overlap (May through July). If the new fishways are intended to pass both salmon and alosines, then the new fishways would need to have a trapping and sorting facility so that alosines could be harvested for lobster bait, as they are now. However, if a trapping and sorting facility is included, then that could introduce a source of handling stress and injury, as well as migration delay, all of which could reduce the potential benefits of constructing and operating the new swim-through fishways.

Timing of New Swim-Through Fishway Construction

Black Bear Hydro proposes to install the new upstream fish passage facilities within 15 years after license issuance, consistent with Commerce's fishway prescription; whereas, DSF recommends that upstream fish passage facilities be operational within 2 years of license issuance. In addition, Black Bear Hydro proposes and Commerce recommends that the existing upstream fish passage facility at the Ellsworth Project be operated and maintained during the interim period between issuance of any new license for the project and construction and operation of any new fishways.

The 15-year delay recommended by Commerce relates to several factors, including: (1) the time necessary to implement and test the effectiveness of prescribed downstream passage measures at Ellsworth and Graham Lake dams (approximately 6 years); (2) the time between experimental stocking of marked smolts and the resulting anticipated adult salmon returns (approximately 2 years, assuming smolts are available); (3) the time necessary to test the efficiency of the existing Ellsworth fishway at attracting and passing adult salmon (approximately 4 years);[209] and (4) the time necessary to evaluate the results of (1), (2), and (3) and incorporate learned information into the final design of the swim-through fishways.[210] Commerce states that with the known high rate of downstream smolt mortality at the project, it is prudent to improve downstream passage survival of smolts before focusing on improved passage of adult salmon upstream. Commerce estimates that 15 years should be sufficient time to confidently design and operate the new swim-through fishways.

Ultimately, the best case scenario for Atlantic salmon is to have safe, timely, and effective downstream and upstream passage at the project as soon as possible. As

[209] An analysis of the effectiveness testing of downstream and upstream Atlantic salmon passage measures is found in section 3.3.2.2, *Aquatic Resources, Environmental Effects*.

[210] The dates in this estimated timeline come from pages A-61 and A-62 of Commerce's modified fishway prescription, filed on April 23, 2019.

discussed above, the existing upstream passage facility might actually provide safe, timely, and effective upstream passage. Conducting an effectiveness study of the existing upstream passage facility within the next 10 years to assess the efficacy of the modified downstream passage facilities and the existing upstream passage facility would allow for an assessment of the effectiveness of the existing upstream facility using adult salmon that are returning to the Union River. Following the effectiveness study, additional time would be required to determine whether any modifications to the existing fishway trap and truck facility are needed, or whether new upstream passage facilities are needed to provide safe, timely, and effective upstream passage at the project. If the upstream passage facilities are determined to be necessary, then the siting, design, and construction of the upstream facility could be undertaken. Considering this timeline, DSF's recommendation to construct the swim-through fishways at both project dams operational within 2 years of license issuance could potentially result in the construction of facilities that would not significantly benefit the GOM DPS of Atlantic salmon.

Upstream Fishway Operating Season

Providing upstream salmon passage from May 1 to October 31, as proposed by Black Bear Hydro, would capture most of the salmon spawning runs, but would not provide passage for salmon that migrate later in the season. As discussed above in section 3.3.4.1 (*Threatened and Endangered Species, Affected Environment*), most adult Atlantic salmon enter Maine rivers during the spring and early summer (May-July), but upstream migrations can occur from April to early November (Baum, 1997). Commerce's prescription would require upstream passage to be provided for salmon from May 1 to November 15 of each year, which includes the early November timeframe for Atlantic salmon in Maine. Providing upstream fish passage one month earlier, from April 1 to November 15, would minimize the potential for adverse project effects on salmon passage, including effects associated with migration delay and obstruction to passage.

Downstream Passage

Graham Lake Development

Black Bear Hydro proposes to continue operating the Graham Lake Development as a water storage reservoir to support downstream generation at the Ellsworth Development and to meet minimum flow requirements of 250 cfs from May 1 to June 30 each year and 105 cfs from July 1 to April 30 each year. Black Bear Hydro proposes to modify the temporarily-installed Alden weir[211] by May 1 of the third year following

[211] Black Bear Hydro temporarily replaced the existing bypass weir in the log sluice at Graham Lake Dam with an Alden weir in the spring of 2017. An "Alden weir" is a surface-oriented flume with a large bell-shaped entrance that gradually slopes upward

issuance of any new license to accommodate a 3-foot depth of flow over the full range of reservoir elevations allowed in any new license issued by the Commission. Black Bear Hydro proposes to operate the modified bypass weir and Tainter gates at Graham Lake Development for downstream fish passage from April 1 through December 31.

Commerce's fishway prescription would require Black Bear Hydro to modify the Alden weir at Graham Lake Dam by May 1 of the third year of any new license to allow at least 3 feet of water over the weir under all headpond conditions to provide safe, timely, and effective downstream passage. Commerce's fishway prescription would require Black Bear Hydro to provide downstream passage from April 1 through December 31 or until the impoundment surface freezes over.

Interior's fishway prescription and Maine DMR's section 10(j) recommendation would require Black Bear Hydro to modify the existing downstream passage surface weir at Graham Lake Dam within 2 years of license issuance to allow at least 2 feet of water over the weir under all headpond conditions to provide safe, timely, and effective downstream passage conditions for all diadromous species. Interior and Maine DMR would require the construction and operation of an Alden weir, or a comparable weir design that provides a uniform accelerating flow through the weir. Interior's prescription would require Black Bear Hydro to operate the new downstream fish passage facility from August 1 through October 31 and to use the new downstream passage facility to pass the minimum flow required in any new license issued by the Commission. Maine DMR's recommendation would require Black Bear Hydro to operate the weir from April 1 through December 31 or until the impoundment surface freezes over. Interior's prescription and Maine DMR's recommendation would also require Black Bear Hydro to design, operate, and maintain the new downstream fish passage facility in a manner that is consistent with FWS's 2017 Fish Passage Engineering Design Criteria Manual (Design Criteria Manual; FWS, 2017).

Our Analysis

Atlantic salmon smolts migrating downstream past Graham Lake Dam can pass downstream over the surface bypass weir or through any of the development's three Tainter gates when they are releasing flow to provide generation at the Ellsworth Development or minimum flows to the downstream reach. There are no generating

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to create a uniform accelerating flow that conveys downstream migrating fish to a high-velocity (greater than 9 fps) bypass flow (Haro *et al*., 1998). The Commission has not issued an amendment order requiring permanent installation of the Alden weir and the Union River Comprehensive Management Plan does not provide specific guidance on the installation of the Alden weir to improve downstream fish passage.

facilities at the Graham Lake Development that could adversely affect smolts through entrainment into project turbines.

During May 2016 and 2017, Black Bear Hydro conducted studies to evaluate passage route selection, delay, and survival past the project dams for downstream migrating Atlantic salmon smolts. In 2016, Black Bear Hydro released tagged smolts with radio tags at three locations: approximately 5 miles upstream of Graham Lake in the West Branch of the Union River, approximately 0.75 mile upstream of Graham Lake Dam, and approximately 120 feet downstream of Graham Lake Dam. In 2016, Black Bear Hydro also released smolts tagged with acoustic tags at the release location downstream of Graham Lake Dam. For the 2017 study, Black Bear Hydro released tagged smolts with radio tags at three release sites: approximately 0.75 mile upstream of Graham Lake Dam, approximately 120 feet downstream of Graham Lake Dam, and downstream of Ellsworth Dam. In 2017, Black Bear Hydro also released acoustic-tagged smolts at the release sites downstream of Graham Lake Dam and Ellsworth Dam. Black Bear Hydro also installed an Alden weir at Graham Lake Dam in the spring of 2017 (Black Bear Hydro, 2017a).

<u>Graham Lake Dam Residency Time, Passage Survival, and Migration Rates</u>

In 2016, radio-tagged smolts migrating through Graham Lake experienced considerable delay and low survival during passage (see Table 28). The median transit time for smolts released in the West Branch of the Union River to reach Graham Lake Dam was over 100 hours while the median transit time for smolts released just upstream of the dam was over 40 hours. Once at the dam, 50 percent of the smolts had a residence time of less than 80 hours prior to passing downstream. Twenty-three of 100 smolts passed Graham Lake Dam, of which 14 survived passage and were detected 2.1 miles downstream.[212] However, the cause of mortality (*e.g.*, predation, passage-related mortality) cannot be determined from the radio-tag data.

[212] Black Bear Hydro did not provide any information about route selection at Graham Lake Dam for the 2016 study.

Table 28. Migration time, residence time, and survival of Atlantic salmon in Graham Lake during the 2016 downstream smolt passage study. "NR" indicates that Black Bear Hydro did not report those values.

Reach	Distance (miles)	Median Time (hours)	Range of Time (hours)	Number Surviving	Percent Surviving
West Branch release site to upper reach of Graham Lake	3.4	17.5	8.4-79.7	47 of 60	78.3
Upper reach of Graham Lake to Graham Lake Dam	11.3	117.8	30.4-288.9	41 of 47	87.2
Graham Lake release site to Graham Lake Dam	0.75	41.1	3.1-298.4	59 of 60	98.2
Passage at Graham Lake Dam	0.02	79.8	2.1-287.4	23 of 100	23.0
Survival through Graham Lake Dam to Union River near the Route 1A bridge	2.1	NR*	NR*	14 of 23	60.8

*Black Bear Hydro only reported the combined median transit times for smolts that passed the dam and the fish that were released directly in the tailrace. (Source: Black Bear Hydro, 2016 as modified by staff).

Transit time, residence time, and passage survival rates for 2017 are shown in Table 29. Transit times in Graham Lake in 2017 were similar to 2016, but residence time prior to passage was lower and passage survival was higher. Of the smolts released upstream of Graham Lake Dam, 104 of 120 smolts (86.7 percent) reached the dam in 2017. Of the 104 smolts that arrived at Graham Lake Dam in 2017, 86 smolts (82.7 percent) passed downstream, with 63 (73.3 percent) passing downstream via the Alden weir. The remainder passed undetected or through one of the Tainter gates. Of the smolts that passed through Graham Lake Dam, 90.7 percent survived passaged and were detected 2.1 miles downstream (Black Bear Hydro, 2017a).

Table 29. Migration time, residence time, and survival of Atlantic salmon in Graham Lake during the 2017 downstream smolt passage study. "NR" indicates that Black Bear Hydro did not report those values.

Reach	Distance (miles)	Median Time (hours)	Range (hours)	Number Surviving	Percent Surviving
Graham Lake release site to dam	0.75	39.2	5.5-305.6	104 of 120	86.7
Passage at Graham Lake Dam	0.02	5.6	0.1-118.1	86 of 104	82.7
Survival through Graham Lake Dam to Union River near the Route 1A bridge	2.1	NR*	NR*	78 of 86	90.7

*Black Bear Hydro only reported the combined median transit times for smolts that passed the dam and the fish that were released directly in the tailrace. (Source: Black Bear Hydro, 2017a, as modified by staff).

The migration rates Black Bear Hydro reported for smolts in Graham Lake and the Union River between Graham Lake and Lake Leonard the 2016 and 2017 studies (see Table 30) are generally consistent with the rates reported for Atlantic salmon smolts in different rivers throughout their geographic range (0.05 to 2.24 mph) (Ruggles, 1980; Stich *et al*., 2015b, Black Bear Hydro, 2018). Migration speed was slower in Graham Lake than in the Union River between Graham Lake Dam and Lake Leonard. In addition, there appears to be some delay associated with release because smolts released in the Graham Lake tailrace had lower migration speeds than fish released upstream of the dam in both years of the study (Graham Lake smolts versus tailrace smolts). Migration speed in the lower reach of Graham Lake appeared unaffected by the difference in streamflow between years. However, migration speed in the Union River downstream of Graham Lake Dam was higher in 2017, which may have resulted from the higher flow that year.

Table 30. Median migration speeds for radio-tagged smolts migrating from Graham Lake to the upper reach of Lake Leonard in 2016 and 2017. "Graham Lake smolts" refers to smolts released in Graham Lake or in the West Branch of the Union River. "Tailrace smolts" refers to smolts released in the Graham Lake tailrace.

Project Reach	**Distance (miles)**	**2016 Migration Speed (mph)**	**2017 Migration Speed (mph)**
West Branch release site to upper reach of Graham Lake	3.4	0.19 (0.04-0.40)	NA
Upper reach of Graham Lake to Graham Lake Dam	11.3	0.1 (0.04-0.37)	NA
Lower reach of Graham Lake to Graham Lake Dam	0.75	0.02 (0.01-0.24)	0.02 (0.01-0.14)
Graham Lake Dam to Union River near Route 1A bridge, for Graham Lake smolts	2.1	0.6 (0.03-1.23)	0.88 (0.06-1.81)
Graham Lake Dam to Union River near Route 1A bridge, for tailrace smolts		0.19 (0.02-0.93)	0.41 (0.01-0.95)
Union River near Route 1A bridge to upper reach of Lake Leonard, for Graham Lake smolts	0.5	0.77* (0.13-1.72)	1.54 (0.05-3.73)
Union River near Route 1A bridge to upper reach of Lake Leonard, for tailrace smolts		0.62 (0.01-1.85)	1.57 (0.01-3.47)

*Reported number is a weighted average of migration speed based on smolts released in the West Branch of the Union River and smolts released in Graham Lake.
(Source: Black Bear Hydro 2016; 2017a, as modified by staff).

Atlantic salmon smolt migration rates tend to be slower in lakes and impoundments than in free-flowing river reaches (Hansen *et al*., 1984; Holbrook *et al*. 2011; Stich *et al*., 2015b). Smolts migrating through Graham Lake and the Union River exhibited a similar pattern, as shown in Table 30. The similarity in the migration rates between the Graham Lake release site and Graham Lake Dam in 2016 and 2017 (*i.e.*, a median migration rate of 0.02 mph) despite a 2.5-fold difference in streamflow suggests that factors other than streamflow affect migration rates within Graham Lake.[213]

Based on previously-recorded data, it appears that smolts migrate through Graham Lake at a much lower rate than other impounded river systems. Stich *et al*. (2015b) reported smolts migrating at an average of 1.12 mph through reaches of the Piscataquis and Penobscot Rivers containing hydropower project headponds and 1.18 mph through reaches containing dams. The difference in smolt migration rates observed in Graham Lake compared to those reported by Stich *et al*. (2015b) do not appear to be directly related to project operation. Many of the hydropower projects in the study area of Stich *et al*. (2015b) operate in run-of-river mode.[214] The water surface elevations in Graham Lake were relatively similar and consistent during the 2016 and 2017 studies at approximately 103 feet msl (Black Bear Hydro 2016; 2017a), which suggests that Black Bear Hydro operated Graham Lake in a manner similar to run-of-river operation during the study periods. Therefore, the low migration rates observed in Graham Lake may be due to other environmental (*e.g.*, temperature or river gradient) or physiological factors (*e.g.*, smolt condition or developmental stage).

Delayed downstream passage at a dam can expose smolts to additional predation mortality (Poe *et al*., 1991) and may reduce the survival of smolts entering the estuary and ocean (McCormick *et al*., 1998; 1999). To quantify the extent of delay that is experienced by out-migrating smolts at Graham Lake Dam, Commission staff compared the fastest median smolt migration rates in the free-flowing Union River to the fastest median migration rates for smolts in Graham Lake for both 2016 and 2017 (see Table 30). Based on a free-flowing migration rate of 0.77 mph during the 2016 study, smolts would be expected to travel the approximately 80 feet between the telemetry receivers upstream and downstream of Graham Lake in approximately 1 minute and 34 seconds. With a free-flowing migration rate of 1.57 mph in 2017, smolts would be expected to travel the same distance in 46 seconds. Therefore, Graham Lake Dam delayed smolts by approximately 79.8 hours in 2016 and 5.6 hours in 2017. With regard to the smolt downstream passage season, FWS reviewed smolt trapping data collected by NMFS in the nearby Penobscot River from 2000 to 2005 and found that 74 percent of the

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[213] Mean flow during the 2016 study period was 478 cfs, which is slightly more than half of the long-term median flow for May of 900 cfs (Black Bear Hydro, 2016). Mean flow during the 2017 study was 1,190 cfs, which is 290 cfs higher than the long-term median flow for May (Black Bear Hydro, 2017a).

[214] The hydropower projects in the study area of Stich *et al*. (2015b) include the Mattaceunk Project (FERC No. 2520), the Howland Project (FERC No 2721), the West Enfield Project (FERC No. 2600), the Milford Project (FERC No. 2534), the Stillwater Project (FERC No. 2712), and the Orono Project (FERC No. 2710).

downstream migration occurs within 15 days (unpublished FWS data cited in Black Bear Hydro, 2012b). This suggests a delay of 79.8 hours could represent approximately 22.2 percent of the downstream migration season for most smolts, whereas a 5.6 hour delay represents only 1.6 percent of the passage season for most smolts.

Effect of Graham Lake Surface Bypass Weir on Passage

Based on the low passage efficiency and high salmon smolt mortality observed in 2016, Black Bear Hydro temporarily replaced the existing bypass weir in the log sluice with an Alden weir in the spring of 2017. Commerce's and Interior's fishway prescriptions and Maine DMR's section 10(j) recommendation would require Black Bear Hydro to modify the temporarily-installed Alden weir to provide safe, timely, and effective passage of Atlantic salmon and other migratory fish species at Graham Lake Dam. Commerce's prescription is consistent with Black Bear Hydro's proposal to modify the temporarily-installed Alden weir to allow at least 3 feet of water over the weir under all headpond conditions, while Interior's prescription and Maine DMR's recommendation would require at least 2 feet of water over the weir under all headpond conditions. In addition, Interior's prescription requires Black Bear Hydro to pass the minimum flow through the Alden weir from August through October, and Maine DMR requires Black Bear Hydro to pass the minimum flow through the Alden weir from April 1 through December 31.

As discussed above, the residence time at Graham Lake Dam was lower in 2017 after installation of the Alden weir (5.6 hours) than in 2016 (79.8 hours), and survival through the dam was higher in 2017 than in 2016 (82.7 percent versus 23.0 percent). However, the effect of the Alden weir on reducing downstream smolt passage delay and survival at Graham Lake Dam cannot be quantified conclusively because the data is confounded by the 2.5-fold difference in streamflow during the 2016 and 2017 studies.

The Alden weir is designed to eliminate areas of high water acceleration within the weir, which juvenile salmonids appear to avoid (Haro *et al*., 1998; Kemp *et al*., 2005). The Alden weir creates a uniform rate of flow acceleration such that velocity increases within the weir by 1 fps or less over each linear foot toward the exit of the weir. The uniform acceleration rate reduces the hesitation and avoidance behavior often observed as fish approach sharp-crested weirs (Johnson *et al*., 1995; Haro *et al*. 1998), such as the former bypass weir at Graham Lake. Haro *et al*. (1998) compared the number of Atlantic salmon smolts passed by an Alden weir and a sharp-crested weir in 10-minute intervals for 3 hours and found significantly more smolts passed via the Alden weir in the first 30 minutes than via the sharp-crested weir. Furthermore, significantly more smolts passed in groups of two or more via the Alden weir than the sharp-crested weir. Because smolts migrate downstream in schools, maintaining the integrity of the school during passage reduces stress and predation risk (Haro *et al*., 1998), which would improve survival after passage. Therefore, the results and observations reported by Haro *et al*.

(1998) and Kemp *et al*. (2005) suggest that retaining the Graham Lake Dam Alden weir and modifying it to provide passage at all water surface elevations would likely reduce delay, enhance downstream smolt passage efficiency, increase downstream passage survival at Graham Lake Dam, and improve survival of smolts when they enter the estuary and ocean.

Use and efficiency of the Alden weir for downstream kelt passage is unknown. Previous studies of downstream kelt passage indicate that kelts pass primarily during spill (GNP, 1989; Hall and Shepard, 1990). Kelt route selection was analyzed at the Mattaceunk Project (FERC No. 2520) in the fall season of 1992 and spring season of 1993, as well as the fall season of 1993 (GNP, 1994).[215] Data collected during these studies indicated that, for those kelts that used non-spillage routes, 82 percent used the downstream surface bypass. Because the Graham Lake Alden weir is a surface weir, the drop from the weir to the tailwater is relatively short (approximately 16.2 feet), and the plunge pool is relatively deep (approximately 9.5 feet deep),[216] kelt downstream passage survival from the Alden weir would likely be high and the Alden weir would not likely adversely affect downstream kelt passage.

Downstream Passage Weir Design Criteria

Interior's section 18 fishway prescription and Maine DMR's section 10(j) recommendation require the Alden weir to be designed in a manner that is consistent with the baseline design criteria provided in FWS's Design Criteria Manual. FWS's Design Criteria Manual states that surface bypasses should be a minimum of 3 feet wide and 2 feet deep. Black Bear Hydro does not provide any specific information about the width of the Alden weir in its license application and related filings. However, the weir appears to provide a conveyance that is approximately 4 feet wide based on photos included in the 2017 Atlantic salmon smolt downstream passage study report and based on the fact that Black Bear Hydro installed the weir in the bay containing the 4-foot-wide downstream bypass weir (Black Bear Hydro, 2017a). Therefore, the width of the Alden weir is likely consistent with the guidance in the Design Criteria Manual.

The Design Criteria Manual recommends a minimum depth of 2 feet for surface bypasses. The Design Criteria Manual also includes a general recommendation for depth of flow in a fish passage facility of at least twice the body depth of the largest individual to provide an adequate zone of passage, and states that the body depth for adult Atlantic

[215] The fall 1993 study provided limited information on survival because only 1 of 13 radio-tagged adult salmon returned to the project after spawning.

[216] FWS's Design criteria manual recommends that the plunge pool be at least 4 feet deep, or 25 percent of the fall height.

salmon is 8 inches.[217] Therefore, twice the body depth for an adult Atlantic salmon would be about 1.3 feet. Using the Design Criteria Manual as a guide for the depth of flow over the weir, it appears that Interior and Maine DMR's recommendation to modify the Alden weir to provide a water depth of 2 feet through the Alden weir would provide a sufficient water depth to allow salmon to be fully submerged as they swim through the weir, thereby reducing the potential for adverse behavioral reactions (*e.g.*, avoidance behavior) that would occur at lower depths. Black Bear Hydro's proposal and Commerce's fishway prescription to provide a 3-foot-deep flow through the weir would also eliminate the risk of water being too shallow for salmon to pass through the weir; however, Commerce and Black Bear Hydro do not explain why a 3-foot-depth of flow is needed and it appears that a 2-foot-deep flow would be sufficient for safe, timely, and effective passage through the weir.

The depth of flow that would be provided over the Alden weir depends on the elevation of the Alden weir. In the 2017 salmon smolt passage study, Black Bear Hydro states that the crest elevation of the sluice containing the Alden weir is 96.7 feet msl (Black Bear Hydro, 2017a).[218] At a crest elevation of 96.7 feet msl, water flowing through the weir would be at least 2 feet deep until the water elevation drops to 98.7 feet msl. As shown by the long-term average daily water elevation for Graham Lake (see Figure 5), the licensee has historically operated Graham Lake at a water elevation below 98.7 feet msl during the downstream fall migration season for salmon kelts (October 17 – December 31), particularly between October and December, and has dropped the water surface elevation to as low as 93.9 feet msl during October 2017.

Modifying the Alden weir to provide a mechanism for vertical adjustment to provide a flow of at least 2 feet of depth within the weir would help ensure that safe,

[217] An Atlantic salmon kelt would be the largest fish to use the Alden weir for downstream passage. Kelts are currently not present in the project area, but kelt passage will become necessary if adult Atlantic salmon migrate or are transported upstream of Graham Lake Dam.

[218] Information in the record indicates that the crest elevation of the intake with the Alden weir could be higher than 96.7 feet msl. In the 2017 salmon smolt passage study, Black Bear Hydro states that the depth within the sluice during the 2017 salmon smolt passage study ranged from 4.9 to 5.6 feet. If the crest elevation and reported depths are correct, then the water surface elevation during the 2017 study should have been between 101.6 and 102.3 feet msl. However, in its November 30, 2017 letter regarding water level concerns in Graham Lake, Black Bear Hydro reported that the water surface elevation for Graham Lake ranged from 102.6 to 103.2 feet msl when the study was conducted. Assuming that the water elevation data is correct, it appears that the information included in the 2017 study is inaccurate by about 1 foot, either as it relates to the depth of flow over the weir or the elevation of the weir.

timely, and effective downstream passage for Atlantic salmon smolts and kelts is consistently available. In addition, releasing the proposed minimum flows through the modified Alden weir during the downstream fish passage season, as prescribed by Interior and recommended by Maine DMR would ensure consistency between the release of minimum flows and conveyance flows, and would help provide a stronger attraction flow for surface-oriented passage.

Smolt Loss Study

Within three years of issuance of a new license, Black Bear Hydro proposes to conduct a 1-year study to investigate the potential causes of smolt losses in the downstream most reaches of the impoundment to continue the research of existing downstream passage conditions at Graham Lake Dam.

Black Bear Hydro does not define the “downstream most reaches” of Graham Lake. Therefore, staff assumes that Black Bear Hydro is referring to the region of Graham Lake between the Graham Lake release site for the 2016 and 2017 studies (approximately 0.75 mile upstream from Graham Lake Dam) and Graham Lake Dam. However, it is unclear why this region of Graham Lake requires additional study. In 2016, 98.2 percent of tagged smolts survived from the Graham Lake release site to the dam, but only 23.0 percent passed through the dam (see Table 28). While a large percentage of the smolts that reached the dam died before passing through the dam in 2016, 86.7 percent of smolts released from the Graham Lake release site reached the dam in 2017, and 82.7 percent of those reaching the dam survived passage (see Table 29). While the effect of the Alden weir Black Bear Hydro installed at Graham Lake in 2017 cannot be separated from the effect of higher flows that year, the extremely low survival of smolts at Graham Lake Dam observed in 2016 was not repeated in 2017.

Furthermore, Black Bear Hydro did not specify a target survival rate, or otherwise acceptable levels of impoundment mortality that would suggest that mortality in the impoundment is excessive. Without specific information to indicate whether or not mortality in the impoundment is excessive either today, or in the future, there is no means to determine whether environmental measures would be needed, or the type of environmental measures that would be beneficial. Therefore, without a means to determine whether mortality in the impoundment is excessive, and thus whether environmental measures are needed, there is no benefit to conducting an impoundment mortality study.

NMFS prescribes a 95 percent survival rate for each development for a proposed total project survival rate of 90 percent. However, the proportion of background mortality in the impoundment (*i.e.*, mortality that is unrelated to dam passage, but still caused by the project) would be difficult to identify because estimates of mortality in the impoundment could be the result of other sources that may or may not be related to project operation. Most notably, mortality could also be caused by any number of freshwater fish (*e.g.*, chain pickerel, smallmouth bass) or bird predators (*e.g.*, double breasted cormorants, mergansers, osprey) found in the Union River watershed (Fay *et al.*, 2006). Smallmouth bass, in particular: (1) are very effective predators on both Pacific and Atlantic salmon smolts (Van den Ende, 1993; Fayram and Sibley, 2000); (2) are present in the project impoundment; and (3) could have a negative effect on smolt survival in the impoundment. Furthermore, Maine DIFW actively supports the presence of smallmouth bass in Graham Lake through fisheries management, which is unrelated to project effects, but could nonetheless affect smolt mortality in the project impoundment. Removing the effect of managing for smallmouth bass would be necessary to begin to identify the proportion of mortality in the impoundment caused by the project.

In comments on the draft EA, NMFS states that Black Bear Hydro could quantify impoundment-related mortality (*i.e.*, the mortality due to the presence of the impoundment rather than due to dam passage) during a post-license smolt mortality study by comparing smolt mortality in the impoundment prior to passage to smolt mortality in an unimpounded reference reach, such as the West Branch of the Union River. However, Black Bear Hydro already collected mortality data for a 3.4-mile reach of the West Branch in 2016 and for the unimpounded reach between Graham Lake and Lake Leonard in 2016 and 2017 (see Table 31). Using this information,[219] staff calculated the percent survival per mile using the survival rates Black Bear Hydro provided for the different reaches using the following equation (Stich *et al*. 2015c):

$$s = \sqrt[d]{S}$$

Where:

s = percent survival per mile

S = reach survival (percent)

d = length of the reach (miles)

Staff then subtracted the per-mile survival rates from 100 percent to obtain per-mile mortality rates to facilitate comparison among mortality rates in the West Branch

[219] To remove the potential effects of dam passage on mortality after passage, staff only used the mortality data for the smolts released in the West Branch of the Union River or in Graham Lake prior to passage at Graham Lake Dam and the mortality data for smolts released downstream of Graham Lake Dam. Because Black Bear did not report mortality rates for all reaches in the study reports for each year, staff calculated the mortality rates for some reaches using the radio-tagged smolt detection histories Black Bear Hydro provided in the appendix of each report.

Union River, Graham Lake, and the Union River between Graham Lake and Lake Leonard (see Table 31).

Table 31. Reach survival and per-mile mortality rates for radio and acoustic-tagged smolts migrating through the West Branch Union River, Graham Lake, and the Union River between Graham Lake Dam and Lake Leonard in 2016 and 2017. "NA" indicates Black Bear did not collect survival and mortality data in that reach in 2017.

Reach	Reach Length (miles)	2016 Survival (percent)	2016 Mortality Rate (percent/mile)	2017 Survival (percent)	2017 Mortality Rate (percent/mile)
West Branch Union River to Upper Graham Lake	3.4	78.3	6.9	NA	NA
Upper Graham Lake to Graham Lake Dam	11.3	87.2	1.2	NA	NA
Graham Lake release site to Graham Lake Dam	0.75	98.3	2.2	86.7	17.4
Graham Lake Dam tailwater release site to Union River near Route 1A bridge	2.1	100	0.0	96.6	1.7
Mainstem Union River reference reach	0.5	100	0.0	98.2	3.5
Graham Lake Dam tailwater release site to Ellsworth Dam for radio-tagged smolts	4.1	96.7	0.8	93.1	1.7

Reach	Reach Length (miles)	2016 Survival (percent)	2016 Mortality Rate (percent/mile)	2017 Survival (percent)	2017 Mortality Rate (percent/mile)
Graham Lake Dam tailwater release site to Ellsworth Dam for acoustic-tagged smolts		95.0	1.2	88.3	3.0

In comments on the draft EA, NMFS states that the combination of increased habitat for predators due to the presence of Graham Lake and the slower movement rates of smolts through Graham Lake increases the probability of smolt predation (Venditti *et al*., 2000). However, the relationship between habitat type, movement rate, and per-mile mortality rate is not straightforward. For the reaches where Black Bear Hydro collected mortality data during both study years, percent mortality per mile was generally lower in 2016 than in 2017 (see Table 31). In fact, smolt movement rates downstream of Graham Lake Dam were much faster in 2017 than 2016 (see Table 30), which would be expected to reduce the exposure time of smolts to potential predators as suggested by Venditti *et al*. (2000). However, differences in mortality between the two years do not appear to be directly related to movement rates.

In 2016, the highest per-mile mortality rate (6.9 percent per mile) occurred in the West Branch of the Union River, which is analogous to the reference reach NMFS recommends for the post-license smolt mortality study. The per-mile mortality rate in the West Branch reach was two-fold higher than that of Graham Lake during 2016 (see Table 31) despite smolt movement rates in the West Branch that were 3.1 to 5.8 times faster than in Graham Lake (see Table 30).

The highest per-mile mortality rate occurred in the reach upstream of Graham Lake Dam in 2017 (17.4 percent per mile) and was the highest mortality rate observed during both years of study. This rate was 7.9 times higher than the mortality rate for the same reach in 2016 (see Table 31) despite identical smolt movement rates (see Table 29). However, impoundment elevation and movement rates were similar between years, which suggests that background mortality in Graham Lake may vary from year to year for reasons other than project operation or smolt movement rates.

Environmental conditions differed between the two study years, with higher flow and slightly warmer temperatures during the smolt release period in 2017; however, neither factor explains the observed differences in mortality between years. Higher flow has been shown to be associated with higher survival of Chinook salmon smolts in impoundments (Conner *et al*., 2003; Smith *et al*., 2003). However, Stich *et al*. (2015c) found that survival for Atlantic salmon smolts migrating through the entire Penobscot River basin past multiple dams was highest at intermediate flow levels. Stich *et al*. (2015c) suggested that smolt movement rates may decrease at flow levels above some optimum level, which would potentially increase the exposure of smolts to predators. While flow in the Union River during the study period in 2017 was 2.5 times higher than during the 2016 study period, the relationship between higher flow and movement rates differed upstream and downstream of Graham Lake Dam. In the lower reach of Graham Lake, movement rates did not change despite higher flow in 2017, but mortality was much higher. In contrast, mortality increased downstream of Graham Lake Dam in 2017 despite the faster movement rates. Therefore, the differences in survival in Graham Lake and the Union River observed during the two years do not appear to be directly related to differences in flow or movement rates. In addition, slower movement rates do not consistently result in higher mortality rates in Graham Lake or the mainstem Union River.

With regard to the effect of temperature on Atlantic smolt survival, Stich *et al*. (2015c) found that survival for smolts migrating downstream in the Penobscot River basin was highest between 54.5 °F and 66.2 °F because smolt movement rates decline outside of this range. While the temperature regime differed slightly between 2016 and 2017, nearly all smolt releases occurred at temperatures greater than 53.6 °F, and temperature exceeded 66.2 °F only briefly near the end of the 2016 study. Temperature never exceeded 66.2 °F in 2017. Because the temperature was generally between 59 °F and 61 °F for most of the 2017 study, it seems unlikely that the higher mortality rates were caused by the effects of temperature on movement rates. Temperature also affects feeding rates for chain pickerel and smallmouth bass due to temperature-related changes in metabolism (Van den Ende, 1993); however, it is unclear how encounter rates between smolts and these predators and prey selection would change with temperature. Therefore, there does not appear to be a direct relationship between the differences in temperature and mortality rates observed during the two study years.

Except for the mortality rates observed in the West Branch Union River in 2016 and lower Graham Lake in 2017, all the per-mile mortality rates observed during the two study years were fairly similar among the impounded and free-flowing reaches. Furthermore, the per-mile mortality rates observed in 2016 and 2017 were similar to the per-mile mortality rates that Stich *et al*. (2015c) reported for a multi-year study of smolts migrating through multiple hydropower projects in the Penobscot River basin. Aside from the aforementioned exceptions, the per mile mortality rates observed in Graham Lake and the Union River were similar to per-mile mortality rates observed in the Mattaceunk Project (FERC No. 2520) impoundment and nearby free-flowing reaches, which ranged from 0.2 to 4.8 percent per mile (Stich *et al*., 2015c). Lastly, the 17.4 percent per mile mortality rate observed in Graham Lake in 2017 is only slightly higher than the highest impoundment per-mile mortality rate that Stich *et al*. (2015c) reported for the Howland Project (FERC No. 2721) impoundment prior to its decommissioning, which ranged from 0.32 to 15.2 percent per mile. Therefore, both the per-mile mortality rates observed during 2016 and 2017 and the variability of those rates are similar to those observed during the multi-year study by Stich *et al*. (2015c).

Based on the information discussed above, there is no evidence that per-mile background mortality (*i.e.*, mortality not due to dam passage) for smolts in Graham Lake is consistently higher than background mortality in the free-flowing reaches upstream and downstream of Graham Lake or that the observed mortality rates were drastically different from those observed in the Penobscot River Basin. Therefore, the presence of Graham Lake does not appear to have any more of an effect on smolt mortality than the free-flowing reaches of the Union River. In addition, given the difference in per-mile mortality rates in each of the reaches monitored in 2016 and 2017, identifying any residual project effects on smolt mortality in the impoundment would be difficult with due to the inherent variability of factors unrelated to project operation that may affect smolt survival, such as variability between years in streamflow, temperature, and predator abundance. For these reasons, there is no justification for conducting a post-licensing impoundment mortality study.

Downstream Passage Operation Schedule

Black Bear Hydro proposes to continue to operate the downstream fish passage facility at the Graham Lake Development from April 1 through December 31 each year, as river conditions allow, which is consistent with Commerce's prescription and Maine DMR's recommendation. Operating the downstream fish passage facility from April 1 through December 31 would encompass the entire downstream Atlantic salmon smolt and kelt migration period and accounts for downstream passage of alosines, as discussed in section 3.3.2.2 (*Aquatic Resources, Environmental Effects*).

Schedule for Completion

Black Bear Hydro proposes to complete the modification of the Alden weir by May 1 of the third year after license issuance. Interior's prescription and Maine DMR's section 10(j) recommendation would require the modified downstream fish passage facility to be operational within 2 years of license issuance. Commerce's fishway prescription would require that the modified downstream passage facility be operational by May 1 of the third year of any new license. Completing the modifications in 2 years would result in more timely benefits for downstream migrating fish relative to completing the modifications in three years, but a shorter construction timeline increases the risk of construction activities overlapping with the downstream passage season. Because river herring are currently present the project area and Atlantic salmon fry are annually stocked in the West Branch of the Union River, adjusting the completion timing for the new downstream fish passage facility around migration seasons would ensure that construction activities were completed outside of the migration period for these species. Scheduling construction outside of the downstream passage season for these species would minimize the effects of construction on migrating fish.

Ellsworth Development

Black Bear Hydro proposes to continue operating the Ellsworth Development as a generation peaking facility with two powerhouse intake facilities: one near the western end of the spillway that contains a 2.5-MW turbine-generator unit (Unit 1) and the other on the western end of the dam that contains two 2.0-MW and one 2.4-MW turbine-generator units (Units 2 through 4).

Black Bear Hydro proposes to continue operating the existing downstream fish passage facility at the Ellsworth Development from April 1 to December 31 of each year, as river conditions allow, and proposes to install the following protective measures by May 1 of the third year following license issuance: (1) a fish guidance system (Worthington boom or similar technology) with rigid panel depths between 10 to 15 feet (where water depths are adequate); and (2) full-depth trashracks or overlays with 1-inch clear spacing at the intakes for Units 2, 3, and 4. Black Bear Hydro also proposes to prioritize operation of Units 1 and 4 over Units 2 and 3 during critical downstream passage seasons, the timing of which would be determined in consultation with the resource agencies. Black Bear Hydro also proposes to make the following modifications to the downstream fish passage facility by May 1 of the third year following license issuance:

1. Modify the eastern surface weir entrance by increasing the depth of the weir to a minimum of 3 feet and installing tapered walls similar to an Alden weir;

2. Increase the capacity of the eastern surface weir to pass up to 5 percent of station hydraulic capacity;

3. Increase the height of the sides of the spillway flume in consultation with resource agencies, to improve containment of fish passing through the flume; and

4. Modify the existing fish downstream migrant pipe to improve its discharge angle into the spillway flume to limit potential injury to fish that are exiting the pipe.

Interior's section 18 fishway prescription would require the following measures to provide safe, timely, and effective passage for diadromous fish species within two years of license issuance:

1. Install full-depth trashrack overlays with 1-inch clear spacing over the intakes of generating Units 2, 3, and 4 at the Ellsworth Development from August 1 to October 31 of each year;

2. Modify the existing downstream fish passage facility at the Ellsworth Development by: (1) increasing the total combined flow through the three existing surface weirs to 5 percent of the maximum station hydraulic capacity (approximately 123 cfs); (2) realigning the end of the downstream migrant pipe so that water discharges downward to the spillway flume and fish do not impact the spillway when exiting the pipe; and (3) eliminating leakage at the sidewalls of the spillway flume and eliminate discharge from the flume to the ledges at the toe of the dam; and

3. Operate the modified downstream passage surface weirs at the Graham Lake Dam on an annual basis from August 1 to October 31, and design the downstream passage facility in a manner that is consistent with the FWS's 2017 Fish Passage Engineering Design Criteria Manual (FWS, 2017).

Commerce's section 18 fishway prescription would require the following measures to provide safe, timely, and effective passage for anadromous fish species by May 1 of the third year of any new license:

1. Modify the downstream fish passage facility at the Ellsworth Development as follows: (1) install a fish guidance system that is comprised of a rigid hanging curtain or boom that leads to the surface weir entrance(s); (2) increase the total combined flow through the surface weir(s) to 5 percent of station capacity by modifying the fish passage entrance to provide a minimum water depth of 3 feet, with tapered walls similar to an Alden weir; (3) realign the downstream migrant pipe to improve the discharge angle to the spillway flume; and (4) increase the height of the sides of the spillway flume to contain the increased conveyance flow and reduce spillage;

2. Operate the modified downstream fish passage facility at the Ellsworth Development from April 1 to December 31 each year;

3. Curtail operation of Unit 1 and prioritize operation of Unit 4 over Units 2 and 3 at the Ellsworth Development during the critical downstream fish passage seasons, to be determined in consultation with the resource agencies; and

4. Install full-depth trashrack overlays with 1-inch clear spacing over the intakes of Units 2, 3, and 4;

In its section 10(j) recommendation, Maine DMR recommends the same modifications to the downstream fish passage facility for alosines and salmon that would be required by Commerce's section 18 prescription, but states that the modifications should be completed within three years of license issuance. Maine DMR's section 10(j) recommendation specifies that the fish boom guidance system should be installed from the eastern end of the intake structure to the west shore of the impoundment, with a maximum depth of 15 feet. Maine DMR also recommends that the downstream fish passage facility modifications be designed in consultation with the resource agencies consistent with the FWS's design criteria manual and that resource agencies review design plans.

DSF recommends full-depth trashracks with 1-inch clear spacing,[220] a Kevlar diversionary guidance boom, an increase in downstream bypass flow from 60 cfs to 120 cfs, and a spillway plunge pool. DSF recommends that Black Bear Hydro implement these measures within 2 years of license issuance. DSF also recommends that the Kaplan turbine units (Units 2 and 3) be shut down during downstream migration periods.

Our Analysis

Ellsworth Dam Passage Residency Time, Survival, and Route Selection

As discussed above in the analysis of Atlantic salmon passage through the Graham Lake Development, Black Bear Hydro conducted studies in May 2016 and 2017 to evaluate passage route selection, delay, and survival past the project dams for downstream migrating Atlantic salmon smolts.

During the 2016 and 2017 studies, salmon smolts traveled downstream approximately 4 miles from the release site downstream of Graham Lake Dam to Ellsworth Dam. Residence time prior to passage was much lower in 2017 than 2016 (see Table 32). As discussed above, residence time cannot be directly compared between the two study years because streamflow was 2.5-fold higher in 2017 than in 2016. In addition, Black Bear Hydro removed approximately 21 feet of flashboards from the Ellsworth Dam near the Unit 1 downstream bypass to increase attraction to the bypass and provide another route of passage (Black Bear Hydro, 2017a). Passage survival rates were similar for radio and acoustic-tagged smolts in 2016 (74.6 and 73.7 percent, respectively). The survival rate for acoustic-tagged smolts was lower in 2017 than 2016 (62.3 versus 73.7 percent, respectively).

[220] Commission staff assume that DSF recommends trashracks with 1-inch clear spacing for all four intakes at the Ellsworth Dam.

Table 32. Residence time and passage survival at Ellsworth Dam for radio-tagged and acoustic-tagged smolts during the 2016 and 2017 downstream smolt passage study.

Group	Median Time (hours)	Range (hours)	Number Passing	Number Surviving	Percent Surviving
2016 radio-tagged	17.5	0.6-213.0	71 of 71	53 of 71	74.6
2016 acoustic-tagged	21.9	0.1-355.7	57 of 57	42 of 57	73.7
2017 radio-tagged	1.5	0.2-39.5	121 of 130	NR*	NR
2017 acoustic-tagged	5.7	0.1-104.2	NR	NR	62.3

* "NR" indicates that the values were not reported. Black Bear Hydro did not provide information about the numbers of tagged smolts passing or surviving. (Source: Black Bear Hydro, 2016; 2017, as modified by staff).

Differences in project operation between the 2 years appear to have affected smolt route selection (see Table 33). Black Bear Hydro only operated Units 2 and 3 during the passage study in 2016, and 54.9 percent of the radio-tagged smolts passed downstream through those units. Of the smolts that passed downstream through Units 2 and 3 during the 2016 study, 69.2 percent survived. The majority of the remaining smolts passed downstream using the western surface bypass entrances by the intakes for Units 2 and 4 (28.2 percent) or the eastern surface weir (7.0 percent), and 96.0 percent of smolts using these downstream passage facilities survived passage. In 2017, downstream passage was relatively evenly distributed among the spillway flashboard gap, Unit 1, and Units 2 and 3. Black Bear Hydro did not provide route-specific survival rates for radio-tagged smolts in 2017.[221]

[221] Black Bear Hydro euthanized and tagged five smolt-sized trout with radio tags and released them into the Unit 1 downstream bypass sluice to quantify downstream drift after passage-induced mortality. In 2017, euthanized smolts drifted downstream of the last radio telemetry receiver, which indicated that dead smolts could drift past the last receiver. Based on these study results, Black Bear Hydro did not estimate survival rates for radio-tagged smolts passing Ellsworth Dam in 2017.

Table 33. Route selection by radio-tagged smolts during 2016 and 2017. "NA" indicates "not applicable" because Black Bear Hydro did not operate those units during the study.

Passage Route	2016 Selection Rate (percent)	2017 Selection Rate (percent)
Bypass entrances near the intakes of Units 2 and 4	28.2	5.4
Eastern surface weir	7.0	0.8
Spill	0	28.5
Unit 1 (propeller)	NA	24.6
Units 2-3 (Kaplan)	54.9	30.8
Unit 4 (propeller)	NA	NA
Unknown	2.8	3.1
Did not pass	7.0	6.9

(Source: Black Bear Hydro, 2016; 2017).

The 2017 balloon tag study provided addition information about downstream passage survival and injury rates at Ellsworth Dam (see Table 34). Survival rates were higher for Unit 1 than Unit 2, and the proportion of fish exhibiting no injuries or loss of equilibrium (*i.e.*, "malady-free") followed the same pattern.[222] Twelve fish injected into Unit 1 had passage-related maladies, with seven showing visible injuries, and five exhibiting loss of equilibrium. All seven fish with visible injuries died within 48 hours, and the five fish with loss of equilibrium recovered during the same time period. For Unit 1, six of the injuries were attributed to mechanical forces, one was attributed to shear forces, and five could not be assigned a causal mechanism.[223] Of the injected into Unit 2, 22 of them had passage-related maladies: 18 had visible injuries, two had loss of equilibrium, and two died within 1-hour with no visible injuries. Of the passage-related maladies for Unit 2, ten were due to mechanical forces, seven were due to shear forces, one was due to mechanical and shear forces, and four were undetermined. Only one fish

[222] Following downstream passage, some fish are temporarily unable to swim or maintain an upright orientation despite no visible injuries, which is referred to as "loss of equilibrium." Typically, these fish recover their equilibrium in 10 to 15 minutes (Black Bear Hydro, 2017b).

[223] Shear injuries are caused as fish transition between two zones of drastically different water velocity (Cada, 2001). Mechanical injuries occur when fish physically contact some structure (*i.e.*, the dam, turbine blade, *etc.*; Cada, 2001).

from Unit 2 with a visible injury survived the 48-hour holding period. Two fish injected into the downstream bypass had visible injuries that were due to mechanical and shear forces, and one died during the 48-hour holding period.

Table 34. Passage survival and malady-free rates from the 2017 balloon-tag study.

Passage Route	1-hour Survival (percent)	48-hour Survival (percent)	Malady-free (percent)
Unit 1 (propeller)	84.4	81.0	79.3
Unit 2 (Kaplan)	65.9	62.4	71.6
Bypass	98.1	96.2	98.0

(Black Bear Hydro, 2017b).

Based on the route selection rates obtained from the radio-tagged smolts and the 48-hour survival rates from the balloon tag study, Black Bear Hydro estimated an overall downstream passage survival rate at Ellsworth Dam of 80.5 percent in 2017. In contrast, only 62.3 percent of acoustic-tagged smolts survived downstream passage at Ellsworth Dam in 2017 (see Table 32). The cause of the lower survival rate for acoustic-tagged smolts in 2017 is unknown, but might have resulted from differences in route selection between the radio-tagged and acoustic-tagged smolts. Applying the balloon tag downstream passage survival rates to the 2016 route selection data results in an overall downstream passage survival rate at Ellsworth Dam of 76.6 percent, which is slightly higher than the 74.6 percent survival estimated for radio-tagged smolts and the 73.7 percent survival estimated for acoustic-tagged smolts (see Table 32).

Ellsworth Migration Rates and Passage Delay

As observed for migration rates in Graham Lake, migration rates through Lake Leonard were slower than in the Union River upstream and downstream of Ellsworth Dam (see Table 35, Table 36, and Table 37). Similar to smolts released in the Graham Lake Dam tailrace, acoustic-tagged smolts released in the Ellsworth tailrace in 2017 had faster migration rates than smolts passing through Ellsworth Dam (see Table 37). For acoustic-tagged smolts, migration speed from the Graham Lake Dam to Ellsworth Dam was similar in both years, but migration speed for acoustic-tagged smolts downstream of Ellsworth Dam was higher in 2017 than 2016 (see Table 36 and Table 37).

Commission staff quantified delay at Ellsworth Dam using the same method described above for Graham Lake Dam. Based on a free-flowing migration rate of 0.77 mph during the 2016 study, smolts would be expected to travel the approximately 656 feet from the Lake Leonard telemetry receivers to Ellsworth Dam in approximately 9 minute and 40 seconds. With a free-flowing migration rate of 1.57 mph in 2017, smolts would be expected to travel the same distance in 4 minutes and 44 seconds. Therefore, passage at Ellsworth Dam delayed radio-tagged smolts by approximately 17.3 hours in 2016 and 1.4 hours in 2017. Passage at Ellsworth Dam delayed acoustic-tagged smolts by 21.7 hours in 2016 and 5.6 hours in 2017. As described in section 3.3.4.2, *Graham Lake Downstream Passage Weir*, 74 percent of the downstream migration occurs within 15 days in the nearby Penobscot River (unpublished FWS data cited in Black Bear Hydro, 2012b). Therefore, a delay of 21.7 hours represents 6.0 percent of the downstream migration period for most smolts, and a delay of 5.6 hours represents 1.6 percent of the migration period.

Table 35. Median migration speeds for radio-tagged smolts in 2016 and 2017. "Graham Lake smolts" refers to smolts released in Graham Lake or in the West Branch of the Union River. "Tailrace smolts" refers to smolts released in the Graham Lake tailrace. "NA" indicates not applicable because the euthanized smolt drift beyond the last radio telemetry receiver.

Project Reach	Distance (miles)	2016 Migration Speed (mph)	2017 Migration Speed (mph)
Union River near Route 1A bridge to upper reach of Lake Leonard, for Graham Lake smolts	0.5	0.77* (0.13-1.72)	1.54 (0.05-3.73)
Union River near Route 1A bridge to upper reach of Lake Leonard, for tailrace smolts		0.62 (0.01-1.85)	1.57 (0.01-3.47)
Upper reach of Lake Leonard to Ellsworth Dam for Graham Lake smolts	1.5	0.54* (0.06-1.24)	0.31 (0.03-1.52)
Upper reach of Lake Leonard to Ellsworth Dam, for tailrace smolts		0.28 (0.05-1.52)	0.17 (0.03-0.74)
Ellsworth Dam tailrace to 350 feet upstream of Main Street bridge	0.25	1.08 (0.04-2.64)	NA
350 feet upstream of Main Street bridge to 440 feet downstream of Main Street bridge	0.15	1.4 (0.01-2.45)	NA

*Reported number is a weighted average of migration speed based on smolts released in the West Branch of the Union River and smolts released in Graham Lake.

(Source: Black Bear Hydro 2016; 2017a, as modified by staff).

Table 36. Median migration speeds for acoustic smolts in 2016.

Project Reach	2016 Distance (miles)	2016 Migration Speed (mph)
Graham Lake tailrace to Ellsworth Dam	4.1	0.16 (0.04-0.34)
Ellsworth Dam to Union River downstream reach (first receiver)	0.7	1.03 (0.02-1.94)
First receiver to second receiver in Union River downstream reach	0.55	0.59 (0.02-1.75)
Second receiver to third receiver in Union River downstream reach	0.65	0.7 (0.10-3.38)

(Source: Black Bear Hydro 2016, as modified by staff).

Table 37. Median migration speeds for acoustic-tagged smolts in 2017. "Graham Lake tailrace smolts" refers to smolts released in the Graham Lake tailrace. "Ellsworth tailrace smolts" refers to smolts released in the Ellsworth tailrace.

Project Reach	2017 Distance (miles)	2017 Migration Speed (mph)
Graham Lake tailrace to Ellsworth Dam	4.1	0.18 (0.02-0.46)
Ellsworth Dam to Union River downstream reach (first receiver), for Graham Lake tailrace smolts	1.9	0.54 (0.02-2.38)
Ellsworth Dam to Union River downstream reach (first receiver), for lower Union River smolts		0.27 (0.01-0.36)
First receiver to second receiver in Union River downstream reach for Graham Lake tailrace smolts	0.9	0.94 (0.01-2.25)
First receiver to second receiver in Union River downstream reach for lower Union River smolts		0.49 (0.01-1.64)
Second receiver to third receiver in Union River downstream reach for Graham Lake tailrace smolts	0.5	1.39 (0.11-4.27)
Second receiver to third receiver in Union River downstream reach for lower Union River smolts		1.21 (0.01-2.43)

(Source: Black Bear Hydro 2017a, as modified by staff).

Overall Project Survival

Black Bear Hydro calculated the overall project survival rate in 2016 based on the reach-specific survival rates. In 2016, the overall survival rate for radio-tagged smolts released in the West Branch of the Union River to downstream of Ellsworth Dam was 8.3 percent, and overall survival for radio-tagged smolts released upstream of Graham Lake Dam was 9.7 percent. Overall survival in 2016 was higher for fish that did not have to pass Graham Lake Dam: 42.2 percent for radio-tagged smolts and 69.4 percent for acoustic-tagged smolts released in the Graham Lake Dam tailrace. The overall project survival rate in 2017 was 38.1 percent before correcting for background mortality experienced by smolts,[224] and 57.6 percent after correcting for background mortality experienced by smolts.

Ellsworth Downstream Fish Passage Facility

Downstream Migrant Pipe, Spillway Flume, and Plunge Pool

The downstream migrant pipe and spillway flume present a safety risk to downstream migrating smolts and kelts. In fact, 2 out of 56 smolts released into the downstream migrant pipe were injured during the 2017 balloon tag study, and their injuries suggested the effects of shear and mechanical (*i.e.*, collision) forces (Black Bear Hydro, 2017b). The downstream migrant pipe discharges the conveyance flow and out-migrating fish in the opposing direction of the flow that is being released from the eastern surface weir (see Figure 18 and Figure 19). The conveyance flow from the downstream migrant pipe also discharges directly into the hard plastic floor of the spillway flume. Depending on the amount of flow from the downstream migrant pipe and the eastern surface weir, fish exiting the downstream migrant pipe could be injured or killed by the shear forces from water flowing in opposing directions or from impacting the plastic floor of the spillway flume.

In addition, conveyance water spills over the sidewalls of the spillway flume (Figure 18). Smolts or kelts could be swept over the walls of the flume and impact the face of the spillway, which could cause injury or death. Leakage outside the spillway flume could also reduce the water levels within the flume and create conditions where there is insufficient water to prevent fish from impacting the walls and floor of the spillway flume, which could injure migrants during downstream passage.

Commerce's and Interior's fishway prescriptions, Maine DMR's recommendations, and Black Bear Hydro's proposal would reduce downstream passage

[224] Background mortality is the mortality that occurs in a natural free-flowing section of river and is unrelated to downstream passage.

injury and mortality rates associated with the downstream migrant pipe and spillway flume. Consistent with Commerce's fishway prescription and Maine DMR's recommendation, Black Bear Hydro proposes to realign the end of the downstream migrant pipe so that the discharge from the pipe flows in the same direction as the conveyance flow in the spillway flume, which would reduce the risk of smolts and kelts being injured or killed by shear forces and striking the spillway fume. Similarly, increasing the height of the sides of the flume to fully contain water and fish within the spillway flume (as required by Commerce and recommended by Maine DMR) would reduce the risk of injury and mortality associated with impacting the walls, the floor of the flume, and the face of the spillway.

Although DSF recommends installing a spillway plunge pool downstream of the Ellsworth Dam within 2 years of license issuance, a natural plunge pool already exists at the toe of dam. In its October 10, 2018 response to Commission staff's request for additional information, Black Bear Hydro explains that it does not have drawings of the river bed at the base of the spillway to confirm the depth of the plunge pool, but "the minimum depth of the plunge pool appears to be several feet with a potential depth of approximately 12 feet."

Interior's fishway prescription would require Black Bear Hydro to "eliminate discharge to ledges at the toe of the dam." Rocky outcrops (*i.e.*, "ledges") located immediately adjacent to the spillway flume could pose a safety risk to alosines, smolts, and kelts. Low tide exposes the rocky outcrops (see Figure 20) and discharge from the spillway flume at low tide could impact the rock ledge and injure or kill migrating salmon. Modifying the spillway flume exit to eliminate the rock ledge, as required in Interior's prescription, would protect salmon from being injured or killed from impacting the rock ledge during passage.

Eastern Surface Weir

The existing eastern surface weir is a 3-foot-wide, sharp-crested weir that provides a means for surface-oriented fish species to pass downstream of the development. As discussed above, Black Bear Hydro currently operates the eastern surface weir by opening the weir by approximately 17 inches to provide an attraction and conveyance flow of 16 cfs. Based on the size of the opening, the water depth in the eastern surface weir cannot be greater than 17 inches. Although a water depth of 17 inches provides a minimum zone of passage for adult Atlantic salmon,[225] this water depth is less than the

[225] As discussed above, the Design Criteria Manual includes a general recommendation for depth of flow in a fish passage facility of at least twice the body depth of the largest individual to provide an adequate zone of passage, and states that the body depth for adult Atlantic salmon is 8 inches. Therefore, twice the body depth for an

minimum depth recommended by FWS's Design Criteria Manual (2 feet) and could make passage less attractive to juvenile and adult salmon, which could create passage delay. In addition, flow through a sharp-crested weir typically creates regions of high flow acceleration that can cause migrating fish to avoid the weir for downstream passage (FWS, 2017). Juvenile and adult fish that exhibit avoidance behavior at the weir could be delayed in passing downstream, or could seek an alternate means of downstream passage that could be less safe, such as turbine passage or spill.

Consistent with Commerce's fishway prescription, Black Bear Hydro proposes to modify the existing eastern surface weir near the spillway to have tapered walls similar to an Alden weir to provide safe, timely, and effective passage of Atlantic salmon and other migratory fish species at Ellsworth Dam. Black Bear Hydro's proposal is consistent with Commerce's prescription to modify the Alden weir to allow at least 3 feet of water over the weir under all headpond conditions.

The effects of modifying the current downstream passage sluice at Ellsworth Dam into an Alden weir on smolts and kelts migrating downstream would likely be similar to those described for the Alden weir at Graham Lake Dam (see section 3.3.4.2, *Graham Lake Downstream Passage Weir* and included subsections). Briefly, the reduced time for passage and increased school cohesion for smolts that Haro *et al.* (1998) observed suggest that an Alden weir at Ellsworth Dam would reduce delay, enhance downstream smolt passage efficiency, and increase downstream passage survival at Ellsworth Dam compared to the current stoplog-controlled weir. Reduced passage delay would likely improve survival of smolts when they enter the estuary and ocean (McCormick *et al*., 1998; 1999). Similarly, the Alden weir is likely to be effective for kelts since they have been observed using surface bypasses and spill for downstream passage at the Mattaceunk Project (GNP, 1989; Hall and Shepard, 1990; GNP, 1994).

Downstream Passage Weir Design Criteria

As described in section 3.3.4.2, *Graham Lake Downstream Passage Weir*, FWS's Design Criteria Manual states that surface bypasses should be a minimum of 3 feet wide and 2 feet deep. The current width of the bypass weir near Unit 1 is 3 feet. Therefore, the width of the proposed Alden weir is likely consistent with the Design Criteria Manual recommendation.

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adult Atlantic salmon would be about 1.3 feet. An Atlantic salmon kelt would be the largest fish to use the Alden weir for downstream passage. Kelts are currently not present in the project area, but kelt passage will become necessary if adult Atlantic salmon migrate or are transported upstream of Graham Lake Dam.

As discussed in the aforementioned section, the Design Criteria Manual recommends a minimum depth of 2 feet for surface bypasses. The Design Criteria Manual also provides a general recommendation for depth of flow in a fish passage facility of at least twice the body depth of the largest individual, which would be 1.3 feet for a kelt. The existing weir is typically only operated at a depth of 17 inches. A depth of 2 feet would increase the conveyance flow and reduce the potential for avoidance behavior associated with shallower passage depths. While Black Bear Hydro's proposal and Commerce's prescription for a 3-foot depth of flow are consistent with the Design Criteria Manual, it is unclear how the additional 1 foot of depth would provide any additional reduction of project effects on kelts or other migratory fish passing downstream at Ellsworth Dam.

Attraction Flow

As evidenced by the fish kills reported annually from 2014 to 2018, the existing attraction flow at the Ellsworth Dam does not adequately attract fish to the downstream fish passageway entrances and away from the turbine intakes. The combined flow through all three entrances is approximately 56 cfs, or 2.3 percent of station capacity. Black Bear Hydro proposes to modify the existing downstream fish passage facility by increasing the capacity of the eastern surface weir to 5 percent of station hydraulic capacity, which is equal to approximately 123 cfs. Commerce's and Interior's fishway prescriptions require, and Maine DMR and DSF also recommend a conveyance flow of 5 percent of station capacity for downstream fish passage. A flow of 5 percent of station capacity is consistent with the FWS Design Criteria Manual that recommends an attraction flow of 5 percent of station capacity under all headpond and operating conditions.

Black Bear Hydro proposes to release the 123-cfs attraction flow through the eastern surface weir; whereas, the resource agencies and DSF do not specifically state how the attraction flow would be allocated among the three existing surface weirs at Ellsworth Dam. The eastern surface weir currently passes approximately 16 cfs, which is 0.6 percent of station capacity. To pass 123 cfs through the eastern surface weir, Black Bear Hydro would have to increase the flow through the weir by approximately 7.7 times.

To be effective, downstream passage facilities must create hydraulic signals that are strong enough to attract fish to the entrance in the presence of competing flows, such as those created by the turbine intakes (FWS, 2017). During the 2016 study, 54.9 percent of the tagged smolts passed through Units 2 and 3, while only 28.2 percent used the downstream bypass entrances near the intakes for Units 2 and 4. Increasing the flow passing through the eastern surface weir would likely reduce the proportion of smolts that pass downstream through the turbines. Reducing passage through Units 2 and 3, in particular, would likely provide a measurable increase in whole station survival given the low survival of smolts passing through those units.

Distributing the 123 cfs among the three bypass weirs would diffuse the attraction flow across the project forebay and reduce its effectiveness because the flow entering each bypass weir would be significantly lower than the flow through the intakes. This effect would be especially pronounced on the western side of the forebay where the flow signal for the bypass weirs would be attenuated by the flow through the intakes for Units 2 through 4. In contrast, directing 123 cfs through the eastern surface weir and continuing to pass 20 cfs through each of the bypass weirs near the intakes for Units 2 and 4 would provide a larger bypass flow signal away from the three intakes, thereby reducing entrainment into those intakes. Meanwhile, continuing to provide 20 cfs through each of the bypass weirs near the intakes for Units 2 and 4 would provide downstream passage routes for any smolts or kelts passing on the western side of the forebay. This scenario would be similar to project operation during the 2017 smolts study when increased spill and operation of Unit 1 reduced smolt entrainment into Units 2 and 3, which have low passage survival for smolts. Overall, a 123-cfs attraction flow at the eastern surface weir and a 40-cfs attraction flow at the western surface weirs would provide a total attraction flow of 163 cfs at the Ellsworth Dam, which would exceed the recommended 5 percent station hydraulic capacity at the project.

Diversionary Guidance Boom

Consistent with Commerce's fishway prescription and Maine DMR's and DSF's recommendation, Black Bear Hydro proposes to install a fish guidance system consisting of 10 to 15-foot deep rigid panels suspended inline from a series of large floats (*i.e.*, "diversionary guidance boom"). Only Maine DMR provides additional details regarding the design and approximate location of the guidance boom, including that the boom should have a maximum depth of 15 feet and that it should "boom extend from the eastern end of the intake structure to the western shore of the impoundment." Because no entity provided a specific and unambiguous location for the guidance boom, staff assume that the proposed guidance boom would extend from the western shore of the impoundment to a location between the intake of Unit 1 and the eastern surface weir.

As discussed above, the existing downstream fish passage facilities at the Ellsworth Development do not provide safe, timely, and effective downstream passage. The existing downstream fish passage facility does not have any means to guide salmon to the downstream fish passage facility entrances and away from the intake, and the existing attraction flows are too weak to attract fish away from the intake. Any salmon that do not locate the entrances to the downstream fish passage facility are attracted to the intakes where they are entrained and subsequently injured or killed by turbine passage.

Diversionary guidance booms have been installed at Weston (FERC No. 2325), Hydro-Kennebec (FERC No. 2611), and Lockwood (FERC No. 2574) Projects on the Kennebec River to reduce the entrainment of Atlantic salmon smolts. At the Weston and Hydro-Kennebec Projects, the guidance booms consist of 10-foot-tall metal punch plates with 5/16-inch perforations. The guidance boom at the Lockwood Project consists of a 4-foot-tall, 5/16-inch punch plate and a 6-foot-tall section of 5/16-inch Dyneema netting (Brookfield, 2013; 2014; 2015; 2016).[226] Brookfield, the licensee of these projects, evaluated the effectiveness of the guidance boom at each project from 2012 to 2015 by releasing radio-tagged smolts upstream of each project.[227] The overall effectiveness of the boom at the three projects ranged from 33.1 to 69.2 percent (see Table 24) with an overall average across projects of 57.6 percent.

At each project, the guidance boom tended to be less effective for smolts that were released in the project impoundment than for smolts released at the projects upstream (Brookfield, 2013; 2014; 2015; 2016). For example, the bypass effectiveness at the Lockwood Project in 2012 was 23.1 to 42.9 percent for smolts released at the Lockwood Project, 57.1 to 91.7 percent for smolts released at the Hydro-Kennebec Project, and 40.0 to 80.0 percent for smolts released at the Weston Project. This differential effectiveness relative to release site is likely a function of the time it takes for tagged smolts to resume more natural behavior and distribution within the river, such that fish released farther upstream from a project are behaving more naturally than fish released a short distance upstream. In addition, bypass effectiveness at the Weston Project generally increased as the percentage of flow released through the bypass increased from 2 to 10 percent (Brookfield, 2013; 2014; 2015; 2016). With the exception of a whole station survival rate of 89.5 percent at the Weston Project in 2014, the guidance booms help the Kennebec River projects achieve whole station survival estimates of at least 94 percent at each project for smolts migrating downstream (Brookfield, 2013; 2014; 2015; 2016).

A diversionary guidance boom could reduce salmon entrainment at the project intakes if the boom curtain is placed at an appropriate location and sufficient depth to divert salmon away from the turbine intakes and guide them to the eastern surface weir. As discussed above, increasing the attraction flow to 5 percent of station capacity at the eastern surface weir would provide a stronger hydraulic signal and increase the safety, timeliness, and effectiveness of passage relative to the existing environment. However, salmon that are migrating downstream on the western side of the Union River would still be susceptible to entrainment due to the strong hydraulic signal associated with Units 2 – 4, which have a total maximum hydraulic capacity of 1,775 cfs. A diversionary guidance boom that extends from the western shore of the impoundment to the eastern end of the Unit 1 intake could be used to divert out-migrating fish from the generator intakes.

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[226] Dyneema is an ultra-high-weight-molecular-weight, nontoxic polyethylene fiber used to create barrier nets that can be used exclude fish from undesirable locations.

[227] Brookfield defined "bypass effectiveness" as the percent of smolts that arrived at the project and passed downstream via the bypass.

Given that the Unit 1 intake is separated from the other intakes by approximately 130 feet, a diversionary guidance boom may be an effective way to reduce smolt entrainment for all the intakes. However, some smolts may still be entrained because the diversionary guidance boom would likely not be 100 percent effective at directing smolts to the eastern surface weir, as discussed above for the other projects. Orienting the guidance boom to direct fish to the eastern surface weir and passing 5 percent of the projects maximum hydraulic capacity (*i.e.*, 123 cfs) through that weir would create conditions similar to those at the Lockwood Project where the guidance boom directs fish toward a bypass passing 6 percent of the projects' maximum hydraulic capacity. Bypass effectiveness ranged from 52.6 to 67.8 percent at the Lockwood Project (see Table 24). In addition, continuing to operate the bypass weirs near the intakes for Units 2 and 4 would provide safe downstream passage routes for any smolts that swim underneath the guidance boom.

Downstream Passage Operating Schedule

Commerce's fishway prescription requires Black Bear Hydro to provide downstream passage measures from April 1 to June 15 for Atlantic salmon smolts and kelts and from October 17 to December 31, or ice in, for kelts. Maine DMR recommends Black Bear Hydro provide the recommended downstream passage measures from October 17 through December 31, or ice in, for kelts. Black Bear Hydro proposes to continue operating the downstream passage facilities from April 1 through December 31.

The timing of the peak of the smolt downstream migration shifts from year to year in response to environmental conditions (Bakshtansky *et al.*, 1976; Jonsson and Ruud-Hansen, 1985); however, there are some predictable aspects to the timing of smolt migration. Smolt population surveys conducted in the Penobscot River from 2000 to 2005 demonstrate that smolts migrate between late April and early June with a peak in early May (Fay *et al.*, 2006). Based on an aggregate of 6 years of monitoring data collected between 1988 and 1995, smolts migrated through the Mattaceunk Project from late-April to mid-June, with peak migration (80 percent of smolts) occurring in May (GNP, 1995). The same studies also demonstrate that the majority of the smolt migration takes place over a 2- to 3-week period after water temperatures rise to about 50° F. Black Bear Hydro's proposed downstream fish passage facility operating schedule is consistent with Commerce's required operating schedule for smolts and with the smolt migration period observed in the nearby Penobscot River and should ensure timely downstream passage for smolts.

Commerce's prescription and Maine DMR's recommendation for the fall kelt migration period is consistent with the timing of the fall kelt migration period for the Penobscot River (GNP, 1993; 1994; USASAC, 2007), which is approximately 19 miles west of the Union River. However, GNP (1993; 1994) reported that the spring kelt migration period lasted until June 25 rather than June 15 as required by Commerce. Black Bear Hydro's proposed operating schedule would contribute to timely downstream passage for kelts by fully encompassing the kelt downstream passage period required by Commerce, recommended by Maine DMR, and observed in the Penobscot River.

Potential for Entrainment and Impingement

Trashracks

The trashracks at the Ellsworth Development have different sizes of clear spacing. The intakes for Units 2 - 4 have a trashrack with 1-inch clear spacing over the top 6.75 feet of the intake structure, and then 2.37-inch clear spacing. The Unit 1 intake has a single trashrack with 2.44-inch clear spacing. Black Bear Hydro measured approach velocities along a regularly-spaced grid approximately 3 feet upstream of the trashracks at near maximum generation.[228] The approach velocities ranged from a maximum of 2.08 fps at Unit 3 to 2.43 fps at Unit 4 (see Table 38). The velocities through the open spaces of the trashracks (*i.e.*, "through velocities") are higher than the approach velocities for each of the intakes because the bars of the trashrack reduce the area where water can flow through the trashrack into the intake. Average through velocity is 4.4 fps for Unit 1, 3.5 fps for Units 2 and 3, and 3.8 fps for Unit 4.[229] Downstream migrating Atlantic salmon would be able to overcome these velocities and avoid impingement on the trashracks and entrainment in the turbines, as smolts have a burst speed of 6.0 fps and kelts have a burst speed of 16.5 to 19.7 to fps (Peake *et al*., 1997; Wolter and Arlinghaus, 2003).

Table 38. Approach velocities for the Units 2 through 4.

Unit	Number of Locations Measured	Minimum Velocity (fps)	Maximum Velocity (fps)
Unit 2	22	0.10	2.27
Unit 3	36	-0.13	2.08
Unit 4	35	0.49	2.43
Overall	93	-0.13	2.43

(Source: Black Bear Hydro, 2015b)

However, under the existing conditions at the project, the 1-inch, 2.37-inch, and 2.44-inch trashracks do not physically exclude smolts from entrainment as shown by the high percentage of smolts that passed downstream through the turbines during the 2016

[228] Black Bear Hydro did not measure velocity at the intake for Unit 1; however, based on the similarity of the design and operation of Units 1 and 4, the risk of impingement at Unit 1 would likely be the same as the risk of impingement at Unit 4.

[229] Calculations of through velocities are described in section 3.3.2.2, *Aquatic Resources, Environmental Effects, Downstream Eel Passage, Impingement*.

and 2017 downstream smolt passage studies (see Table 33). While smolts have the potential to avoid entrainment because they have burst swim speeds of about 6.0 fps, which exceeds the approach velocities and through velocities of the intakes (see Table 38), a large percentage of smolts become entrained at the project because of the weak attraction flows at the surface weirs. Smolts are unlikely to become impinged because they can either pass through the trashrack or swim away from the intake.

Consistent with Commerce's and Interior's fishway prescriptions and Maine DMR and DSF's recommendation, Black Bear Hydro proposes to install trashracks having 1-inch bar spacing to the full depth of the turbine intakes for Units 2 through 4, with the intention of reducing entrainment of smolts and kelts. While 1-inch, clear spaced trashracks are consistent with FWS' Design Criteria Manual recommendation for smolts, 1-inch clear spaced trashracks would not physically exclude smolts from entering the intakes based on downstream smolt passage data collected at hydropower projects on the lower Penobscot River. During a downstream smolt passage study conducted in 2017, smolts were entrained through full-depth trashracks with 1-inch clear spacing at the Orono (FERC No. 2710) and Stillwater (FERC No. 2712) Projects (Black Bear Hydro, 2018).

Turbine Operation Priority and Curtailment

Black Bear Hydro proposes to prioritize the operation of Units 1 and 4 over Units 2 and 3 during critical downstream passage seasons, which would be determined in consultation with fisheries resource agencies. Commerce's fishway prescription requires and Maine DMR recommends that Black Bear Hydro prioritize operation of Unit 4 over Units 2 and 3 and curtail the operation of Unit 1 during critical downstream passage seasons, which would be determined in consultation with the resource agencies.[230]

DSF recommends that Black Bear Hydro not operate Units 2 and 3 during downstream migration periods. In addition, DSF recommends that turbine shutdowns as described by Maine DMR should be operational upon license issuance. However, Maine DMR only recommends an operation priority for Units 2 through 4 and an undefined curtailment of Unit 1, rather than turbine shutdowns.

[230] Black Bear Hydro, Commerce, and Maine DMR do not define "critical downstream passage seasons." Commerce and Maine DMR also do not define what "curtail" means for the operation of Unit 1. The results of previous downstream smolt migration studies in the Penobscot River described above may inform definitions of "critical downstream passage seasons" and "curtail," as discussed further below.

Critical Downstream Passage Seasons

As described above, the majority of the smolt migration in the Penobscot River occurs during a 2- to 3-week period after water temperatures rise to about 50° F in the spring of each year. FWS reviewed smolt trapping data collected by NMFS in the Penobscot River from 2000 to 2005 and found that 74 percent of the downstream migration occurs within 15 days (unpublished FWS data cited in Black Bear Hydro, 2012b). Therefore, a critical downstream passage season could be defined for smolts as the 15-day period after water temperature in the Union River reaches 50° F in the spring.

Turbine Operation

Beginning with the 2017 fish passage season, Black Bear Hydro began prioritizing the operation of turbine Units 1 and 4 over Units 2 and 3 at the Ellsworth Development as an interim downstream passage measure to address ongoing fish kills and alosine survival based on the results of the 2016 Downstream Atlantic Salmon Passage Survival Study (Survival Study). Results of the Survival Study showed that test fish utilizing Units 1 and 4 for downstream passage survival had greater survival than test fish utilizing Units 2 and 3 for downstream passage. Black Bear Hydro concluded that because the turbines at Units 2 and 3 rotate at a faster rate, there is a higher likelihood of alosines being injured or killed by turbine blade strike.

Black Bear Hydro's operation prioritization does not appear to effectively reduce adverse effects, as another fish kill involving river herring occurred in August 2017, and fish kills involving river herring occurred every month from June through October 2018. While unit prioritization has the potential to lower the mortality rate of fish that are entrained at the project when flows in the Union River are equal to or less than the combined maximum hydraulic capacity of Units 1 and 4 (1,370 cfs), the evidence of continued fish kills in the 2017 and 2018 passage seasons demonstrates that turbine passage at the project continues to be unsafe under the existing conditions. Because river herring and smolts both migrate downstream in large schools near the surface, smolts may experience similar entrainment rates as river herring. In addition, survival rates for smolts passing through Units 1 and 4 is only 81.0 percent, which indicates substantial smolt mortality could still occur when these units are operating. Therefore, Black Bear Hydro's proposed turbine operation priority (*i.e.*, Units 1 and 4 prioritized over Units 2 and 3) and Commerce's required and Maine DMR's recommended operation priority (*i.e.*, Unit 4 prioritized over Units 2 and 3) would likely not provide much protection from entrainment for smolts without additional protective measures.

Regarding Unit 1 operation, Unit 1 may entrain more smolts than Unit 4 if Unit 1 cannot be fitted with a smaller sized trashrack. While a 1-inch clear spaced trashrack would not physically exclude smolts, the Unit 1 intake would not have the potential behavioral deterrent associated with water moving through narrowly spaced trashrack bars (Coutant and Whitney, 2000). Furthermore, the Unit 1 intake is approximately 20 feet way from the eastern surface weir, and smolts may be attracted to the flow associated with the intake and attempt to pass downstream via the intake. Therefore, defining "curtailing operation" as ceasing operation during the 15-day period after water temperature reaches 50° F would likely reduce entrainment of smolts into Unit 1.

DSF's recommendation to cease operation of Units 2 and 3 during the downstream migration period would prevent smolt entrainment into the units with low survival. However, shutting down Units 2 and 3 would reduce the project's maximum hydraulic capacity from 2,460 cfs to 1,370 cfs for the entire downstream migration period. According to the flow duration curves based on project generation, flow exceeds 1,370 cfs approximately 63 percent of the time in April, 27 percent of the time in May, and 23 percent of the time in June. Similarly, flow exceeds the maximum hydraulic capacity of the project (*i.e.*, 2,460 cfs) approximately 12, 7, and 5 percent of time in April, May, and June, respectively. Shutting down Units 2 and 3 would result in the project spilling for approximately 15.5 days in April, 6.3 days in May, and 5.3 days in June. Because of the rocky outcrops present at the base of Ellsworth Dam (see Figure 20), passing via spill may result in smolt mortality. In comments on Black Bear Hydro's 2017 downstream smolt passage study plan, NMFS indicated that smolt mortality resulting from passage via spill may occur because of the height and condition of the spillway and the rocky outcrops at the base of Ellsworth Dam.[231] Dead alewives were observed in the Union River on June 2 and 3, 2017,[232] before Black Bear Hydro replaced the flashboard that had been removed for the 2017 smolt study, and dead river herring were no longer observed after Black Bear Hydro replaced the flashboards at the conclusion of the 2017 smolt study.[233] In addition, if the proposed and recommended downstream fishway modifications and protective measures discussed above are implemented during the term of any new license, then ceasing turbine operation might not provide any additional significant reductions to turbine impingement and entrainment.

<u>Schedule for Completion</u>

As discussed above, modifying the existing downstream fish passage facilities, including the eastern surface weir, spillway flume, and plunge pool, and installing a new diversionary guidance boom and trashracks at the project would significantly reduce ongoing project effects on downstream migrating fish. Interior's fishway prescription would require the modified downstream fish passage facility to be operational within 2 years of license issuance, Commerce's fishway prescription would require the modified

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[231] *See* Black Bear Hydro's Atlantic salmon smolt downstream passage study plan filed January 31, 2017.

[232] *See* Jane Langley's June 20, 2017 letter.

[233] *See* NMFS' July 5, 2017 letter.

downstream passage facility to be operational within three fish passage seasons, and Black Bear Hydro proposes and Maine DMR recommends modifying within 3 years license issuance.

Downstream migrating salmon would benefit from a construction schedule that reduces the ongoing project effects in a timely manner, while also limiting construction activities to periods outside of the downstream migration season. Adjusting the completion timing for the new downstream fish passage facility around migration seasons would minimize the effects of construction on migrating fish.

Interim Downstream Passage Measures

Because no adult salmon have been collected in the trap and truck facility since 2014, no salmon spawning is currently occurring upstream of Ellsworth Dam. Therefore, the extent to which Atlantic salmon experience adverse effects due to project operation largely depends upon stocking efforts by Interior and other entities. Any stocked smolts or fry that smoltify prior to the implementation of the downstream passage measures described above could be adversely affected by entrainment or injury or mortality associated with downstream passage via the downstream migrant pipe at the Ellsworth Development.

Given the current configuration of the project, the primary means of protecting out-migrating smolts would be project shutdown during the smolt migration period. Black Bear Hydro currently implements a shutdown procedure when a fish kill involving river herring occurs, in order to reduce further entrainment mortality for a wave of river herring that are migrating downstream. However, project shutdown would result in spill, which some smolts might use as a downstream passage route. As described earlier, NMFS indicated that smolt mortality resulting from passage via spill may occur because of the height and condition of the spillway and the rocky outcrops at the base of Ellsworth Dam. Therefore, there is no existing passage route at the project that does not have the potential to kill or injure smolts, and out-migrating smolts would potentially experience adverse effects prior to the third passage season after license issuance, at which point Black Bear Hydro would be required to implement the downstream passage measures described above.

Consistency with Atlantic Salmon Recovery Plan

Black Bear Hydro's proposed measures, along with the agencies' prescriptions and recommendations, and Commission staff's recommendations would be consistent with the 2018 Final Recovery Plan for the Gulf of Maine Distinct Population Segment of Atlantic Salmon (FWS and NMFS, 2018). This is because the proposed, required, and recommended measures, including enhancements of upstream and downstream fish passage facilities, would: (1) enhance connectivity between the ocean and freshwater habitat; (2) provide adequate instream flow conditions to support Atlantic salmon spawning, incubation, rearing, and migration; and (3) allow co-evolved diadromous species to be restored to the extent possible to support a recovered GOM DPS.

Based on our analysis throughout the sections above on Atlantic salmon, we conclude that Black Bear Hydro's proposed measures, the agencies' recommended and required environmental measures, and the additional measures recommended by staff, would minimize many adverse effects of the project on the GOM DPS of Atlantic salmon. Nevertheless, project operation would result in the take of some Atlantic salmon smolts, and therefore continued operation may affect, and is likely to adversely affect Atlantic salmon.

Designated critical habitat for the GOM DPS of Atlantic salmon occurs in the project area, and the PCEs of critical habitat include sites generally free from physical and biological barriers that delay or prevent upstream (PCE 8) and downstream migration (PCE 11) of Atlantic salmon. After Black Bear completes the proposed, required, and recommended improvements to the upstream and downstream passage facilities to provide 90 percent passage effectiveness, we conclude that operating the project may affect, but is not likely to adversely affect the designated critical habitat for the GOM DPS of Atlantic salmon.

In comments filed on December 21, 2018, NMFS states that regulation of flow in the Union River and the maintenance of two impoundments affect the critical habitat essential features regarding safe, timely, and effective swim-through passage (PCE 8 and PCE 11). NMFS states, therefore, that it cannot concur with Commission staff's finding that licensing the project under the staff alternative with mandatory conditions is not likely to adversely affect Atlantic salmon critical habitat.

As stated in section 3.3.4.2, *Atlantic Salmon Critical Habitat*, the tributaries of Graham Lake would remain accessible to adult salmon at water surface elevations greater than 97 feet msl. In addition, minimum flows of 250 cfs from May 1 to June 30 and at least 105 cfs for the rest of the year would ensure that an adequate zone of passage exists in the mainstem of the Union River between Lake Leonard and Graham Lake for both adult and juvenile salmon. In addition, meeting 90 percent effectiveness for upstream and downstream passage after developing volitional upstream passage facilities and modifying existing downstream passage facilities, as proposed in Commerce's section 18 fishway prescription, would ensure that the safe, timely, and effective passage requirements of PCE 8 and PCE 11 would be met. NMFS did not provide any information about how the maintenance of the project impoundments would adversely affect salmon migration. Therefore, staff has not changed the conclusion that staff's alternative with mandatory conditions is not likely to adversely affect Atlantic salmon critical habitat. However, based on NMFS's statement that it does not concur with staff's determination that the project is not likely to adversely affect critical habitat, we are requesting formal consultation with NMFS for Atlantic salmon critical habitat.

Atlantic and Shortnose Sturgeon

Atlantic and shortnose sturgeon could occur in the Union River downstream of Ellsworth Dam. Black Bear Hydro proposes to continue the current licensed mode of operation, including releasing 105 cfs from the Ellsworth Development from July 1 through April 30 and releasing 250 cfs from May 1 through June 30 to protect fishery resources.

Black Bear Hydro is not proposing to modify the structure or operation of the existing vertical slot upstream fishway and trap that is used to transport Atlantic salmon and river herring upstream of the project, but not used to transport sturgeon. However, Black Bear Hydro is proposing to implement a sturgeon handling plan that describes procedures to follow in the event that Atlantic or shortnose sturgeon are encountered during operation of the fish trap or during maintenance of project facilities. According to the proposed plan, healthy sturgeon would be weighed, measured, scanned for PIT tags,[234] and immediately released downstream of the project. Black Bear Hydro personnel would be responsible for handling sturgeon. Injured sturgeon would be measured, photographed, and released, and NMFS would be notified within 24 hours. Badly injured fish would be retained by Black Bear Hydro, if possible, until obtained by a NOAA-recommended facility for potential rehabilitation. Dead sturgeon would be photographed, measured, scanned for tags, and stored in a refrigerator or freezer until NMFS could take possession of the specimen for analysis. Also, Black Bear proposes to protect sturgeon by not scheduling any generation units or draft tubes at the Ellsworth Development for dewatering during the most likely time of year for spawning (*i.e.*, April or May), unless there is an emergency at the project.

Based on its assessment that sturgeon can occur downstream of the dam and are known to be capable of accessing fishways, Commerce states in its April 10, 2018 comments that because sturgeon could be incidentally captured in the fish trap, a sturgeon handling plan should be incorporated into any new license issued for the project.

Our Analysis

Ellsworth Dam was built on the Union River in the vicinity of Ellsworth Falls, which is thought to have been the natural barrier to the upstream migration of Atlantic

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[234] Typically, PIT tags are rice-sized tags injected into the pelvic fin area of the body cavity of the fish, effectively providing each individual study fish with its own barcode that can be detected without handling the fish after initial implantation.

and shortnose sturgeon. Accordingly, the project is not preventing access to any potential historical habitat for either species.

Based on their migration range, both species of sturgeon have the potential to occur in the Union River downstream of Ellsworth Dam and to be affected by project operation. There are no proposed changes to project facilities or operation that would adversely affect either species of sturgeon. Black Bear Hydro's proposed minimum flow releases from Ellsworth Dam would maintain the existing minimum flow to the Union River from the project and would not affect sturgeon relative to the existing environmental baseline.

Atlantic and shortnose sturgeon could be affected by operation of the existing fish trap or project maintenance if individuals become trapped and/or injured in the fish trap, or stranded in the draft tubes of the turbine-generator units when the draft tubes are being dewatered for project maintenance. The measures included in the proposed sturgeon handling plan would reduce the potential effects associated with operation of the existing fish trap and project maintenance by reducing the likelihood of stress or injury to Atlantic or shortnose sturgeon in the event either species enters the fish trap or is encountered during maintenance activities. However, as NMFS states in its letter filed on December 21, 2018, the anticipated handling of any sturgeon would be considered a take under ESA. Although no sturgeon have been handled in the fishway trap or the draft tubes historically, we cannot rule out the possibility that such would be the case during any new license term. Therefore, we must conclude that even with the sturgeon handling plan in place, the project would be likely to adversely affect Atlantic sturgeon (Gulf of Maine DPS and New York Bight DPS) and shortnose sturgeon.

Northern Long-Eared Bat

Black Bear Hydro does not propose any measures for the protection of the NLEB, and no agency recommendations were received regarding the NLEB.

Our Analysis

Black Bear Hydro has not proposed any major ground disturbing or tree clearing activities that would affect potential NLEB summer roosting and foraging habitat. However, project maintenance activities during the term of any new license could require periodic tree removal that may affect NLEB habitat (*e.g.*, vegetation maintenance at project recreation sites).

While no occupied maternity roost trees are known to occur in the project vicinity, no surveys have been conducted to verify the absence of maternity roost trees. Based on the fact that NLEB have been documented within 20 miles of the project, maternity roosts could potentially occur in the project boundary and could potentially be affected by project maintenance.

Removing occupied maternity roost trees or any trees within 150 feet of an occupied roost tree is prohibited during the NLEB pup season (June 1 – July 31) (FWS, 2016b). To avoid prohibited incidental take of NLEB, Black Bear Hydro could restrict tree removal activities to time periods outside of the pup season. With this measure in place, we conclude that the project would not be likely to adversely affect NLEB. We will follow FWS's optional streamlined consultation framework that allows federal agencies to rely on the 4(d) rule to fulfill section 7(a)(2) consultation requirements for NLEB (FWS, 2016a).

On November 26, 2018, Commission staff issued a letter to FWS requesting streamlined consultation under the 4(d) rule for the NLEB. In the letter, staff determined that, although the project may affect the NLEB, any resulting incidental take is not prohibited pursuant to the final 4(d) rule, and requested FWS's concurrence with this determination by December 27, 2018. According to the streamlined consultation framework, as no response was received from FWS, staff's determination satisfies the Commission's responsibilities under the ESA for the NLEB. Therefore, no further consultation under the ESA is required regarding the NLEB.

3.3.5 Land Use, Recreation, and Aesthetics

3.3.5.1 Affected Environment

Land Use

Approximately 90.2 percent of the land area in Hancock County is forested. Agriculture is limited, and predominately includes apple orchards and blueberry barrens. The City of Ellsworth is the most developed part of Hancock County. Use of project land is light, with recreational activities, project operation, and project maintenance being the primary activities that occur on project land. Approximately 160 acres on the southern end of Hardwood Hill Island in the northern part of Graham Lake has been placed under conservation by the property owner, the Frenchman Bay Conservancy.[235]

[235] *See* comments filed by the Frenchman Bay Conservancy on April 9, 2018.

The current project boundary for the Ellsworth Project as established in the Commission's 1987 License Order and amended in 1992[236] and 1999,[237] encompasses approximately 13,449 acres, of which approximately 10,099 acres are water. The existing project boundary includes: (1) land and water up to a contour elevation of 107.0 feet msl on Graham Lake, and the islands located on Graham Lake; (2) land and water up to a contour elevation of 66.7 feet msl on the Union River between the Graham Lake Dam and Lake Leonard; (3) land and water up to a contour elevation of 66.7 feet msl on Lake Leonard; (4) approximately 800 feet of the Union River and shoreline downstream of the Ellsworth Dam; and (5) land associated with the project's two dams, flood control structures, powerhouse, generator lead line, recreation facilities, and appurtenant facilities.

No federal land exists within or adjacent to the project boundary, though the FWS-owned and operated Green Lake National Fish Hatchery is located just outside of the project boundary on Reeds Brook, a tributary of the Union River that flows in to Graham Lake.

Statewide Recreation Plan

The 2014-2019 Maine State Comprehensive Outdoor Recreation Plan (SCORP) identifies outdoor recreation as central to the state's economic, environmental, and community values. The SCORP identifies broad goals of using outdoor recreation to improve health and drive economic development in Maine. The SCORP identifies strong future growth in water-based activity. The SCORP recommends expanding identification, signage, and promotion of resources, like water trails, as a way of connecting both local users and tourists to the state's many existing resources for water-based recreation (Maine DACF, 2015).

Regional Recreation Opportunities

The Union River Basin contains many opportunities for recreation, including fishing, hunting, boating, snowmobiling, picnicking, and vacation homes. Numerous lakes surround the region, of which Graham Lake is the largest. The popular Gulf of Maine coast and its many inlets are immediately to the south of the Union River. Acadia National Park attracts recreationists from all over the world, and its main unit is located on Mount Desert Island 20 miles south of Ellsworth.

[236] *See Bangor Hydro-Electric Company*, 58 FERC ¶ 62,014 (1992).

[237] *See Bangor Hydro-Electric Company*, 86 FERC ¶ 62,221 (1999).

Recreation at the Project

Black Bear Hydro permits public use of the land and waters surrounding the project for recreation. The project has three recreation facilities that Black Bear Hydro owns and maintains (see Figure 27): (1) the Shore Road carry-in boat launch on Lake Leonard that includes a 2-vehicle parking area and a 6-foot-wide concrete plank ramp for carry-in boats; (2) the Graham Lake boat launch near the Graham Lake Dam that includes an 8-vehicle parking area and a 12-foot-wide concrete plank ramp for motorized boats; and (3) an approximately 360-foot-long canoe portage trail around the east side of Graham Lake Dam. An informal fishing area is located immediately downstream of the Ellsworth Dam.

Non-project recreation sites include: (1) a City of Ellsworth-owned picnic area on Shore Road on the east shore of Lake Leonard; (2) a city-owned access site at Infant Street on both sides of the Union River that includes informal trails to the shoreline on the east and west banks of the Union River upstream of Lake Leonard, and an access and parking area on the eastern bank of the Union River on Infant Street; (3) the state-owned Fletcher's Landing unimproved boat launch on the eastern shore of Graham Lake; and (4) a Town of Mariaville-owned carry-in boat launch on the west side of Graham Lake. There is also a Town of Mariaville-owned boat ramp located just outside of the project boundary on the Union River north of Graham Lake. Maintenance of these non-project facilities is not the responsibility of Black Bear Hydro. Informal public access is also available at numerous points where the project is bordered by roads. In addition to public access, many private land owners have waterfront property and use the project for recreation.

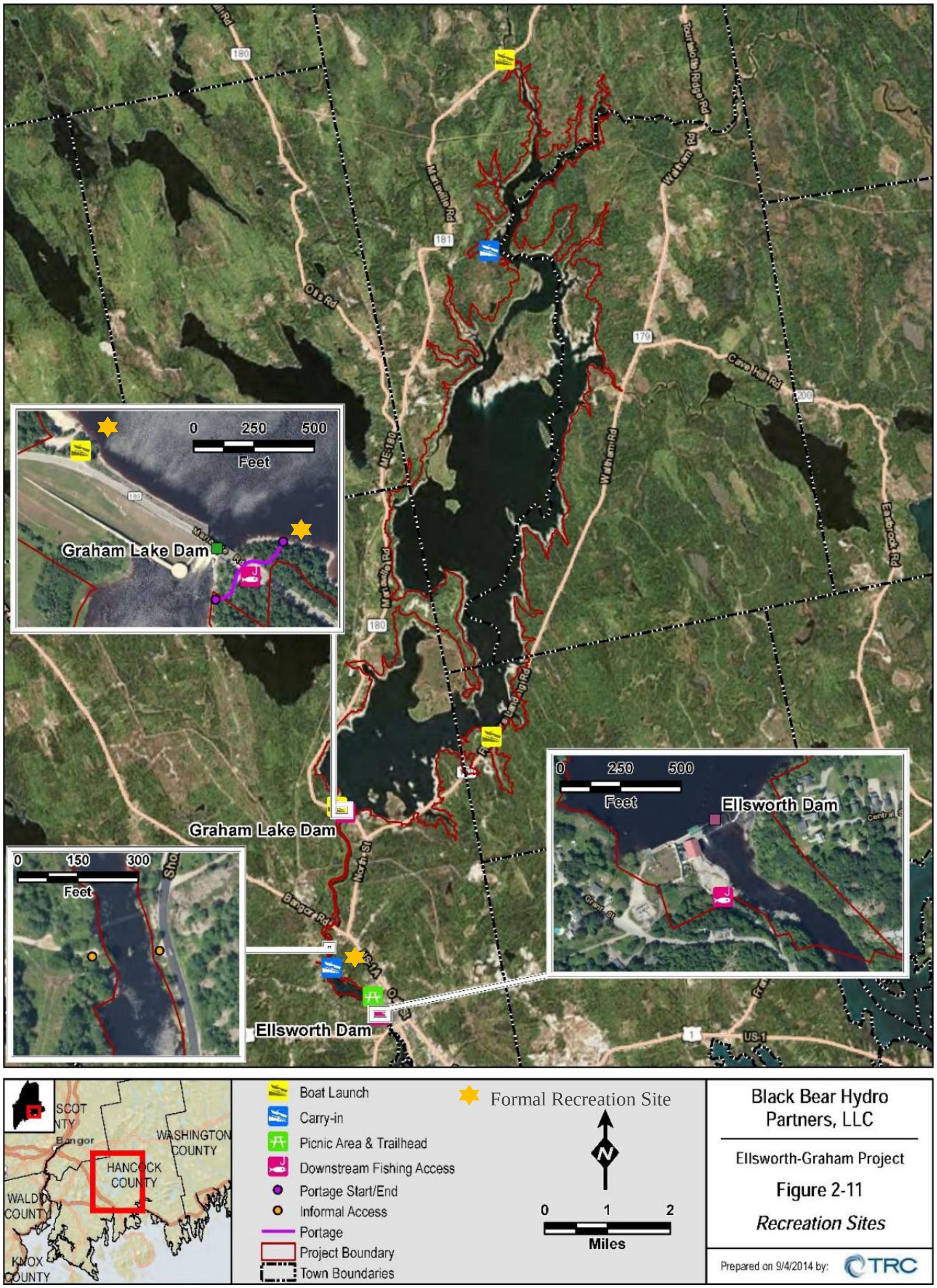

Figure 27. Map showing project recreation facilities. (Source: Black Bear Hydro, 2015b, as modified by staff).

Recreational Use

The most popular recreational activities at the project are fishing and boating. Whitewater boating occurs on the Union River between Graham Lake Dam and Lake Leonard, but use of this whitewater stretch is low. Winter activities include snowmobiling, ice fishing, snowshoeing, cross-country skiing, and ice skating.

Recreational use of project facilities is light, with Black Bear Hydro estimating the annual project recreation to be 2,620 recreation days.[238] Black Bear Hydro estimates that peak weekend use is approximately 50 users, with recreation facility utilization at no more than 20 percent capacity. Recreation use was nearly evenly split between the three project recreation facilities during the 2014 recreation use study that was conducted from April to October, with the Shore Road carry-in launch receiving 890 recreation days, the Graham Lake Dam boat launch receiving 920, and the canoe portage trail receiving an estimated 820. Most of the users of the canoe portage trail were using it to access fishing immediately downstream of the dam, and the trail was only rarely used by boaters.

Hundreds of private residences are located along the shorelines of Graham Lake and Lake Leonard, with 118 waterfront properties located on Graham Lake in the City of Ellsworth alone (Fuller, 2016). Some of these residences are used as seasonal vacation homes, while others are occupied year round.

Graham Lake Water Elevation

Water access for residences along Graham Lake is dependent on the impoundment water elevation. The 1987 License Order requires that the water level in Graham Lake be maintained between 93.4 and 104.2 feet msl. The Graham Lake Development generally follows an informal target operating curve where the impoundment is drawn down during the summer and winter and refilled in the fall and spring. According to the operating curve used by the licensee, Graham Lake is drawn down from a target elevation of approximately 102 feet msl on January 1 to a target elevation of 93.4 feet msl on March 31. Graham Lake is then filled to a target elevation of 104.2 feet msl between April 1 and mid-May, and is gradually drawn down over the summer to a target elevation of 97.8 feet msl by early October. Graham Lake is then partially refilled from mid-October to the end of December to a target elevation of approximately 102 feet msl (see Figure 5).

[238] A "recreation day" is defined as each visit to a development for recreational purposes during any portion of a 24-hour period.

Actual elevations at Graham Lake have varied widely from the target operating curve (see Figure 5).[239] The average daily summer lake elevation from 1999 to 2014 never dropped below 98.5 feet msl. From 2001 through 2015, the lowest single daily impoundment level outside of the winter drawdown was 96.7 feet msl, which occurred from September 24 to September 28, 2010. In recent years, Graham Lake elevations have dropped below 96.7 feet msl (*e.g.*, from mid-September through November 2017, with a minimum elevation of 93.8 feet msl on October 25, 2017).[240]

Much of the shoreline of the Graham Lake is relatively shallow. There is also great variation in depth along the shoreline and in the impoundment (see Figure 4).

Aesthetics

The project waters can be viewed from numerous vantage points, including bridges, recreation facilities, roads, and private properties. The Graham Lake Dam is visible from Patriot Road (the former Maine Route 180). The Ellsworth Dam is visible from the informal downstream fishing access area.

The view of the water in Graham Lake is a popular aesthetic attraction, and is prominently visible from the properties located along the shoreline. Many of these properties have permanent and seasonal homes located along the shoreline of the lake. The attractiveness of the aesthetic values of these shoreline properties causes these properties to be taxed at a higher rate by the City of Ellsworth, whose boundaries include 118 of the waterfront properties on Graham Lake (Fuller, 2016)

3.3.5.2 Environmental Effects

Graham Lake Water Elevation

Black Bear Hydro proposes to continue operating the project as licensed in the 1987 License Order, including operating the project so that water levels at Graham Lake are maintained between the elevations of 93.4 and 104.2 feet msl, and water levels at Lake Leonard are maintained between 65.7 and 66.7 feet msl during normal project operation.[241]

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[239] *See* Black Bear Hydro's April 8, 2013 proposed study plan (Black Bear Hydro, 2013a) and May 12, 2016 response to deficiencies and additional information request.

[240] *See* November 30, 2017 letter from Black Bear Hydro.

[241] On March 29, 2019, Black Bear Hydro filed a new WQC application with Maine DEP that includes a proposal to operate Graham Lake between 98.5 and 104.2 feet msl. However, Black Bear Hydro has not filed an amended final license application

Residents that own land along the shoreline of Graham Lake filed 32 comments requesting that annual elevation drawdowns in Graham Lake be reduced. Most of the commenters did not propose specific water elevations, and simply asked for a reduction in lake level drawdowns. Several landowners indicate that the reservoir drawdowns during 2016 and 2017 were lower than past drawdowns. They stated that the lower lake levels made it difficult if not impossible to access the water from their shoreline properties due to expansive mudflats.[242] Commenters also complained that the mudflats and turbid lake water negatively affected the aesthetic qualities of their waterfront properties.[243]

Maine DIFW filed a comment requesting that elevation drawdowns be reduced, and specifically discussed the negative effect of the current allowable drawdown range on ice fishing. Maine DIFW stated that extremely low lake levels in winter were affecting ice fishing by making it difficult for ice anglers to find water under the ice. Landowners and stakeholders filed several operational alternatives to reduce project effects on recreation and aesthetics by limiting drawdowns that expose mudflats. Landowners and stakeholders recommend minimum elevations ranging from 96.0 feet msl to 102 feet msl. Table 39 compares Black Bear Hydro's current operating regime with the lake elevation regimes recommended by commenters that filed specific elevation ranges. Recommended alternative lake level regimes range from a stable elevation (Cook *et al*., as represented by a one-foot annual drawdown) to a range of 7.2 feet (Maine DIFW) (see Table 39).

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stating that it is revising its formal proposal to continue operating Graham Lake between 93.4 and 104.2 feet msl. To ensure a comprehensive environmental analysis, we include Black Bear Hydro's WQC proposal as an alternative operating range throughout the final EA. We refer to this alternative as "BBH Alternative."

[242] *See, e.g.*, April 5, 2018 filing from the Hancock County Planning Commission; April 9, 2018 filing from Kathryn Mullen; comments of Robert Miller; filed February 11, 2019; and comments of Ed Damm, filed February 25, 2019.

[243] *See, e.g.*, March 19, 2018 filing from Jeffrey Smith; April 3, 2018 filing from Kevin Bullard; April 9, 2018 filing from DSF; April 9, 2018 filing from the Native Fish Coalition; comments of Mark Whiting and Catherine Fox, filed on February 4, 2019; comments of Brad Perry, filed February 6, 2019; comments and signed petitions filed by DSF on February 19, 2019; and comments of Ed Damm, filed February 25, 2019.

Table 39. Comparison of alternative Graham Lake elevation ranges.

Alternative[1]	Minimum Elevation (feet msl)	Maximum Elevation (feet msl)	Operating Range (feet)	Impoundment Surface Area at Minimum Elevation (acres)	Impoundment Surface Area at Maximum Elevation (acres)	Extent of Mudflats (Acres of Land Dewatered at Minimum Impoundment Elevation)
Black Bear Hydro	93.4	104.2	10.8	7,374	10,042	2,668
Maine DIFW	97.0	104.2	7.2	8,076	10,042	1,966
Dunn	96.0	103.0	7.0	7,864	9,620	1,756
Washburn and Friends	96.4	102.2	5.8	7,947	9,388	1,441
BBH Alternative	98.5	104.2	5.7	8,419	10,042	1,623
Whiting 1	98.5	103.0	4.5	8,419	9,620	1,201
Bryant *et al.*	98.0	102.0	4.0	8,301	9,331	1,030
DSF and Flower	99.0	103.0	4.0	8,608	9,620	1,012
Cook *et al.*	102.0	103.0	1.0	9,331	9,620	289

[1] For further description of recommending entities, their recommended elevations, and any assumptions made by staff, see page 86.
(Source: Staff)

Some landowners also recommend that the maximum lake level elevation of 104.2 feet msl be reduced by as much as 2.2 feet, based on shoreline erosion from high water levels in the spring and the resulting turbidity in the impoundment.[244]

Our Analysis

Minimum Water Elevation

Black Bear Hydro's current license allows a maximum operating range of 10.8 feet for Graham Lake on an annual basis, ranging from 93.4 and 104.2 feet msl. However, according to data provided from 1999 through 2014 (see Figure 5), Black Bear Hydro kept the lake elevation within a much smaller band, ranging from an average high elevation of approximately 103.5 feet msl and an average low of approximately 98.2 feet msl. Extreme elevations during this time period reached a maximum high elevation of approximately 104.6 feet msl (slightly above the allowable range) and a minimum low elevation of approximately 95 feet msl (within the allowable range).

The Commission received complaints from Lisa Currie and Maine DIFW about low lake levels in October and November 2017.[245] Ms. Currie discussed the extremely low lake levels that occurred in October 2017, and created large areas of mudflats that impacted the aesthetics of Graham Lake. Maine DIFW discussed the extremely low lake levels that occurred in February 2015 and affected ice fishing access. Thomas Dunn later filed comments indicating that Graham Lake becomes inaccessible to boats at lower lake elevations because of exposed mudflats located at the end of public boat landings, and because of shallow water areas that are strewn with rocks and tree stumps.[246] All of these commenters identified issues that occur at the extreme low end of the allowable elevation range for Graham Lake (*i.e.*, lower than approximately 96 feet msl), and suggested raising the minimum allowable elevation at Graham Lake.

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[244] *See* comments of Richard Arnold, filed March 6, 2018; intervention request of Friends of Graham Lake Association, filed March 26, 2018; comments of Michelle R. Dawson, filed April 6, 2018; intervention request of the Frenchmen Bay Conservancy, filed April 9, 2018; comments of Jane Washburn, filed April 6, 2018; comments of Thomas P. and Diane Dunn, filed April 18, 2018; comments of Edward A. Damm, filed April 6, 2018; comments of Twyla Bryant, filed January 16, 2019 and January 18, 2019; comments of Mark Whiting and Catherine Fox, filed on February 4, 2019; and comments and signed petitions filed by DSF on February 19, 2019.

[245] *See* comments of Lisa Currie, filed October 20, 2017, and Maine DIFW, filed November 2, 2017.

[246] *See* comments of Thomas Dunn, filed April 18, 2018.

The effects of the seasonal reservoir drawdowns on recreation access and the aesthetic value of the project vicinity are more pronounced at lower elevations. In the fall of the 2016 and 2017 drought years, water elevations at approximately 95 to 96 feet msl affected recreational use at Graham Lake by leaving docks dry and reducing access to boating, fishing, and swimming from public boat ramps and private properties. From 1999 through 2014, the average lake elevation during the fall was approximately 99 feet msl. The lowest single elevation during the fall was 95 feet msl (see Figure 5), which occurred in 2001 when the lake was uncharacteristically low until spring of the next year. Satellite imagery from September 25, 2016 when the lake elevation was 97.17 feet msl indicates that the state-owned Fletcher's Landing public boat ramp was unusable during the fall season due to a large mudflat that blocked access to the lake (see Figure 28). Black Bear Hydro states that the Graham Lake Dam boat ramp is usable to an elevation of approximately 94 feet msl.

Figure 28. Satellite image from September 25, 2016 showing a mud flat preventing access to Graham Lake from the state-owned Fletcher's Landing boat ramp (Source: Google Earth, as modified by staff).

Water elevations at 98 feet msl or below also negatively affected the aesthetic value of the shoreline by exposing the impoundment bottom and resulting in substantial areas of mudflats. These lower water elevations were within the existing normal operating range and were above the minimum water elevation of 93.4 feet msl required by the existing license, but nonetheless adversely affected recreational use and aesthetics at Graham Lake (see Figure 29).

Figure 29. Comparison of lakebed exposed at different lake elevations. On the left, Graham Lake is pictured in April 2016 at approximately 103 feet msl (approximately 1 foot below normal full pond elevation of 104.2 ft msl [see Figure 5]) and on the right, Graham Lake is pictured in October 2016 at approximately 96 feet msl. The large rock is the same rock in both photos, though taken from different angles (Source: March 24, 2017 filing from Edward Damm).

Lower water elevation levels in winter can negatively impact recreational use as well, as ice fishing is a popular winter activity on Graham Lake. Large drawdowns in winter can dewater large areas of the lake bed under the ice, making it difficult for ice anglers to locate water, especially close to the shoreline.

Recreation access at lakes during the summer and fall seasons is a regional issue stemming from reduced project inflow after the winter snowpack has melted. To reduce the environmental effects of reservoir drawdowns on recreational access, other hydropower project operators in the region have proposed various operational changes and project modifications, including higher minimum elevation levels, such as at the West Branch Project No. 2618 (Domtar Maine Corp., 2008),[247] and longer boat ramps to allow boating access at lower lake levels, such as at the Brassua Project No. 2615 (FPL Energy Maine Hydro LLC *et al.*, 2010).

Reducing the seasonal reservoir drawdown by increasing the minimum water level elevation, as suggested by landowners and other stakeholders, would improve recreation access to Graham Lake by increasing accessibility to private and public boat ramps and docks relative to the existing minimum elevation level of 93.4 feet msl. Reducing the extent of seasonal drawdowns would also reduce the size of the mudflats that are exposed on a seasonal basis, which could allow for easier access to the lake from the shoreline and improve the aesthetic quality of the lake. While increasing the length of the boat ramps at Graham Lake would increase accessibility, it would not reduce the size of the exposed impoundment bottom that occurs at lower water elevations.

As shown in Table 39, Black Bear Hydro's proposal to maintain the existing minimum impoundment elevation of 93.4 feet msl would result in a minimum reservoir surface area of 7,374 acres. The surface area of the impoundment could change by as much as 2,668 acres between the maximum impoundment elevation of 104.2 feet msl and the minimum impoundment elevation of 93.4 feet msl. Using the change in the impoundment size as an estimate for the amount of land dewatered, staff estimates that up to 2,668 acres of mudflats could be exposed if the full 10.8-foot operating range was used on an annual basis. In comparison, a minimum elevation of 102.0 feet msl, which is consistent with Bryant *et al.*'s recommendation, would increase the minimum reservoir surface area to 9,331 acres and would limit the exposure of the land at the bottom of the impoundment to 1,030 acres across the recommended 4.0-foot operating range. Therefore, a minimum elevation of 102.0 feet msl would increase the minimum impoundment size by 927 acres relative to the existing minimum elevation of 93.4 feet msl.

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[247] *See Woodland Pulp LLC*, 154 FERC ¶ 62,175 (2016).

Due to the uneven topography along the bottom of the lake, the extent of lakebed exposure at any given elevation can vary widely over short distances and create significant differences in the effects on individual shoreline properties (see Figure 30).

Figure 30. Satellite photograph showing variations in lake bed exposure along the shoreline of Graham Lake on September 25, 2016 (lake elevation at 97.17 feet msl) (Source: Google Earth, as modified by Commission staff).

Due to the highly variable shoreline depths along the edges of Graham Lake, it is not possible to determine a specific minimum drawdown elevation that would provide universal impoundment accessibility for all landowners during the fall season. Lake level elevations that would greatly improve water access for some shoreline property owners would only moderately improve access for others.

Maximum Water Elevation

As discussed above, the current license provides for a maximum water elevation limit of 104.2 feet msl at Graham Lake. From 1999-2014, the average daily water surface elevation at Graham Lake exceeded a water elevation of approximately 102 feet msl between mid-April and mid-July, during the time in which the impoundment was being refilled by snowmelt and prior to the impoundment drawdown in the late summer and early fall (Figure 5). In their comments, landowners recommend that the maximum lake level elevation of 104.2 feet msl be reduced by as much as 2.2 feet to reduce shoreline erosion from high water levels in the spring and the resulting turbidity in the impoundment.[248]

Erosion is occurring in select areas along the shoreline of Graham Lake, including bank slumps located primarily along the western shore of the impoundment. Small amounts of localized erosion are also occurring around the shoreline, as reported by landowners. Even though there is very little data available regarding the respective types, rates, and magnitude of shoreline erosion at Graham Lake, a study conducted by the licensee in 1990 confirmed that a majority of the shoreline at Graham Lake has been subject to erosion forces since the establishment of the original impoundment. However, the study also found that the target operating curve that is used by the licensee to guide seasonal drawdowns and impoundment refilling has helped reduce the erosion conditions and reduce the risk of erosion. The study found that while erosion continues to take place along some sections of the shoreline, the erosion is predominantly due to wave action under the maximum water levels that occur in the spring.

Shoreline erosion affects the aesthetic value of Graham Lake and damages lakefront properties at the interface between the land and the impoundment. Erosion of soil along the shoreline also contributes to the turbidity of Graham Lake, which affects aesthetics at the project (see Figure 14 and Table 13). Reducing the maximum shoreline elevation could reduce erosion and turbidity by reducing inundation and wave action at higher elevation levels. For instance, reducing the maximum impoundment elevation by 2.2 feet, as recommended by Bryant *et al*., would reduce the wave action on the edge of the impoundment between 102 feet msl and 104.2 feet msl (see Table 14).

In its comments on the draft EA, Black Bear Hydro states that the analysis does not discuss the effects of reducing the full pond level on shoreline landowners, and whether docks will need to be replaced or extended if the maximum impoundment level is permanently lowered during the summer season.

According to the average daily elevation of Graham Lake between 1999 and 2014 (see Figure 5), Graham Lake has historically increased above 102 feet msl between mid-April and mid-July. In 2016, the lake's elevation was only above 103 feet msl from April

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[248] *See* comments of Richard Arnold, filed March 6, 2018; intervention request of Friends of Graham Lake Association, filed March 26, 2018; comments of Michelle R. Dawson, filed April 6, 2018; intervention request of the Frenchmen Bay Conservancy, filed April 9, 2018; comments of Jane Washburn, filed April 6, 2018; comments of Thomas P. and Diane Dunn, filed April 18, 2018; comments of Edward A. Damm, filed April 6, 2018; comments of Twyla Bryant, filed January 16, 2019 and January 18, 2019; comments of Mark Whiting and Catherine Fox, filed on February 4, 2019; and comments and signed petitions filed by DSF on February 19, 2019.

27 through May 12.[249] Historically, water levels generally decrease below 102 feet msl from mid-July through the end of the summer recreation season. By Labor Day, the average lake elevation has been around 100 feet msl. Provided that the elevation of Graham Lake is lower than 102 feet msl for a large portion of the summer season, most docks on Graham Lake should be constructed to provide access to the lake at lower elevations.

While reducing the maximum elevation limit could temporarily affect the aesthetic value of Graham Lake by exposing mudflats in certain areas until vegetation colonizes the exposed land, over time a reduction in the maximum elevation limit could improve aesthetics in the lake by reducing lake turbidity (see section 3.3.2.2, *Aquatic Resources – Environmental Effects*, for additional discussion on turbidity).

Cook *et al.*'s, Dunn's, DSF and Flower's, and Whiting 1's recommended maximum elevation of 103.0 feet msl would reduce the maximum elevation of Graham Lake by 1.2 feet relative to existing conditions. Similar to Bryant et al.'s recommendation, a maximum elevation of 103.0 feet msl would reduce the wave action at upper elevations, thereby reducing the potential for shoreline erosion and turbidity in Graham Lake. The reduction in the amount of erosion and turbidity would likely be less than the reduction that would be seen under Bryant et al.'s recommendation to reduce the maximum elevation to 102 feet msl, but the extent of the difference between the two sets of recommendations cannot be quantified due to the depth variations along the Graham Lake shoreline. Altogether, relative to the existing maximum elevation limit that Black Bear proposes to continue maintaining, the elevation limits proposed by Cook *et al.*, Bryant et al.'s, Dunn, and Whiting 1 would reduce project effects on recreation and aesthetic resources by reducing shoreline erosion and turbidity in Graham Lake.

<u>Deviations from Normal Project Operation</u>

Black Bear Hydro proposes to temporarily modify the elevation limits at Graham Lake and Lake Leonard during: (1) approved maintenance activities; (2) extreme

[249] *See* November 30, 2017 letter from Black Bear Hydro.

hydrologic conditions;[250] (3) emergency electrical system conditions;[251] or (4) agreement between the Licensee, the Maine DEP, and appropriate state and/or federal fisheries management agencies.

Our Analysis

These deviations from normal operation could affect recreation by resulting in lower lake level elevations at Graham Lake through drawdowns, or in lower lake elevations at Lake Leonard through reduced flows from Graham Lake. In either case, drawdowns could make accessing the water from the shoreline or boat ramps difficult because of exposed lakebed. However, adverse project effects on recreation would be minimized because the deviations would be: (1) temporary in nature; (2) limited to activities that are necessary for project operation and maintenance, or to address emergency conditions; and (3) would be carried out in consultation with resource agencies. In addition, the Commission's standard terms and conditions for a hydropower license provide that licensees can make minor modifications to project operation if such changes do not result in a decrease in efficiency of the project, a material increase in project cost, an adverse environmental impact, or the impairment of the general scheme of development. To the extent additional measures need to be implemented during a planned modification to normal project operation, Black Bear Hydro would need to file the measures with the Commission for approval prior to the occurrence of the planned deviation. The Commission's standard terms and conditions for a hydropower license also provide that licensees can modify project operation when needed during an emergency, including the protection of navigation, life, health, or property, without prior approval from the Commission. However, any such modifications are subject to alteration as the Commission may direct.

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[250] Black Bear Hydro defines "extreme hydrologic conditions" as the occurrence of events beyond the licensee's control such as, but not limited to, abnormal precipitation, extreme runoff, flood conditions, ice conditions or other hydrologic conditions such that the operational restrictions and requirements for minimum flow releases and impoundment elevation limits are impossible to achieve or are inconsistent with the safe operation of the project.

[251] Black Bear Hydro defines "emergency electrical system conditions" as operating emergencies beyond the licensee's control which require changes in flow regimes to eliminate such emergencies which may in some circumstances include, but are not limited to, equipment failure or other temporary abnormal operating conditions, generating unit operation or third-party mandated interruptions under power supply emergencies, and orders from local, state, or federal law enforcement or public safety authorities.

Recreation Facilities

Black Bear Hydro is proposing improvements to enhance access and use of the project for recreation. Black Bear Hydro proposes to improve the Graham Lake boat launch by grading and compacting the gravel section of the boat launch to redirect drainage from the parking lot and correct an erosion problem near the top of the ramp. Black Bear Hydro also proposes to relocate and extend the existing canoe portage trail at Graham Lake Dam by: (1) moving the trail from the east side to the west side of the Union River; (2) adding a new upstream take-out near the Graham Lake boat launch instead of using the existing launch so as to avoid conflict between paddlers and motor boater users; (3) moving the trail to more level ground; (4) increasing trail length from approximately 360 to 1,000 feet; (5) adding a new downstream put-in area on the Union River; and (6) installing directional and safety signage. Black Bear Hydro is planning to construct the new portage trail to avoid potential safety issues caused by the current trail's take-out that is close to the upstream boat barrier at Graham Lake Dam (see Figure 31). The downstream portion of the existing portage trail would still be maintained for angler access from the road to the water at the bottom of the dam. Black Bear Hydro is also proposing to improve the downstream shoreline access trail for fishermen on the east side of the Graham Lake Dam, but has not provided details on what improvements would be made. Black Bear Hydro is also proposing to maintain directional and safety signage at the project.

Black Bear Hydro is proposing to implement a Recreation Facilities Management Plan that includes measures for the proposed recreational improvements described above and measures for management of project recreation facilities during the term of any new license.

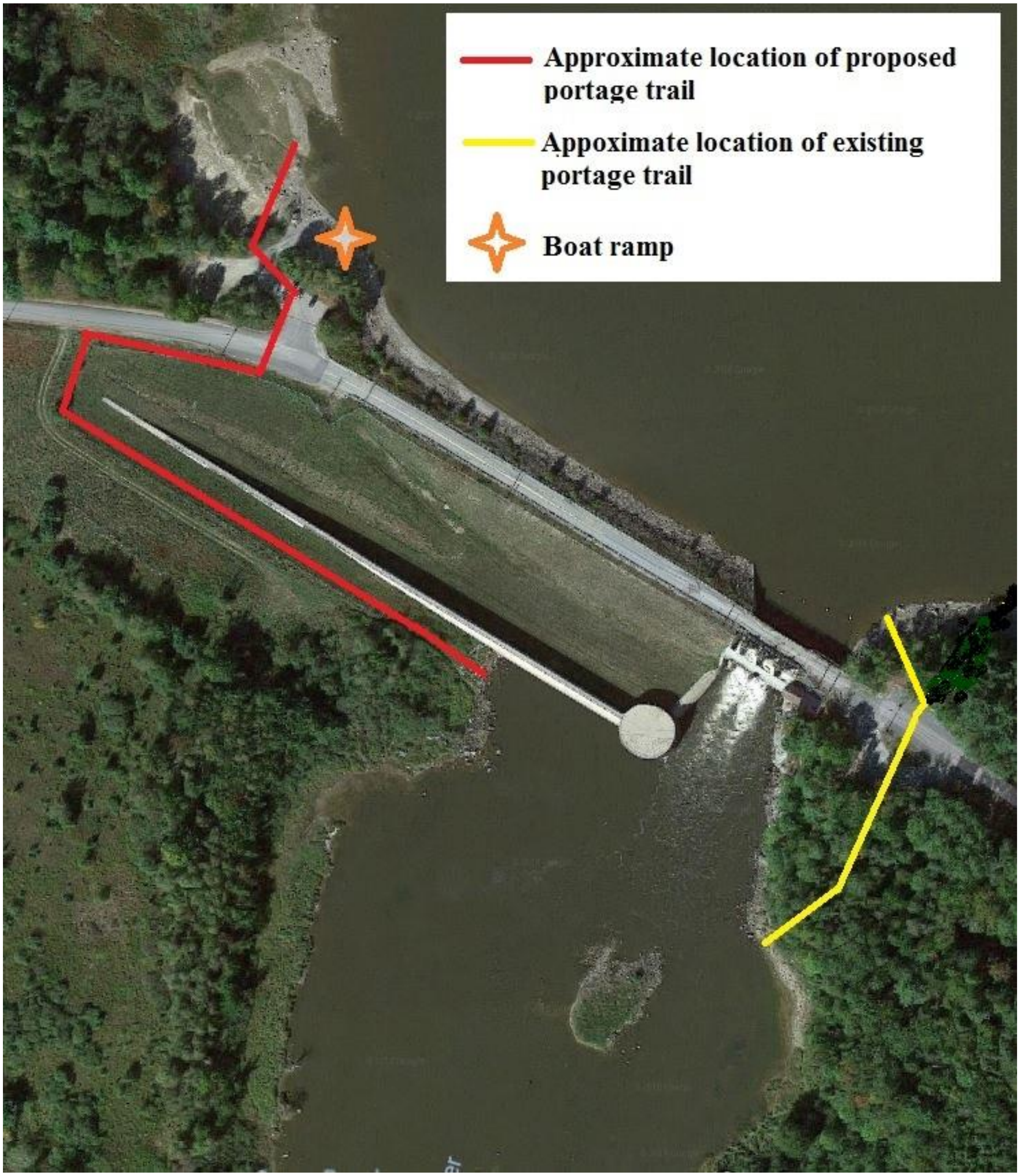

Figure 31. Satellite image showing the location of the proposed portage trail(Source: Google Earth, as modified by staff).

Our Analysis

Black Bear Hydro currently operates and maintains recreation facilities that provide opportunities for boating and fishing in the project impoundments. The existing project recreation facilities are used at only a fraction of their capacity, and therefore appear to be sufficient to meet the demand for recreation in the project vicinity.

The canoe portage trail receives relatively little use by portaging boaters, but still provides a vital link between boating in Graham Lake and the Union River downstream of Graham Lake. A lack of a portage trail around the Graham Lake Dam would prevent any boaters from easily continuing to canoe from Graham Lake to the Union River and Lake Leonard. The existing take-out on Graham Lake, however, is located immediately adjacent to the boat barrier upstream from the intake gates at the dam, which creates a potential safety concern. The trail is relatively steep, and is more popular with anglers than boaters because it provides access to fishing immediately downstream from the Graham Lake Dam at the put-in area.

Relative to the existing canoe portage facility around the Graham Lake Dam, Black Bear Hydro's proposal to relocate the existing canoe portage trail would provide safer portage because the take-out would be located further from the dam gates. Although the proposed portage trail would increase the length of the portage route from approximately 360 feet to approximately 1,000 feet, the increase in length would be offset by easier portage along a grassy and more gently-sloping route compared to the existing portage route that is steeper and forested. Black Bear Hydro's proposal to place the take-out near to, but separate from, the motorized boat ramp would make the portage take-out easier to locate because it would be near the existing boat ramp, but would reduce the chance for potential conflicts between paddlers and motorized boaters.

Black Bear Hydro's proposal to improve the fisherman's downstream access trail would likely improve the user experience for anglers visiting the project because the trail is currently heavily vegetated with overhanging tree limbs and the existing trail is steep, with uneven footing and areas of erosion. However, Black Bear Hydro does not describe the actual improvements that it is proposing to make to the access trail. Based on the description of the trail as steep and uneven, and photographs showing that the trail is heavily vegetated by shrubs and small trees, it appears that safer access to the Union River downstream of the Graham Lake Dam could be provided by vegetation clearing, trail grading, and installing erosion control mechanisms. Maintaining directional and safety signage would improve recreation at the project by directing the public to recreation sites and informing the public about safety issues, including individuals using the canoe portage route.

The Graham Lake boat ramp is the only Commission-licensed boat ramp that provides public access to Graham Lake. Correcting the drainage problem near the top of the boat ramp would help to protect the boat ramp from further erosion damage and thereby ensure public access. However, Black Bear Hydro's proposal lacks detail, including the size of the area that needs to be stabilized and a schedule detailing when the improvements would be completed.

Black Bear Hydro's proposed Recreation Facilities Management Plan includes measures for improving and maintaining project recreation facilities, which would help ensure that project facilities are properly maintained for the term of any new license issued for the project. Revising the Recreation Facilities Management Plan to describe the recommended improvements to the fisherman access trail and the Graham Lake boat ramp, including a schedule for making the improvements and a description of the extent of the improvements, would help to ensure that the improvements are made in a timely manner and that facilities remain accessible for anglers and boaters during the term of any new license.

Guaranteed Access

Interior recommends under section 10(a) of the FPA that Black Bear Hydro ensure reasonable access to the project waters for recreation and other uses. Interior recommends that Black Bear Hydro develop an access plan in consultation with Interior and the State of Maine showing the routes over which access will be guaranteed, and the mechanism for such guarantee, including any associated fees and the basis for these fees. The recommended plan would focus on Graham Lake, but would also include the Ellsworth impoundment and the tailrace waters. The plan would note how access is made available to Graham Lake over the range of operating water levels. The plan would also provide for the posting of notices informing the general public as to the available access routes. Interior recommends that the plan be filed with the Commission within one year if the issuance of any new license for the project.

Our Analysis

Multiple points of public access to project waters for recreation and other uses exist at the project. There are five boat access points to project water: two are owned and operated by the licensee, one is owned and operated by the state, and two are owned and operated by municipalities. There is also an informal boat access point to Lake Leonard, and fishing access downstream of each dam. The existing canoe portage trail around the Graham Lake Dam provides access to fishing downstream of the Graham Lake Dam, and Black Bear Hydro proposes to improve this trail. In addition, project water can be accessed at numerous informal access points along roads that parallel the water.

Black Bear Hydro proposes to continue to operate and maintain existing recreation facilities (*e.g.*, the Graham Lake Dam boat launch, the existing portage trail around Graham Lake Dam, and the Shore Road carry-in boat launch on Lake Leonard) that provide public access to project waters. Black Bear Hydro is also proposing recreation improvements (*e.g.*, constructing a new portage trail around Graham Lake and improving the Graham Lake Dam boat launch and the existing fisherman's access trail) that would help to ensure continued public access.

Some of the formal access sites, however, do not provide access to Graham Lake at lower water elevations. At the lower allowable lake levels, most public boat ramps become unusable because of several feet or more of mud between the end of the boat ramp and the water, or because of mudflats that block submerged boat ramps from the rest of the lake (*e.g.*, Figure 28 indicates that the Fletchers Landing boat ramp is cut off from the lake by a mudflat at 97.17 feet msl). However, Black Bear Hydro states that the Graham Lake Dam boat ramp is usable down to 94 feet msl (Black Bear Hydro, 2018b). Increasing the minimum impoundment elevation from the existing 93.4-foot msl level to an elevation above 94 feet msl would provide access to the lake through the Graham Lake Dam boat ramp.

Interior recommends that Black Bear Hydro ensure reasonable access to project waters for recreation and other uses by developing an access plan. However, the Commission's standard terms and conditions for a hydropower license already require a licensee to maintain and operate reasonable access to project recreation facilities, including access roads and launching ramps. As far as it is consistent with the proper operation of the project, the standard terms and conditions for a hydropower license also require a licensee to provide the public with free access, to a reasonable extent, to project waters and adjacent project land owned by the licensee for the purpose of full public utilization of such lands and waters for navigation and for outdoor recreational purposes, including fishing and hunting. In addition, Black Bear Hydro's proposed Recreation Facilities Management Plan includes a map showing the existing and proposed recreation facilities and a description of each of the recreation facilities (including the location and accessibility). With the Commission's standard terms and conditions, and the proposed Recreation Facilities Management Plan, Interior's recommended access plan would result in little to no benefit for recreational access and use.

However, Interior's recommendation to post notices describing the availability of access routes would help inform the public of recreation opportunities and access to different sites around the project. The notifications could be posted on a website maintained by the licensee, and could include information including: (1) any planned maintenance at project recreation facilities that would limit public access to the facilities (including a proposed schedule for such maintenance); and (2) ongoing accessibility issues involving maintenance events or extreme hydrologic conditions. The notifications could include estimated schedules for when the project facilities are expected to be accessible by the public. Black Bear Hydro's proposed Recreation Facilities Management Plan could be modified to include the notification requirement, as opposed to including the notification requirement in a separate access plan as recommended by Interior.

3.3.6 Cultural Resources

3.3.6.1 Affected Environment

Area of Potential Effect

Under section 106 of the NHPA of 1966, as amended, the Commission must take into account whether any historic properties within the proposed project's APE could be affected by the issuance of a license for the project. The Advisory Council on Historic Preservation defines an APE as the geographic area or areas in which an undertaking may directly or indirectly cause alterations in the character or use of historic properties, if any such properties exist (36 C.F.R. § 800.16(d)).

Black Bear Hydro developed their APE in consultation with the Maine SHPO. The APE for architectural resources includes the land enclosed by the project boundary and land or properties outside of the project boundary where project construction and operation or project-related recreational development or other enhancements may cause changes in the character or use of historic properties, if any historic properties exist. The APE for archaeological resources includes all land enclosed within the project boundary and/or land located within 50 feet (15 meters) of the edge of the impoundments or river bank, whichever is the greater of the two.

Cultural History Overview

Pre-contact Period

The earliest inhabitants of the region and throughout North America were the Paleoindian people, who rapidly colonized the continent in pursuit of large game (Martin, 1973). The hallmark of the Paleoindian tradition is the fluted spear point, which was presumably used to hunt large game. In Maine, the Paleoindian period dates from approximately 9,500 to 7,500 B.C., when much of the landscape was still tundra and/or woodlands. Paleoindian people living in the region are characterized as highly mobile hunters and gatherers reliant mainly on the caribou that were abundant at that time. They crafted their tools out of fine-grained, colorful rocks obtained from a limited number of sources in the region, and they camped in locations typically removed from present day water bodies (Spiess *et al.*, 1998).

The Archaic period (ca. 7,500 - 1,000 B.C.) represents the longest cultural period in the region. This timeframe is indicative of persistent cultural adaptations over several millennia. This period is subdivided into the Early, Middle, and Late Archaic period. Although Early and Middle Archaic people probably continued a nomadic hunter and gatherer lifestyle, their subsistence and settlement patterns were different from those of the Paleoindian people. This distinction is suggested by the location of most Early and Middle Archaic sites along present-day water bodies and the presence of food remains of aquatic species, particularly beaver, muskrat, and fish (Robinson, 1992).

The close of the Late Archaic period is characterized by a transition to the Susquehanna Tradition, which is widespread in Maine and New England. The people of the Susquehanna Tradition appear to have been more focused on a terrestrial economy than a marine economy (Sanger, 1979).

The introduction of pottery manufacturing and use in Maine defines the onset of what Maine archaeologists call the Ceramic period, but is known more widely as the Woodland period in other parts of the Northeast. Ceramics first appear in the archaeological record of Maine around 3,000 years ago, and they persist until contact with Europeans when clay pots were replaced in favor of iron and copper kettles that were traded for beaver pelts and other animal furs. Ceramic period sites are abundant in Maine, along the coast and in the Maine interior. Sites in the interior are most common along waterways, especially rivers, ponds, and lakes. The presence and nature of artifact forms, and certain types of stone recovered from Ceramic period sites, indicate trade and communication with peoples far to the north, south, and west. By the end of the period, historical and archaeological evidence suggests horticulture was practiced in southern Maine. The Ceramic period ends with European contact around 450 years ago. At this time, most of the artifacts attributable to Pre-contact inhabitants of Maine disappear from the archaeological record (Sanger, 1979).

Post-contact Period

At the time of European contact, a number of tribal groups were living in the region of Maine and the maritime Canadian provinces. Collectively, these groups identified as the Wabanaki, meaning “people of the land of the dawn.” The term generally applies to the Passamaquoddy, Penobscot, Maliseet, and Abenaki, although there is no consensus on use of the term Wabanaki and the peoples who identify as Wabanaki (American Friends Service Committee, 1989).

The Union River was near the border of the Penobscot and Passamaquoddy territories, and there is disagreement between them and amongst historians as to which tribe, if either, controlled the area. It is likely that both tribes made use of the Union River and its runs of Atlantic salmon, shad, and herring. Hunting, fishing, and trade between tribes were conducted in ocean-going canoes along the coast (Bassett, 2015; Prins and McBride, 2007).

Throughout the 16th Century, European fishing vessels frequently made contact with the Wabanaki, but it was not until the first years of the 17th Century that Europeans permanently began to settle in Wabanaki territory and provide written records of these societies. In 1600, the population of Wabanaki in Maine and maritime Canada is estimated to have been 32,000 people. Villages ranged in size from a half-dozen houses to over 100 and they were built at the coast, along the estuaries of rivers, and near lakes, rivers, and streams (American Friends Service Committee, 1989). Samuel de Champlain's 1607 map of the region indicates a Native village along the Rivière des Monts Deserts (*i.e.*, Mount Desert River, which is now known as the Union River) at the site of the City of Ellsworth (Prins and McBride, 2007). As European settlement increased, the native populations experienced sudden and catastrophic population change due to disease epidemics. In the span of a few years, the native population in the region was reduced by as much as 75 percent (American Friends Service Committee, 1989).

European settlement of southeastern, or "Downeast," Maine was light until the mid-18th Century. Until then, Europeans used the area for fishing and trading, with nearby Mount Desert Island serving as a natural beacon for ships. Control was contested between the British moving east from Massachusetts and the French moving west from Acadia in what is now Nova Scotia, as well as the Dutch from New Amsterdam. Multiple wars between European nations, and between the British and the Natives, occurred during this period (Prins and McBride, 2007).

Settlement began at what is now the City of Ellsworth soon after the French lost most of their North American colonial territory to the English after the fall of Quebec in 1759 during the French and Indian War. The first settlers arrived on the Union River in 1763. The settlement and its surroundings were initially known by several names, including the Union River Settlement, Plantation No.7, Bowdoin, New Bowdoin and Sumner. By 1767, the first successful sawmill using the power of the falls in the canyon (present site of the Ellsworth Dam) on the Union River was constructed.

The Union River was occupied by the British from 1779 through 1782, after which it reverted to the United States at the end of the Revolutionary War. In 1800, the towns along the Union River combined to form the City of Ellsworth, named after Connecticut-native Oliver Ellsworth, then Chief Justice of the U.S. Supreme Court (Ellsworth American, 2013). The Union River was again occupied by the British during the end of the War of 1812 (Woodard, 2012). Following the War of 1812, the Union River again reverted back to the United States. After statehood was granted in 1820, the City of Ellsworth became a busy port and shipbuilding center.

The Ellsworth Dam was built in 1907 at the site of a former dam. It was a hollow dam, consisting of two thin, steel-reinforced slabs of concrete supported by concrete buttresses (Ambursen Hydraulic Construction Company, 1908). In 1991, significant portions of the hollow area were filled with concrete to increase the safety of the dam, thus transforming it to more of a gravity-type dam. The dam is the highest hollow dam ever constructed. The powerhouse was also constructed in 1907 and is integral with the dam. The powerhouse is constructed of concrete blocks, and is one-and-a-half stories high with a gable roof covered with Spanish tiles. The building has large arched windows, and there is a decorative Palladian window[252] in the upper story. Above the windows is an ornate concrete cornice. The powerhouse originally housed two turbine-generator units. In 1908, transmission lines were built to connect the Ellsworth power plant with the town of Veazie, Maine and a summer resort at Bar Harbor, Maine. The original two turbine-generator units were expanded to three in 1919. A fourth unit was added in 1923 when the powerhouse was enlarged (Black Bear Hydro, 2012).

The Graham Lake Dam was completed in 1922. In 1923 it was breached by an extreme spring freshet and the City of Ellsworth was flooded and damaged by waterborne logs that had been in the Union River awaiting transport to lumber mills. The flood reduced Ellsworth's preeminence as a port city (Ellsworth American, 2013). The dam was rebuilt the following year. The four-span T-beam Graham Lake Dam Bridge was built atop the Graham Lake Dam and spillway in 1922 by the Bar Harbor & Union River Power Company. The bridge was closed to traffic in 2012 because the Maine Department of Transportation determined that it was no longer structurally sound (Moretto, 2012). A flood control structure was also added to the Graham Lake Dam in 1993 due to concerns over flooding because of the dam's high hazard classification.

Cultural Resource Investigations

Black Bear Hydro conducted a Phase I archaeological survey to identify previously known and previously unidentified Pre-contact sites located in the project vicinity. Desktop analysis and field inspections led to the determination that all previously-known archaeological sites were not eligible for the National Register. The Phase I survey also identified three new Pre-contact sites along the shore of Lake Leonard. In a May 5, 2015 letter, the Maine SHPO concurred with the findings of Black Bear Hydro's survey and recommended a Phase II survey of the three new sites to determine their eligibility for the National Register. The Maine SHPO also stated that although no archaeological site management is necessary along the existing Graham Lake shoreline, an assessment of archaeological sites under the impoundment would be necessary should the Graham Lake water level ever be dropped substantially. In the summer of 2015, Black Bear Hydro conducted a Phase II survey of the three previously unknown Pre-contact sites. Two of the sites were determined to be eligible for listing in the National Register.

Both eligible sites are located along the western shore of Lake Leonard. The first site is a Late Archaic to Middle Ceramic period habitation site stretching for

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[252] A Palladian, or Venetian window has a higher arched central window flanked by shorter and narrower non-arched windows. This style of window is named after its designer, the Venetian Renaissance architect Andrea Palladio (George Washington's Mount Vernon, 2018).

approximately 350 feet along the shore and more than 150 feet inland. The site is relatively undisturbed and contains many artifacts, including pottery sherds, hand axes, bear claws, and eagle talons. The only sign of post-contact use of this site is three glass beads. It is eligible for listing in the National Register under criterion D[253] due to the presence of a hearth with dateable charcoal and Middle Ceramic period pottery. The second eligible site is a habitation site located immediately southeast of the first site along the shore of Lake Leonard. The southern portion of this site has been disturbed, but the northern portion contains evidence that it was occupied during the Late Archaic period (Susquehanna Tradition) as well as the Middle and Late Ceramic period. This site is also eligible for the National Register under criterion D because it contains a Middle Ceramic period component that is within a single stratigraphic level, as well as datable artifacts.

In a December 22, 2015 letter,[254] the Maine SHPO concurred with the finding in the Phase II study report that the two habitation sites on the western shore of Lake Leonard are eligible for listing in the National Register. The Maine SHPO also agreed with the recommendation in the Phase II survey report to monitor the eligible sites on a periodic basis for project-induced erosion and to develop and implement a mitigation plan if project-induced erosion threatens either site. The Maine SHPO recommended that the HPMP for the project include a provision for monitoring the eligible sites on an annual basis for erosion and other possible effects, such as looting.

In addition to the archaeological properties, the APE for the project contains three historic structures: the National Register-listed Ellsworth Powerhouse and Dam, the National Register-eligible Graham Lake Dam and Bridge, and the eligible Maine Central Railroad Bridge. The Ellsworth Powerhouse and Dam and the Graham Lake Dam and Bridge are described above under the post-contact period discussion as they are integral to the history of the area and have distinctive architecture. The Ellsworth Powerhouse and Dam is listed on, and the Graham Lake Dam and Bridge is eligible for listing on, the National Register under criteria A and C.[255]

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[253] Criterion D of National Register eligibility is satisfied by sites that have yielded or may be likely to yield information important in prehistory or history (NPS, 2002).

[254] *See* Black Bear Hydro, 2015b at Exhibit E, Appendix E-6.

[255] Criterion A of National Register eligibility is satisfied by sites that are associated with events that have made a significant contribution to the broad patterns of history. Criterion C is satisfied by sites that embody the distinctive characteristics of a type, period, or method of construction; that represent the work of a master; that possess high artistic values; or that represent a significant and distinguishable entity whose components may lack individual distinction (NPS, 2002).

The Maine Central Railroad Bridge dates back to the early 1900s, and is a three span bridge that carries the single track line of the Calais Branch of the former Maine Central Railroad over the Union River between Graham Lake Dam and Lake Leonard. The line was last used for freight service in 1984. The stretch of track containing the bridge was leased in 2006 from the Maine Department of Transportation to the Downeast Rail Heritage Preservation Trust. The trust is currently working to rehabilitate the line for its Downeast Scenic Railroad so that it can handle excursion trains from the City of Ellsworth to Green Lake. The bridge is eligible for listing in the National Register under criteria A and C.

3.3.6.2 Environmental Effects

Black Bear Hydro's proposed recreational enhancements (including construction of a new portage trail around Graham Lake Dam), and maintenance activities associated with routine operation of the project have the potential to affect historic resources in the APE. In addition, Black Bear Hydro proposes, and Interior's fishway prescription and Maine DMR's section 10(j) recommendation would require, the construction of upstream fish passage ramps for American eel at the Ellsworth and Graham Lake dams, modifications to the spillway fish passage weir, downstream migrant pipe, spillway flume, and the spillway flume discharge for downstream fish passage at Ellsworth Dam, and modifications to the downstream passage weir for fish passage at Graham Lake Dam. Resource agencies have also recommended modifications to fish passage facilities that would require construction at Ellsworth Dam and Graham Lake Dam, including: (1) modifying the existing surface bypass weirs at the Ellsworth and Graham Lake dams by increasing the total fishway flow through the facility; (2) increasing the height of the sides of the spillway flume at the Ellsworth Dam to contain the increased conveyance flow and reduce spillage; (3) installing full-depth trashrack overlays at the generating unit intakes at the Ellsworth Dam; (4) installing upstream fish passage facilities at the Ellsworth and Graham Lake dams that pass Atlantic salmon; and (5) installing a fish guidance system leading to a bypass surface entrance at the Ellsworth Development.

To address any potential adverse effects on historic properties, Black Bear Hydro proposes to implement a draft HPMP that it filed as part of its license application. The draft HPMP includes measures to: (1) avoid development of recreational facilities in areas where historic properties are present, as practicable; (2) keep all archeological site information and site locations confidential to minimize the effects of looting; (3) consult with the Maine SHPO on protection measures to be implemented prior to any planned, non-emergency maintenance or construction activities that have the potential to adversely affect historic properties; (4) consult with the Maine SHPO on protection measures to be implemented if it is determined that future ground-disturbing activities are likely to adversely affect archaeological resources; (5) implement an annual monitoring program to assess whether emergency erosion conditions (*i.e.*, current and dramatic erosion) are occurring at the known National Register listed and eligible archaeological sites, and consult with the Maine SHPO to determine mitigation measures that would be implemented in the event emergency erosion is identified; (6) coordinate with the Maine SHPO to complete archaeological surveys of the inundated portions or Graham Lake, should it be determined that field conditions and planned lower impoundment levels permit the safe and reasonable review of potential historic sites in the drawdown zone; (7) consult with the Maine SHPO to determine what regular maintenance activities (*e.g.*, lawn mowing, in-kind window repair, and roof repair) can be undertaken without SHPO review; (8) provide for the proper curation of existing collections of historic materials from the project derived from Black Bear Hydro's studies and investigations to date, with the ultimate repository for the existing collections to be determined in consultation with the Maine SHPO; (9) treat and dispose of any human remains and grave-associated artifacts that may be inadvertently discovered at the project in a manner that is consistent with the Advisory Council on Historic Preservation's Policy Statement Regarding Treatment of Human Remains and Funerary Objects (Advisory Council on Historic Preservation, 2007); and (10) consult with the Maine SHPO on protection measures to be implemented if new historic sites are discovered during the duration the license.

For the protection of architectural resources, Black Bear Hydro proposes to: (1) consult with the Maine SHPO on protection measures to be implemented prior to undertaking any planned non-emergency maintenance or construction activities that could adversely affect the historic integrity of the contributing resources of any historic resources within the undertaking's APE; and (2) consult with the Maine SHPO to determine what regular maintenance activities (*e.g.*, lawn mowing, in-kind window repair, and roof repair) can be undertaken without SHPO review.

Our Analysis

Project-related effects on cultural resources within the APE could result from modifications to project facilities or project operations; project-related ground-disturbing activities; construction of project recreation facilities and use of such facilities by visitors in the future; and project-induced shoreline erosion.[256] Construction of fish passage facilities could involve major alterations to the historic Ellsworth and Graham Lake dams, including modifications to the surface weirs at the dams and the spillway at the Ellsworth Dam.

Continued operation and maintenance of the project could have adverse effects on the Ellsworth Dam and powerhouse and the Graham Lake Dam if there are no protective measures in place. Damage to the structures could occur in the event repairs are needed

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[256] Project-induced shoreline erosion does not include shoreline erosion attributable to flood flows or phenomena, such as wind-driven wave action, erodible soils, and loss of vegetation due to natural causes.

to maintain the structure and function of the aging dams and powerhouse, or to fix structural damage that occurs in the course of project operation.

During the license term, it is also possible that unknown historic resources may be discovered during project operation or other project-related activities that require ground disturbance, such as Black Bear Hydro's proposed relocation of the canoe portage route and improvements to the boat ramp and fishing access areas (see section 3.3.6.2- *Land Use, Recreation, and Aesthetics, Environmental Effects*)

Without protection measures in place, the construction, operation, and maintenance of project facilities could adversely affect the historic structures. The draft HPMP filed with the license application outlines procedures and requirements necessary to protect the dams and powerhouse from adverse effects that could otherwise diminish the integrity of the design and materials of the structures. The draft HPMP also ensures that any previously undiscovered archaeological resources in the APE are not adversely affected by the project. Implementing the draft HPMP would ensure that continued operation and maintenance of the project would have no adverse effect on historic properties within the APE. To meet the requirements of section 106, the Commission intends to execute a PA with the Maine SHPO for the proposed project to protect historic properties that would be affected by the continued operation and maintenance of the project.[257] The terms of the PA would require Black Bear Hydro to address all historic properties identified within the project's APE through the development of a final HPMP in consultation with the Maine SHPO.

4.0 DEVELOPMENTAL ANALYSIS

In this section, we look at the project's use of the Union River for hydropower purposes to see what effects various environmental measures would have on the project's costs and power generation. Under the Commission's approach to evaluating the economics of a hydropower project, as articulated in *Mead Corp*.,[258] the Commission compares the current project cost to an estimate of the cost of obtaining the same amount of energy and capacity using a likely alternative source of power for the region (cost of

[257] There are no historic properties that are listed or eligible for listing in the National Register along the shoreline of Graham Lake. Therefore, changes in the allowable range for water surface elevation would not have an effect on historic properties along the shoreline. Changes in water elevation would also not affect the eligible Graham Lake Dam.

[258] *See Mead Corporation, Publishing Paper Division*, 72 FERC ¶ 61,027 (1995). In most cases, electricity from hydropower would displace some form of fossil-fueled generation, in which fuel cost is the largest component of the cost of electricity production.

alternative power). In keeping with Commission policy as described in *Mead Corp.*, our economic analysis is based on current electric power cost conditions and does not consider future escalation of fuel prices in valuing the hydropower project's power benefits.

For each of the licensing alternatives, our analysis includes an estimate of: (1) the cost of individual measures considered in the EA for the protection, mitigation, and enhancement of environmental resources affected by the project; (2) the cost of alternative power; (3) the total project cost (*i.e.*, operation, maintenance, and environmental measures); and (4) the difference between the cost of alternative power and total project cost for the project. If the difference between the cost of alternative power and total project cost is positive, the project helps to produce power for less than the cost of alternative power. If the difference between the cost of alternative power and total project cost is negative, the project helps to produce power for more than the cost of alternative power. This estimate helps to support an informed decision concerning what is in the public interest with respect to a proposed license. However, project economics is only one of many public interest factors the Commission considers in determining whether, and under what conditions, to issue a license.

4.1 POWER AND ECONOMIC BENEFITS OF THE PROJECT

Table 40 summarizes the assumptions and economic information we use in our analysis for the project. This information was provided by Black Bear Hydro in its license application or estimated by staff. We find that the values provided by Black Bear Hydro are reasonable for the purposes of our analysis. Cost items common to all alternatives include: taxes and insurance costs, net investment, estimated future capital investment required to maintain and extend the life of facilities, relicensing costs, normal operation and maintenance cost, and Commission fees.

Table 40. Parameters for economic analysis of the Ellsworth Project.

Parameters	Values (2018 dollars) [a]	Sources
Period of analysis	30 years	Staff
Term of financing	20 years	Staff
Escalation rate	0 percent	Staff
Alternative energy value	$57.45/MWh[b]	Staff
Federal tax rate	22 percent	Staff
Local tax rate	8.93 percent	Staff
Interest rate	12 percent	Black Bear Hydro
Discount rate	12 percent[c]	Staff
Net remaining investment	$52,186,891[d]	Black Bear Hydro
Depreciation	2.5 percent per year	Black Bear Hydro
Annual operation and maintenance cost	$930,804	Black Bear Hydro

[a] Values provided by Black Bear Hydro in 2014 dollars were converted to 2018 dollars using the United States Department of Labor Consumer Price Index.

[b] The alternative power cost of $57.45/MWh is based on the average energy value for the period of August 2017 to June 2018, as obtained from the ISO New England at http://www.iso-ne.com.

[c] Assumed by staff to be the same as the interest rate.

[d] Based on Black Bear Hydro's remaining undepreciated net investment and cost to develop the license application for the project.

4.2 COMPARISON OF ALTERNATIVES

Table 41 summarizes the installed capacity, annual generation, annual cost of alternative power, annual project cost, and difference between the cost of alternative power and project cost for each of the alternatives considered in this EA: no-action, Black Bear Hydro's proposal, the staff alternative, and staff alternative with mandatory conditions.

Table 41. Summary of the annual cost of alternative power and annual project cost for the four alternatives for the Ellsworth Project.

	No Action	**Black Bear Hydro's Proposal**	**Staff Alternative**	**Staff Alternative with Mandatory Conditions**
Installed capacity (megawatts)	8.9	8.9	8.9	8.9
Annual generation (MWh)	30,511	28,820[a]	25,890[b]	25,890[b]
Annual cost of alternative power ($ and $/MWh)	$1,752,857 57.45	$1,655,709 57.45	$1,487,381 57.45	$1,487,381 57.45
Annual project cost ($ and $/MWh)	$8,763,980 287.24	$9,133,058[c] 316.90	$9,129,591[c] 352.63	$9,193,280[c] 355.09
Difference between the cost of alternative power and project cost ($ and $/MWh)	($7,011,123)[d] (229.79)	($7,477,349)[d] (259.45)	($7,642,210)[d] (295.18)	($7,705,900)[d] (297.64)

[a] The loss of generation under Black Bear Hydro's proposal is associated with increasing flow from approximately 29 cfs to 123 cfs in the downstream fish passage facilities at the Ellsworth Dam from April 1 through December 31 each year.

[b] The loss of generation under the staff alternative and the staff alternative with mandatory conditions includes: (1) the loss of generation associated with Black Bear Hydro's proposal; (2) the loss of generation associated with staff's recommendation to operate Graham Lake between the elevations of 98.5 and 103.0 feet msl; (3) the loss of generation associated with staff's recommendation to cease operation of Unit 1 at the Ellsworth Development for 15 consecutive days after the water temperature reaches 50 °F in the spring to facilitate downstream passage of salmon; and (4) the loss of generation associated with staff's recommendation to shut down the turbines at the Ellsworth Development from 8 PM to 4 AM from September 1 to October 31 and for 3 consecutive nights following each large rainstorm in August to facilitate downstream passage for migrating eels.

[c] The loss of generation is reflected as a higher project cost, rather than a lower power value.

[d] Numbers in parenthesis are negative.

4.2.1 No-Action Alternative

Under the no-action alternative, the project would continue to operate as it does now. The project would have an installed capacity of 8.9 MW, and generate an average of 35,011 MWh of electricity annually. The average annual cost of alternative power would be $1,752,857, or about $57.45/MWh. The average annual project cost would be $8,763,980, or about $287.24/MWh. Overall, the project would produce power at a cost that is $7,011,123, or about $229.79/MWh, more than the cost of alternative power.

4.2.2 Black Bear Hydro's Proposal

Table 42 lists all environmental measures, and the estimated cost of each, considered for the Ellsworth Project. Under Black Bear Hydro's proposal, the Ellsworth Project would have an installed capacity of 8.9 MW, and generate an average of 28,820 MWh of electricity annually. The cost of alternative power would be 1,655,709, or about $57.45/MWh. The average annual project cost would be $9,133,058, or about 316.90/MWh. Overall, the project would produce power at a cost that is 7,477,349, or about 259.45/MWh, more than the cost of alternative power.

4.2.3 Staff Alternative

The staff alternative is based on Black Bear Hydro's proposal with staff modifications and additional measures. The staff alternative would have an installed capacity of 8.9 MW and an average annual generation of 25,890 MWh. The cost of alternative power would be $1,487,381, or about $57.45/MWh. The average annual project cost would be $9,129,591, or about $352.63/MWh. Overall, the project would produce power at a cost that is $7,642,210, or about $295.18/MWh, more than the cost of alternative power.

4.2.4 Staff Alternative with Mandatory Conditions

Under the staff alternative with mandatory conditions the Ellsworth Project would have an installed capacity of 8.9 MW and an average annual generation of 25,890 MWh. The cost of alternative power would be $1,487,381, or about $57.45/MWh. The average annual project cost would be $9,193,280, or about $355.09/MWh. Overall, the project would produce power at a cost that $7,705,900, or about $297.64/MWh, more than the cost of alternative power.

4.3 COST OF ENVIRONMENTAL MEASURES

Table 42. Cost of environmental mitigation and enhancement measures considered in assessing the effects of operating the Ellsworth Project

Enhancement/Mitigation Measures	Entity	Capital cost	Annual cost[a]	Levelized annual cost[b]
Aquatic Resources				
Water Elevation and Minimum Flow Measures				
Continue releasing a continuous minimum flow of 105 cfs from July 1 through April 30, and a continuous minimum flow of 250 cfs from May 1 through June 30 from the Ellsworth and Graham Lake developments during normal project operation, for the protection of fishery resources.	Black Bear Hydro, Interior,[c] Staff	$0	$0	$0
Continue to operate Lake Leonard between the elevations of 65.7 and 66.7 feet msl, and operate Graham Lake between the elevations of 93.4 and 104.2 feet msl during normal operation.	Black Bear Hydro	$0	$0	$0
Operate Graham Lake between the elevations of 98.5 and 104.2 feet msl during normal operation.	Black Bear Hydro (WQC application)	$0	$69,740 (1,214 MWh in lost generation)[e]	$69,740

Enhancement/Mitigation Measures	Entity	Capital cost	Annual cost[a]	Levelized annual cost[b]
Continue monitoring reservoir elevation levels and minimum flow releases using pressure-sensitive headwater sensors and generation outflow.	Black Bear Hydro, Staff	$0	$0	$0
Temporarily modify the proposed minimum flow releases and elevation limits at the Ellsworth and Graham Lake developments during: (1) approved maintenance activities; (2) extreme hydrologic conditions; (3) emergency electrical system conditions; or (4) agreement between the Licensee, the Maine DEP, and appropriate state and/or federal fisheries management agencies.	Black Bear Hydro, Staff	$0	$0	$0
Operate the project in a run-of-river mode.	DSF	$0	$147,700 (2,571 MWh in lost generation)[e]	$147,700
Operate Graham Lake between the elevations of 102 and 103 feet msl.	Cook *et al.*	$0	$134,030 (2,333 MWh in lost generation)[e]	$134,030
Operate Graham Lake between the elevations of 96.4 and 102.2 feet msl.	Washburn and Friends'	$0[e]	$68,370 (1,190 MWh in lost generation)[e]	$68,370

Enhancement/Mitigation Measures	Entity	Capital cost	Annual cost[a]	Levelized annual cost[b]
Operate Graham Lake between the elevations of 96 and 103 feet msl.	Dunn	$0[e]	$51,990 (905 MWh in lost generation)[e]	$51,990
Operate Graham Lake between the elevations of 97.0 and 104.2 feet msl.	Maine DIFW	$0	$49,230 (857 MWh in lost generation)[e]	$49,230
Operate Graham Lake between the elevations of 98.5 and 103.0 feet msl.	Whiting-1, Staff	$0	$86,180 (1,500 MWh in lost generation)[e]	$86,180
Operate Graham Lake between the elevations of 99 and 103 feet msl.	DSF and Flower	$0	$93,010 (1,619 MWh in lost generation)[e]	$93,010
Operate Graham Lake between the elevations of 98 and 102 feet msl.	Bryant et. al.	$0	$93,010 (1,619 MWh in lost generation)[e]	$93,010
Finalize and implement a draft operation compliance monitoring plan that includes measures for monitoring, recording compliance with, and reporting on deviations from the requisite minimum flow releases and impoundment elevations.	Black Bear Hydro, Staff	$5,350	$0	$870

Enhancement/Mitigation Measures	Entity	Capital cost	Annual cost[a]	Levelized annual cost[b]
Install and operate a set of electronic stream gages at the West Branch and East Branch of the Union River confluences with Graham Lake and at the project dams in conjunction with USGS to ensure monitoring and compliance.	DSF	$36,000	$32,000	$30,800
Downstream Passage Measures for Salmon, Alosines, and/or Eels				
Modify the temporarily-installed Alden weir at the Graham Lake Dam within 2 years of license issuance to provide passage for American eel and anadromous fish species, with the following weir design specifications: (1) a uniform accelerating discharge that is provided by an Alden weir or a weir with a similar design, and (2) at least a 2-foot depth of flow over the weir at all potential water surface elevations included in any new license.	Maine DMR,[c] Interior[d]	$90,000	$0	$14,600
Modify the Alden weir that was temporarily installed at the Graham Lake Dam in 2017 for the passage of downstream migrating anadromous fish from April 1 to December 31 to allow at least 3 feet depth of water to flow over the weir under all headpond conditions.	Black Bear Hydro, Commerce[d]	$90,000	$0	$14,600

Enhancement/Mitigation Measures	Entity	Capital cost	Annual cost[a]	Levelized annual cost[b]
Complete the recommended modifications to the weir at Graham Lake within three years of license issuance.	Black Bear Hydro	$0	$0	$0
Complete the proposed modifications to the weir at Graham Lake by May 1 of the third year of a new license.	Commerce[d]	$0	$0	$0
Pass minimum flows through the modified Alden weir at Graham Lake	Maine DMR,[c] Interior[d] Staff	$0	$0	$0
Redesign or replace the Alden weir at Graham Lake in order to provide a flow of 250 cfs in May and June at the staff-recommended 4.5-foot operating range and for the passage of downstream migrating anadromous fish from April 1 to December 31 to allow at least 3 feet depth of water to flow over the weir under all headpond conditions.	Staff	$180,000	$0	$29,200
Construct the proposed modifications to the temporarily-installed Alden weir at Graham Lake Dam within 2 years of license issuance, and perform all construction activities outside of the downstream migration season (April 1 to December 31 (or ice-in).	Staff	$0	$0	$0

Enhancement/Mitigation Measures	Entity	Capital cost	Annual cost[a]	Levelized annual cost[b]
Improve the existing downstream fish passage system at Ellsworth Dam as follows: (1) modify the existing downstream fish passage weir entrance that is adjacent to the intake for generating Unit 1 by increasing the depth of the weir to a minimum of 3 feet, installing tapered walls similar to an Alden weir, and increasing the weir capacity to pass up to 5 percent of station hydraulic capacity; (2) increase the height of the sides of the spillway flume in consultation with the resource agencies, to improve containment of fish passing through the flume; and (3) modify the existing fish downstream migrant pipe to improve its discharge angle into the spillway flume to limit potential injury to fish that are exiting the pipe. Provide downstream fish passage at the project from April 1 to December 31 of each year.	Black Bear Hydro, Maine DMR,[c] Commerce,[d,h] Staff	$180,000	$97,150 (1,691 MWh in lost generation)[f]	$126,360
Complete the recommended modifications to the downstream fish passage system at Ellsworth Dam within 3 years of license issuance.	Black Bear Hydro, Maine DMR[c]	$0	$0	$0

Enhancement/Mitigation Measures	Entity	Capital cost	Annual cost[a]	Levelized annual cost[b]
Complete the proposed modifications to the downstream fish passage system at Ellsworth Dam by May 1 of the third year of any new license.	Commerce[d]	$0	$0	$0
Complete the proposed modifications to the downstream fish passage system at Ellsworth Dam within three passage seasons after license issuance.	Staff	$0	$0	$0
Modify the existing downstream fish passage facility at the Ellsworth Development within 2 years of license issuance in consultation with resource agencies to provide safe, timely, and effective passage for American eel and anadromous fish species, including the following structural modifications: (1) increase the total combined flow through the three existing surface weirs to 5 percent of the maximum station capacity (approximately 123 cfs), (2) realign the end of the downstream migrant pipe so that water discharges downward to the spillway flume and fish do not impact the spillway when exiting the pipe, and (3) eliminate leakage at the sidewalls of the spillway flume. Operate the modified downstream passage surface weirs at the Ellsworth and Graham Lake dams on an annual basis from August 1 to October 31.	Interior[d]	$180,000	$30,280 (527 MWh in lost generation)[g]	$59,480

Enhancement/Mitigation Measures	**Entity**	**Capital cost**	**Annual cost[a]**	**Levelized annual cost[b]**
Eliminate discharge from the spillway flume to the ledges at the toe of the dam	Interior,[d] Staff	$10,000	$0	$1,620
Continue to operate a spillway plunge pool at the Ellsworth Development.	DSF, Staff	$0	$0	$0
Install a fish guidance system (Worthington boom or similar technology) with 10- to 15-foot-deep, rigid panels at Ellsworth Dam.	Black Bear Hydro, Commerce,[d] Maine DMR,[c] Staff	$90,000	$0	$14,600
Install a Kevlar diversionary guidance boom at Ellsworth Dam.	DSF	$90,000	$0	$14,600
Provide downstream bypass flow to 120 cfs.	DSF	$0	$94,090 (1,638MWh in lost generation)[i]	$94,090
Prioritize operation of generating Units 1 and 4 over Units 2 and 3 during critical downstream passage seasons, as determined in consultation with resource agencies.	Black Bear Hydro	$0	$0	$0

Enhancement/Mitigation Measures	Entity	Capital cost	Annual cost[a]	Levelized annual cost[b]
Curtail operation of Unit 1 and prioritize operation of Unit 4 over Units 2 and 3 at the Ellsworth Development during the critical downstream fish passage seasons, to be determined in consultation with the resource agencies, within three passage seasons of license issuance.	Maine DMR,[c] DSF	Unknown – recommendation lacks specificity needed to estimate a cost.	Unknown – recommendation lacks specificity needed to estimate a cost.	Unknown – recommendation lacks specificity needed to estimate a cost.
Curtail operation of Unit 1 and prioritize operation of Unit 4 over Units 2 and 3 at the Ellsworth Development during the critical downstream fish passage seasons, to be determined in consultation with the resource agencies, by May 1 of the third year of any new license.	Commerce[d]	Unknown – recommendation lacks specificity needed to estimate a cost.	Unknown – recommendation lacks specificity needed to estimate a cost.	Unknown – recommendation lacks specificity needed to estimate a cost.
Prioritize operation of Units 1 and 4 over Units 2 and 3 at the Ellsworth Development during the entire downstream passage season, from April 1 to December 31.	Staff	$0	$0	$0
Shut down Kaplan units (Units 2 and 3) the Ellsworth Development during the downstream migration period.	DSF	$0	$530,190 (9,229 MWh in lost generation)[j]	$530,190

Enhancement/Mitigation Measures	Entity	Capital cost	Annual cost[a]	Levelized annual cost[b]
Continue to provide downstream passage for out-migrating Atlantic salmon and river herring at Graham Lake Dam through the existing surface weir and Tainter gate until the proposed modifications to the surface weir are operational.	Black Bear Hydro, Staff	$0	$0	$0
Install full-depth 1-inch trashracks (permanent or seasonal overlay) over the intakes of Units 2, 3, and 4 at the Ellsworth Development from April 1 to December 31 each year to physically exclude Atlantic salmon, alosines and eels from the turbine intake.	Black Bear Hydro,[k] Maine DMR,[c] Commerce,[d] Interior,[d] DSF, Staff	$73,000	$10,950	$20,390
Submit design plans for 1-inch full-depth trashrack overlays at the Ellsworth Development to the resource agencies for review and approval at least 6 months prior to the first passage season following issuance of any new license.	Commerce[d]	$0	$0	$0

Enhancement/Mitigation Measures	Entity	Capital cost	Annual cost[a]	Levelized annual cost[b]
Implement the following adaptive management measure(s) in consultation with resource agencies, as necessary to improve downstream fish passage effectiveness at the Ellsworth Dam to meet the 90 percent performance standard: (1) add panels or curtains to deepen the fish guidance system; (2) increase flows over the spillway by reducing generation or shutting down turbines at night for two weeks during May; (3) modify the spillway ledge, plunge pool, or spillway surface to reduce injury to fish passing over the spillway.	Black Bear Hydro	Unknown – proposal lacks specificity needed to estimate a cost.	Unknown – proposal lacks specificity needed to estimate a cost.	Unknown – proposal lacks specificity needed to estimate a cost.
Implement adaptive management measures in consultation with resource agencies, as necessary to improve downstream fish passage effectiveness at Graham Lake to meet the 90 percent performance standard.	Black Bear Hydro	Unknown – proposal lacks specificity needed to estimate a cost.	Unknown – proposal lacks specificity needed to estimate a cost.	Unknown – proposal lacks specificity needed to estimate a cost.
Continue to provide downstream passage for out-migrating Atlantic salmon and river herring at the Ellsworth Dam through the three existing surface weirs until the proposed modifications to the surface weir are operational.	Black Bear Hydro, Staff	$0	$0	$0
Downstream Passage Measures for Atlantic Salmon				

Enhancement/Mitigation Measures	Entity	Capital cost	Annual cost[a]	Levelized annual cost[b]
Develop an evaluation plan in consultation with the resource agencies and conduct effectiveness testing of the downstream fish passage facilities at the Ellsworth and Graham Lake developments to determine if the downstream fish passage facilities meet performance standards for Atlantic salmon developed through the course of consultation under the ESA. If performance standards are not met, implement additional measures including increasing the depth of the Worthington fish guidance system, curtail project operation, spill or nighttime shutdowns; and modifying the ledge/plunge pool and spillway surfaces.	Maine DMR[c]	Unknown – recommendation lacks specificity needed to estimate a cost.	Unknown – recommendation lacks specificity needed to estimate a cost.	Unknown – recommendation lacks specificity needed to estimate a cost.
Test the effectiveness of the proposed modifications to the existing downstream passage weir for Atlantic salmon smolt passage at Graham Lake Dam for a 1- to 3-year period using a performance standard of 90 percent effectiveness for downstream passage, beginning in the year following implementation of the modifications.	Black Bear Hydro, Staff	$450,000	$0	$73,020

Enhancement/Mitigation Measures	Entity	Capital cost	Annual cost[a]	Levelized annual cost[b]
Implement additional adaptive management measures in consultation with resource agencies, as necessary to improve downstream fish passage effectiveness at Graham Lake Dam to meet the 90 percent performance standard.	Black Bear Hydro	Unknown – proposal lacks specificity needed to estimate a cost.	Unknown – proposal lacks specificity needed to estimate a cost.	Unknown – proposal lacks specificity needed to estimate a cost.
Test the effectiveness of the proposed downstream fish passage measures for Atlantic salmon smolt passage at Ellsworth Dam for a 1- to 3-year period beginning in the year following implementation of the modifications, using a performance standard of 90 percent effectiveness for downstream passage.	Black Bear Hydro, Staff	$450,000	$0	$73,020
Implement the following adaptive management measure(s) in consultation with resource agencies, as necessary to improve downstream fish passage effectiveness at Ellsworth Dam to meet the 90 percent performance standard: (1) add panels or curtains to deepen the fish guidance system; (2) increase flows over the spillway by reducing generation or shutting down turbines at night for two weeks during May; (3) modify the spillway ledge, plunge pool, or spillway surface to reduce injury to fish passing over the spillway.	Black Bear Hydro	Unknown – proposal lacks specificity needed to estimate a cost.	Unknown – proposal lacks specificity needed to estimate a cost.	Unknown – proposal lacks specificity needed to estimate a cost.

Enhancement/Mitigation Measures	Entity	Capital cost	Annual cost[a]	Levelized annual cost[b]
Test the effectiveness of any adaptive management measures that are implemented for Atlantic salmon smolt passage at Ellsworth Dam for a 1- to 3-year period following implementation of the measures, using a performance standard of 90 percent effectiveness for downstream passage.	Black Bear Hydro	Unknown – proposal lacks specificity needed to estimate a cost.	Unknown – proposal lacks specificity needed to estimate a cost.	Unknown – proposal lacks specificity needed to estimate a cost.
Test the effectiveness of any adaptive management measures that are implemented for Atlantic salmon smolt passage at Graham Lake Dam for a 1- to 3-year period following implementation of the measures, using a performance standard of 90 percent effectiveness for downstream passage.	Black Bear Hydro	Unknown – proposal lacks specificity needed to estimate a cost.	Unknown – proposal lacks specificity needed to estimate a cost.	Unknown – proposal lacks specificity needed to estimate a cost.
Conduct a 1-year study to investigate the potential causes of Atlantic salmon smolt mortality in the downstream most reaches of Graham Lake within three years of issuance of any new license.	Black Bear Hydro	Unknown – recommendation lacks specificity needed to estimate a cost.	Unknown – recommendation lacks specificity needed to estimate a cost.	Unknown – recommendation lacks specificity needed to estimate a cost.
Cease operation of Unit 1 at the Ellsworth Development during the critical downstream passage season for Atlantic salmon smolts.	Commerce,[d] Maine DMR,[c] DSF, Staff	$0	$25,910 (451 MWh in lost generation)[l]	$25,910
Downstream Passage Measures for Eels				

Enhancement/Mitigation Measures	Entity	Capital cost	Annual cost[a]	Levelized annual cost[b]
Cease operation at the Ellsworth Development from 8 PM to 4 AM from September 1 to October 31 and for 3 consecutive nights following each large rainstorm in August and operate the existing downstream fish passage facility to provide safe, timely, and effective downstream passage for migrating eels.	Maine DMR,[c] Interior,[d] DSF, Staff	$0	$56,240 (979 MWh in lost generation)[m]	$56,240
Modify the eel passage operating schedule during the term of the license based on empirical passage data developed for the project and/or a predictive model for eel movements through the project.	Maine DMR[c]	Unknown – recommendation lacks specificity needed to estimate a cost.	Unknown – recommendation lacks specificity needed to estimate a cost.	Unknown – recommendation lacks specificity needed to estimate a cost.
Design the downstream eel passage facility at the Graham Lake Development in a manner that is consistent with the FWS's 2017 Fish Passage Engineering Design Criteria Manual (FWS, 2017), and submit design plans to the FWS for review and approval prior to Commission approval.	Interior,[d] Staff	$0[n]	$0[n]	$0[n]

Enhancement/Mitigation Measures	Entity	Capital cost	Annual cost[a]	Levelized annual cost[b]
Develop and implement a downstream American eel passage effectiveness monitoring plan within six months of license issuance that includes effectiveness monitoring at the Ellsworth and Graham Lake dams using radio telemetry to determine migratory delay, route of downstream passage (i.e., via surface bypasses, turbines, or spillage), immediate survival, and latent survival.	Interior,[d] Maine DMR	$200,000	$0	$32,450
If the downstream fish passage facilities at the Ellsworth and Graham Lake developments do not pass eels in a safe, timely, and effective manner, implement passage improvements approved by FWS, including but not limited to: (1) extending the passage season, (2) restricting generation to certain times of the day, (3) installing trashrack overlays with 0.75-inch clear spacing, (4) installing a deep bypass gate, and/or (5) constructing a new downstream eel passage facility with angled trash racks.	Interior[d]	Unknown – recommendation lacks specificity needed to estimate a cost.	Unknown – recommendation lacks specificity needed to estimate a cost.	Unknown – recommendation lacks specificity needed to estimate a cost.
Construct a deep gate for outmigrating adult silver eels at Ellsworth Dam.	DSF	$535,000	$0	$86,810

Enhancement/Mitigation Measures	Entity	Capital cost	Annual cost[a]	Levelized annual cost[b]
Downstream Passage Measures for Alosines				
During the interim period between license issuance and implementation of the proposed and recommended modifications to the downstream fish passage facilities, monitor the forebay of Graham Lake Dam and the tailrace of Ellsworth Dam for out-migrating alosines during the downstream passage season (June 1 – November 30) and implement generation shut down procedures at the Ellsworth Development if: (1) a school of out-migrating alosines is observed at Graham Lake following a storm event that exceeds 17 percent of the total average monthly rainfall; or (2) dead or injured alosines are observed in the tailrace of Ellsworth Dam.	Staff	\$3,600	\$0	\$580
Upstream Passage Measures for Alosines, Atlantic Salmon, and Eels				
Provide upstream fish passage at the project from May 1 to November 15 of each year.	Black Bear Hydro, Staff	\$0	\$0	\$0
Upstream Passage Measures for Alosines and Salmon				
Submit design plans for alosine and Atlantic salmon fishways to the resource agencies for review and approval no later than 2 years before the anticipated operational date.	Commerce,[d] Staff	\$0	\$0	\$0

Enhancement/Mitigation Measures	Entity	Capital cost	Annual cost[a]	Levelized annual cost[b]
Continue to provide upstream passage for alosines and Atlantic salmon by maintaining and operating the existing fishway trap and truck facility at Ellsworth Dam until the proposed upstream fish passage measures are operational.	Black Bear Hydro	$0	$0	$0
Continue to provide upstream passage for alosines and Atlantic salmon from May 1 to November 15 of each year by operating and maintaining the existing fishway trap and truck facility at Ellsworth Dam during the term of any new license.	Staff	$0	$0	$0
Provide volitional (24 hour) upstream fish passage suitable for adult Atlantic salmon, American shad and river herring at both project dams within 2 years of license issuance.	DSF	$3,450,000	$10,000	$567,610
Upstream Passage Measures for Atlantic Salmon				
Continue to operate and maintain the existing upstream fish passage facility for Atlantic salmon at the Ellsworth Development from May 1 to November 15 until the prescribed upstream fish passage facilities at the Ellsworth and Graham Lake developments are operational.	Commerce[d]	$0	$0	$0

Enhancement/Mitigation Measures	**Entity**	**Capital cost**	**Annual cost[a]**	**Levelized annual cost[b]**
Meet with resource agencies annually to discuss fish passage operation, study results, and the siting, design, and construction of the new upstream fishways for Atlantic salmon.	Commerce,[d] Staff	$0	$0	$0
Construct, operate, and maintain a swim-through fishway (e.g., a vertical slot, Denil, Ice Harbor, or fishlift) that provides safe, timely, and effective upstream passage for Atlantic salmon at the Ellsworth and Graham Lake dams no later than year 15 of any new license.	Commerce[d]	$3,450,000[o]	$10,000	$53,720 [o]
Design and install new upstream Atlantic salmon passage measures at Ellsworth and Graham Lake dams 15 years after license issuance, unless the management or restoration priorities of the resource agencies would warrant a delay in construction of the new passage measures.	Black Bear Hydro	$3,450,000[o]	$10,000	$53,720 [o]
Conduct effectiveness testing of the new upstream Atlantic salmon passage measures for 1 to 3 years beginning in the second fish passage season after each fish passage measure is operational.	Black Bear Hydro	$450,000	$0	$73,020

Enhancement/Mitigation Measures	**Entity**	**Capital cost**	**Annual cost[a]**	**Levelized annual cost[b]**
Conduct effectiveness testing of the existing fishway and trap at Ellsworth Dam for passing Atlantic salmon, after downstream passage improvements have been implemented and smolts stocked upstream of Ellsworth Dam have had a chance to return as upstream migrating adults.	Black Bear Hydro, Staff	$150,000	$0	$24,340
Modify the upstream fish passage facilities for Atlantic salmon if the 90 percent performance standard is not met in two of the test years following implementation of fish passage measures	Black Bear Hydro	Unknown – proposal lacks specificity needed to estimate a cost.	Unknown – proposal lacks specificity needed to estimate a cost.	Unknown – proposal lacks specificity needed to estimate a cost.
Upstream Passage Measures for Alosines				
Continue to operate and maintain the existing upstream fish passage facility for alosines at the Ellsworth Development from May 1 to July 31.	Commerce[d]	$0	$0	$0
Upstream Passage Measures for Eels				
Design and install upstream eel passage facilities at Ellsworth and Graham Lake dams, in consultation with FWS, NMFS, Maine DIFW, and Maine DMR.	Black Bear Hydro, Staff, Interior,[d] Maine DMR,[c] DSF	$160,500	$21,400	$42,740

Enhancement/Mitigation Measures	Entity	Capital cost	Annual cost[a]	Levelized annual cost[b]
Operate the upstream eel passage facilities on an annual basis from June 1 to August 31.	Interior[d]	$0	$0[p]	$0
Operate the upstream eel passage facilities on an annual basis from June 1 to October 31 each year.	Maine DMR,[c] Staff	$0	$0[p]	$0
Construct the proposed new upstream eel passage facilities at the Ellsworth and Graham Lake dams within 2 years of license issuance, as prescribed by Interior, and perform all construction activities outside of the upstream migration season of June 1 to October 31.	Staff	$0	$0	$0
Design and install upstream eel passage facilities at Ellsworth and Graham Lake dams within 2 years of the effective date of the license, in consultation with the fisheries management agencies.	Interior,[d] Maine DMR	$0	$0	$0
Design the upstream eel passage facilities at the Ellsworth and Graham Lake developments in a manner that is consistent with the FWS's 2017 Fish Passage Engineering Design Criteria Manual (FWS, 2017), and submit design plans to the FWS for review and approval prior to Commission approval.	Interior,[d] Staff	$0[q]	$0[q]	$0[q]

Enhancement/Mitigation Measures	Entity	Capital cost	Annual cost[a]	Levelized annual cost[b]
Develop an upstream American eel effectiveness monitoring plan within six months of license issuance, including evaluating: (1) attraction efficiency over a minimum of three nights during the first year of operation (*i.e.*, total number of migrating eels at the project versus the number of eels that pass upstream using the eel ramp); and (2) passage effectiveness (*i.e.*, whether 90 percent of eels pass from the entrance of the fishway to the exit of the fishway in 24 hours).	Maine DMR,[c] Interior,[d] Staff	$10,000	$0	$1,620
If 90 percent of eels do not pass over the upstream fishway within 24 hours during the effectiveness test, then modify the upstream eel passage facility in consultation with FWS by, *e.g.*, changing the substrate, reducing the slope of the ramp, increasing the attraction flow, or modifying the conveyance flow.	Interior, Staff	$0[r]	$0[r]	$0[r].
Downstream and Upstream Passage Measures for all Species				

Enhancement/Mitigation Measures	Entity	Capital cost	Annual cost[a]	Levelized annual cost[b]
Continue to implement and update as needed, a fish passage operation and maintenance plan that describes how Black Bear Hydro would operate and maintain the existing fish passage facilities, including: (1) the period in which the facilities are to be operated; (2) guidance on the annual start-up and shut-down procedures; (3) routine operating guidelines; (4) debris management; and (5) safety rules and procedures	Black Bear Hydro, Interior,[d] Maine DMR,[c] Staff	$0	$0	$0
Maintain fishways in proper working order; remove trash, logs, and material from fishways that would otherwise hinder fish passage, and perform routine maintenance before a migratory period so that fishways can be tested, inspected, and operational prior to the migratory periods.	Commerce,[d] Maine DMR,[c] Staff	$0[s]	$0[s]	$0[s]

Enhancement/Mitigation Measures	Entity	Capital cost	Annual cost[a]	Levelized annual cost[b]
Modify the proposed fish passage operation and maintenance plan within 12 months of license issuance to include the following additional measures to help ensure that project fishways are operated and maintained in proper working order during the term of any new license: (1) a schedule of fishway operating times and minimum conveyance flows; (2) procedures for maintaining the downstream passage facilities in proper order and clear of trash, logs, and material that would hinder fish passage; (3) procedures for completing any anticipated maintenance before a migratory period such that fishways can be tested, inspected, and operational prior to the migratory periods, as prescribed by Interior and Commerce; and (4) provisions for updating the plan on an annual basis to reflect any changes in fishway operation and maintenance for the following year.	Interior,[d] Maine DMR,[c] Staff	$5,000	$0	$810
Operate each new/modified fish passage facility for a one-season “shakedown” period and make adjustments to the facilities if they are not operating as designed.	Staff	$0	$0	$0

Enhancement/Mitigation Measures	Entity	Capital cost	Annual cost[a]	Levelized annual cost[b]
Provide information on fish passage operation and project generating operation that may affect fish passage upon written request from FWS.	Interior,[d] Staff	$0	$0	$0
Monitor upstream and downstream fishways at the Ellsworth and Graham Lake dams to ensure fish passage protection measures are constructed, operated, and functioning as intended for the safe, timely and effective passage of migrating fish, based on performance standards that Commerce is currently developing for alosine and Atlantic salmon.	Commerce[d]	Unknown – recommendation lacks specificity needed to estimate a cost.	Unknown – recommendation lacks specificity needed to estimate a cost.	Unknown – recommendation lacks specificity needed to estimate a cost.
Develop study design plans in consultation with resource agencies to monitor the effectiveness of upstream and downstream fish passage facilities for juvenile and adult life stages of alosines and Atlantic salmon using scientifically accepted practices, beginning at the start of the first migratory season after each fish passage facility is operational and continuing for up to three years.	Commerce[d]	Unknown – recommendation lacks specificity needed to estimate a cost.	Unknown – recommendation lacks specificity needed to estimate a cost.	Unknown – recommendation lacks specificity needed to estimate a cost.

Enhancement/Mitigation Measures	Entity	Capital cost	Annual cost[a]	Levelized annual cost[b]
Prepare and submit fish passage monitoring study reports to the resource agencies for review and consultation prior to submitting the reports to the Commission for final approval on an annual basis during the monitoring study.	Commerce[d]	$0	$0	$0
File final as-built drawings for any new fishways with Commerce and FWS after construction is complete.	Commerce,[d] Staff	$0	$0	$0
If the downstream fish passage facility fails to meet Commerce's performance standards, then modify the facility to reduce fish injury and mortality by, e.g., increasing the depth of the guidance system, curtailing or shutting down turbines, or modifying the spillway and/or the ledge at the base of the dam.	Commerce[d]	Unknown – recommendation lacks specificity needed to estimate a cost.	Unknown – recommendation lacks specificity needed to estimate a cost.	Unknown – recommendation lacks specificity needed to estimate a cost.
Develop the fish effectiveness plans in consultation with FWS and submit the plans to FWS for review and approval prior to Commission approval.	Interior[d]	$0	$0	$0

Enhancement/Mitigation Measures	Entity	Capital cost	Annual cost[a]	Levelized annual cost[b]
Provide FWS personnel and FWS-designated representatives with timely access to the fish passage facilities and to pertinent project records for the purpose of inspecting the fishways and determining compliance with the fishway prescription.	Interior,[d] Staff	$0	$0	$0
Develop and implement an effectiveness testing plan proposed by Black Bear Hydro in the Species Protection Plan for the Atlantic salmon effectiveness testing studies.	Staff	$5,000	$0	$810
Implement a sturgeon handling plan in order to protect Atlantic and shortnose sturgeon that may be encountered during fish passage operation or routine maintenance activities at the Ellsworth Dam.	Black Bear Hydro, Staff	$5,000	$0	$810
Terrestrial Resources				
Avoid cutting trees between June 1 and July 31 to protect roosting northern long-eared bats.	Staff	$0	$0	$0
Recreation Resources				

Enhancement/Mitigation Measures	**Entity**	**Capital cost**	**Annual cost**[a]	**Levelized annual cost**[b]
Improve drainage and stabilize existing erosion areas at the existing Graham Lake Dam boat launch facility by grading and compacting the gravel section of the boat launch.	Black Bear Hydro, Staff	45,000	$0	$7,302
Continue to operate and maintain the Shore Road boat launch on Lake Leonard, the Graham Lake boat launch near Graham Lake Dam, a canoe portage route around Graham Lake Dam, and an angler access trail at Graham Lake Dam.	Black Bear Hydro, Staff	$0	$0	$0
Improve the safety of the canoe portage route at the Graham Lake Dam by: (1) replacing the existing canoe portage facility that is located at the east end of Graham Lake Dam with a new canoe portage trail located at the west end of Graham Lake Dam; and (2) installing a canoe take-out area on the existing Graham Lake Dam boat launch property that is separate from the hard surface ramp used by motorized watercraft.	Black Bear Hydro, Staff	$48,150	$0	$7,810
Improve and maintain the existing angler access trail that is located on the east side of Graham Lake Dam.	Black Bear Hydro, Staff	$26,750	$0	$4,340

Enhancement/Mitigation Measures	Entity	Capital cost	Annual cost[a]	Levelized annual cost[b]
Implement a final Recreation Facilities Management Plan that includes measures for maintaining the existing and proposed recreation facilities and directional and safety signage at each project recreation facility.	Black Bear Hydro, Staff	$5,350	$5,350	$5,040
Modify the proposed Recreational Facilities Management Plan to describe the recommended improvements to the fisherman access trail; to provide additional detail on Black Bear Hydro's proposal to correct the erosion problem at the Graham Lake boat ramp, including details on the size of the area that needs to be stabilized; and to require public notice of site access and the schedule for resolving any access issues to project water and recreation facilities.	Staff	$2,500	$0	$410
Post notices around the project describing access, with maps of access sites which provide public access.	Interior	$1,000	$100	$240
Develop and implement a guaranteed access plan.	Interior[d]	$2,000	$200	$480
Cultural Resources				

Enhancement/Mitigation Measures	Entity	Capital cost	Annual cost[a]	Levelized annual cost[b]
Implement the draft HPMP filed on December 30, 2015 to provide for management of historic resources throughout the term of the license.	Black Bear Hydro, Staff	$5,350	$5,350	$5,040

[a] Annual costs typically include operational and maintenance costs and any other costs that occur on a yearly basis.

[b] All capital and annual costs are converted to equal annual costs over a 30-year period to give a uniform basis for comparing all costs.

[c] Section 10(j) recommendation.

[d] Section 18 fishway prescription.

[e] The costs are based on Black Bear Hydro's estimate of reduced hydropower generation potential under the Whiting-1 alternative, as scaled according to changes in storage potential. The storage capacity for each alternative was derived from the Graham Lake stage-storage curve filed by Black Bear Hydro on May 12, 2016.

[f] Staff estimated this cost based on the cost of the lost generation associated with operating the modified fishway from April 1 through December 31 each year, and increasing flow in the facility from approximately 29 to 123 cfs.

[g] Staff estimated this cost based on the value of the lost generation associated with operating the modified fishway from August 1 to October 31.year, and increasing flow in the facility from approximately 29 to 123 cfs.

[h] Commerce's mandatory section 18 requirement specify a minimum flow is 120 cfs, which would be included in the 123 cfs minimum flow recommended by Maine DMR. Further, although Commerce states that 5 percent of the station capacity is approximately 120 cfs, 5 percent of the station capacity (2,460 cfs) is actually 123 cfs, as discussed above.

[i] Staff estimated this cost based on the cost of the lost generation associated with increasing the downstream fish bypass flow from approximately 29 to 120 cfs at the Ellsworth Development. Staff did not include a cost for a plunge pool since there is an existing plunge pool at the Ellsworth Development.

[j] Staff estimated this cost based on the value of the lost generation associated with shutting down unit 2 and unit 3 at the Ellsworth Development from April 1 to December 31.

[k] Black Bear Hydro's proposal would install the 1-inch trashrack or seasonal overlay from May 1 of the third year of any license issued by the commission. However, staff assumes that this change would have a minimal effect on the cost of the measure.

[l] Staff estimated this cost based on the value of the lost generation associated with shutting down unit 1 at the Ellsworth Development for half the time during May.

[m] Staff estimated this lost generation based on monthly average generation at the Ellsworth Development between 1994 and 2004. For this analysis, staff assigned equal weight to both nighttime and daytime power generation values and assumed that power generation would generally occur round the clock from September 1 to October 31with no storage. The cost of ceasing operations for three consecutive nights following each massive rainstorm is unknown, but this cost is expected to be minimal since August is a dry time of the year with lower than average rainfall.

[n] The cost of this measure is included in the $14,600 levelized annual cost of interior's mandatory section 18 requirement to modify the existing surface weir at the Graham Lake Dam within 2 years of license issuance to provide safe timely, and effective downstream passage for American eel and anadromous fish species.

[o] The capital cost of this measure would be $3,450,000. However the cost is discounted to account for the 15 year implementation schedule which is approximately half way through an assumed 30-year license term.

[p] Staff assumed that the value of the lost generation associated with operating an upstream fishway for eels would be minimal on the basis that any flows associated with the upstream passage for American eel would be minimal and could be redirected from the downstream passage facilities.

[q] The cost of this measure is included in the $42,740 levelized annual cost included in the cost of constructing the upstream eel passage facilities at the Ellsworth and Graham Lake developments.

[r] Staff assumed that the cost of the measure would be minimal.

[s] Staff assumed that the cost of this measure is included in the $930,804 of overall annual operation and maintenance cost of the project shown above in Table 40.

5.0 CONCLUSIONS AND RECOMMENDATIONS

5.1 COMPARISON OF ALTERNATIVES

In this section, we compare the developmental and non-developmental effects of Black Bear Hydro's proposal, Black Bear Hydro's proposal as modified by staff, staff alternative with mandatory conditions, and the no-action alternative.

We estimate the annual generation of the project under the four alternatives identified above. Our analysis shows that the annual generation would be 28,820 MWh for the proposed action; 27,390 MWh for the staff alternative and the staff alternative with mandatory conditions; and 30,511MWh for the no-action alternative.

We summarize the environmental effects of the different alternatives in Table 42. Additional information on the measures listed below, including information related to the design, construction, operation, maintenance, monitoring, and effectiveness of the measures, is discussed in further detail in section 3, *Environmental Analysis*, and section 5.2, *Comprehensive Development and Recommended Alternative*.

Table 43. Comparison of Alternatives for the Ellsworth Project.

Resource	No Action	Black Bear Hydro's Proposal	Staff Alternative	Staff Alternative with Mandatory Conditions
Annual Generation (MWH)	30,511	28,820	25,890	25,890
Aquatics and Recreation (Water Elevation)	Continue operating Lake Leonard between the elevations of 65.7 and 66.7 feet msl, and operate Graham Lake between the elevations of 93.4 and 104.2 feet msl.	No changes to water elevations.	No changes to water elevation in Lake Leonard. Operate Graham Lake between the elevations of 98.5 and 103.0 feet msl to reduce project effects on recreation, erosion, and littoral habitat for aquatic organisms ($86,180 levelized annual cost).	Same as Staff's alternative.
Fisheries (Minimum Flow)	Continue releasing a minimum flow of 105 cfs from July 1 through April 30, and a minimum flow of 250 cfs from May 1 through June 30 from the Ellsworth and Graham Lake developments for the protection of fishery	No changes to minimum flow.	No changes to minimum flow.	No changes to minimum flow.

Resource	No Action	Black Bear Hydro's Proposal	Staff Alternative	Staff Alternative with Mandatory Conditions
	resources.			
Fisheries (Downstream Passage Measures for Salmon and Alosines)	Continue to operate and maintain the existing downstream passage systems at Graham Lake and Ellsworth dams.	Modify the Alden weir that was temporarily installed at the Graham Lake Dam in 2017 for the passage of downstream migrating anadromous fish from April 1 to December 31 to allow at least 3 feet of water to flow over the weir under all headpond conditions ($14,600 levelized annual cost). Prioritize operation of generating Units 1 and 4 over Units 2 and 3 during critical downstream passage seasons, as determined in consultation with resource agencies ($0 levelized annual cost). Improve the existing downstream fish passage system at Ellsworth Dam as follows: (1) modify the	Same as Black Bear Hydro's proposal, plus the following additional measures. Eliminate discharge from the spillway flume to the ledge at the toe of the dam ($1,620 levelized annual cost). Prioritize operation of Units 1 and 4 over Units 2 and 3 at the Ellsworth Development during the entire downstream passage season, from April 1 to December 31 ($0 levelized annual cost).	Same as Staff's alternative, with additional measures for testing the effectiveness of the new facilities and the following additional measure. Curtail operation of Unit 1 and prioritize operation of Unit 4 over Units 2 and 3 at the Ellsworth Development during the critical downstream fish passage seasons, to be determined in consultation with the resource

Resource	No Action	Black Bear Hydro's Proposal	Staff Alternative	Staff Alternative with Mandatory Conditions
		eastern surface weir by increasing the depth of the weir to a minimum of 3 feet, installing tapered walls similar to an Alden weir, and increasing the weir capacity to pass up to 5 percent of station hydraulic capacity; (2) increase the height of the sides of the spillway flume in consultation with the resource agencies; and (3) modify the existing fish downstream migrant pipe to improve its discharge angle into the spillway flume to limit potential injury to fish that are exiting the pipe. ($126,360 levelized annual cost. Install a fish guidance system with 10- to 15-foot-deep, rigid panels at Ellsworth Dam ($14,600 levelized annual cost).		agencies, by May 1 of the third year of any new license.

Resource	No Action	Black Bear Hydro's Proposal	Staff Alternative	Staff Alternative with Mandatory Conditions
Fisheries (Downstream Passage Measures for Eels)	There are no dedicated downstream eel passage facilities at the Graham Lake and Ellsworth Dams. Passage is provided through the Tainter gates and temporarily-installed Alden weir at the Graham Lake Dam and through the existing surface weirs and turbines at Ellsworth Dam.	Black Bear Hydro proposes additional measures to increase the conveyance flow through the surface weirs at the Graham Lake and Ellsworth dams (as discussed above under the downstream passage measures for salmon and alosines), but does not propose any specific measures for eels.	See above for the downstream passage measures recommended for salmon and alosines. In addition, staff recommends ceasing operation at the Ellsworth Development from 8 PM to 4 AM from September 1 to October 31 and for 3 consecutive nights following each large rainstorm in August and operate the existing downstream fish passage facility to provide safe, timely, and effective downstream passage for migrating eels ($56,240 levelized annual cost).	Same as Staff's alternative, with additional measures for testing the effectiveness of the new facilities.
Fisheries (Entrainment)	Continue using existing trashracks with bar spaces ranging from 1 inch to 2.44 inches.	Install full-depth 1-inch trashracks (permanent or seasonal overlay) over the intakes of Units 2, 3, and 4 at Ellsworth Dam from April 1 to December 31 each year to	Same as Black Bear Hydro's proposal, with the following additional measure. Cease operation of Unit	Same as Staff's alternative.

Resource	No Action	Black Bear Hydro's Proposal	Staff Alternative	Staff Alternative with Mandatory Conditions
		physically exclude Atlantic salmon, alosines and eels from the turbine intake ($20,390 levelized annual cost).	1 at the Ellsworth Development during the critical downstream passage season for Atlantic salmon smolts ($25,910 levelized annual cost).	
Fisheries (Upstream Passage Measures for Alosines and Salmon)	Continue to provide upstream passage for alosines and Atlantic salmon by maintaining and operating the existing fishway trap and truck facility at Ellsworth Dam.	Design and install new upstream Atlantic salmon passage measures at Ellsworth and Graham Lake dams 15 years after license issuance, unless the management or restoration priorities of the resource agencies would warrant a delay in construction of the new passage measures ($53,720 levelized annual cost). Conduct effectiveness testing of the existing fishway and trap at Ellsworth Dam for passing Atlantic salmon, after downstream passage	Same as Black Bear Hydro's proposal, with the exception of installing new upstream Atlantic salmon passage measures at Ellsworth and Graham Lake dams.	Same as Black Bear Hydro's proposal.

Resource	No Action	Black Bear Hydro's Proposal	Staff Alternative	Staff Alternative with Mandatory Conditions
		improvements have been implemented and smolts stocked upstream of Ellsworth Dam have had a chance to return as upstream migrating adults ($24,340 levelized annual cost). Continue to provide upstream passage for alosines and Atlantic salmon by maintaining and operating the existing fishway trap and truck facility at Ellsworth Dam until the proposed upstream fish passage measures are operational ($0 levelized annual cost).		
Fisheries (Upstream Passage Measures for Eels)	There are no existing upstream fishways for eels at the project.	Design and install upstream eel passage facilities at Ellsworth and Graham Lake dams ($42,740 levelized annual cost).	Same as Black Bear Hydro's proposal, with additional measures for testing the effectiveness of the new facilities.	Same as Staff's alternative.
Terrestrial Resources	No changes to terrestrial resources.	No changes to terrestrial resources.	Avoid cutting trees between June 1 and July	Same as Staff's alternative.

Resource	No Action	Black Bear Hydro's Proposal	Staff Alternative	Staff Alternative with Mandatory Conditions
			31 to protect roosting northern long-eared bats ($0 levelized annual cost).	
Recreation Resources	Operate and maintain the Shore Road boat launch on Lake Leonard, the Graham Lake boat launch near Graham Lake Dam, a canoe portage route around Graham Lake Dam, and an angler access trail at Graham Lake Dam.	Same as the No Action Alternative, with the following additional proposals. Improve drainage and stabilize existing erosion areas at the existing Graham Lake Dam boat launch facility by grading and compacting the gravel section of the boat launch ($7,302 levelized annual cost). Improve the safety of the canoe portage route at the Graham Lake Dam by: (1) replacing the existing canoe portage facility that is located at the east end of Graham Lake Dam with a	Same as Black Bear Hydro's proposal, with the following additional measure. Modify the proposed Recreational Facilities Management Plan to include the following additional measures: (1) provide additional detail on the improvements that will be made to the fisherman access trail; (2) provide additional detail on Black Bear Hydro's proposal to correct the erosion problem at the Graham Lake boat ramp, including details on the size of the area that	Same as staff's alternative.

Resource	No Action	Black Bear Hydro's Proposal	Staff Alternative	Staff Alternative with Mandatory Conditions
		new canoe portage trail located at the west end of Graham Lake Dam; and (2) installing a canoe take-out area on the existing Graham Lake Dam boat launch property that is separate from the hard surface ramp used by motorized watercraft ($7,810 levelized annual cost). Improve and maintain the existing angler access trail that is located on the east side of Graham Lake Dam ($4,340 levelized annual cost). Implement a final Recreation Facilities Management Plan that includes measures for maintaining the existing and proposed recreation facilities and directional and safety signage at each project recreation facility ($5,040 levelized annual cost).	needs to be stabilized; and (3) provide public notice of site access and the schedule for resolving any access issues to project water and recreation facilities ($410 levelized annual cost).	

Resource	No Action	Black Bear Hydro's Proposal	Staff Alternative	Staff Alternative with Mandatory Conditions
Cultural Resources	No existing HPMP	Finalize and implement a draft HPMP to provide for management of historic resources throughout the term of the license ($5,040 levelized annual cost).	Implement the HPMP.	Same as staff alternative

(Source: Staff)

5.2 COMPREHENSIVE DEVELOPMENT AND RECOMMENDED ALTERNATIVE

Sections 4(e) and 10(a) of the FPA require the Commission to give equal consideration to the power development purposes and to the purposes of energy conservation; the protection, mitigation of damage to, and enhancement of fish and wildlife; the protection of recreational opportunities; and the preservation of other aspects of environmental quality. Any license issued shall be such as in the Commission's judgment will be best adapted to a comprehensive plan for improving or developing a waterway or waterways for all beneficial public uses. This section contains the basis for, and a summary of, our recommendations for relicensing the project. We weigh the costs and benefits of our recommended alternative against other proposed measures.

Based on our independent review of agency and public comments filed on the project and our review of the environmental and economic effects of the proposed project and project alternatives, we selected the staff alternative as the preferred alternative. We recommend this alternative because: (1) issuing a new license for the project would allow Black Bear Hydro to continue to operate its project as a dependable source of electrical energy; (2) the 8.9 MW of electric capacity comes from a renewable resource that does not contribute to atmospheric pollution; (3) the public benefits of the staff alternative would exceed those of the no-action alternative; and (4) the proposed and recommended measures would protect and enhance fish and wildlife resources.

In the following section, we make recommendations as to which environmental measures proposed by Black Bear Hydro or recommended by agencies or other entities should be included in any license issued for the project. In addition to Black Bear Hydro's proposed environmental measures listed below, we recommend additional environmental measures to be included in any license issued for the project.

5.2.1 Measures Proposed by Black Bear Hydro

Based on our environmental analysis of Black Bear Hydro's proposal in section 3.0, *Environmental Effects,* and the costs presented in section 4.0, *Developmental Analysis*, we conclude that the following environmental measures proposed by Black Bear Hydro would protect and enhance environmental resources and would be worth the cost. Therefore, we recommend including these measures in any license issued for the project.

<u>Water Elevation and Minimum Flow Measures</u>

- Continue releasing a continuous minimum flow of 105 cfs from July 1 through April 30, and a continuous minimum flow of 250 cfs from May 1 through June 30 from the Ellsworth and Graham Lake developments during normal project operation, for the protection of fishery resources;

- Continue operating Lake Leonard between the elevations of 65.7 and 66.7 feet msl;

- Continue monitoring reservoir elevation levels and minimum flow releases using pressure-sensitive headwater sensors and generation outflow;

- Temporarily modify the proposed minimum flow releases and elevation limits at the Ellsworth and Graham Lake developments: (1) during approved maintenance activities; (2) during extreme hydrologic conditions; (3) during emergency electrical system conditions; or (4) after agreement among the Licensee, the Maine DEP, and appropriate state and/or federal fisheries management agencies;

- Finalize and implement a draft operation compliance monitoring plan that includes measures for monitoring, recording compliance with, and reporting on deviations from the requisite minimum flow releases and impoundment elevations;

Downstream Fish Passage Measures

- Provide downstream fish passage at the project from April 1 to December 31 of each year, consistent with Commerce's section 18 fishway prescription;

- Modify the invert elevation of the temporarily-installed Alden weir at Graham Lake Dam to provide a 3-foot-deep flow over the full range of lake elevations allowed in any new license, consistent with Commerce's section 18 fishway prescription;

- Test the effectiveness of the proposed modifications to the temporarily-installed Alden weir for Atlantic salmon smolt passage at Graham Lake Dam for a 1- to 3-year period using a performance standard of 90 percent effectiveness for downstream passage, beginning in the year following implementation of the modifications;

- Continue to provide downstream passage for out-migrating Atlantic salmon and river herring at Graham Lake Dam through the existing surface weir and Tainter gate until the proposed modifications to the surface weir are operational;

- Install full-depth trashracks or trashrack overlays with 1-inch clear-spacing at the intakes for generating Units 2, 3, and 4 at Ellsworth Dam from April 1 to

December 31 each year to physically exclude downstream migrating fish from the turbine intakes.

- Install a fish guidance system (Worthington boom or similar technology) with 10- to 15-foot-deep, rigid panels at Ellsworth Dam, consistent with Commerce's section 18 fishway prescription;

- Improve the existing downstream fish passage system at Ellsworth Dam as follows: (1) modify the existing downstream fish passage weir entrance that is adjacent to the intake for generating Unit 1 by increasing the depth of the weir to a minimum of 3 feet, installing tapered walls similar to an Alden weir, and increasing the weir capacity to pass up to 5 percent of station hydraulic capacity; (2) increase the height of the sides of the spillway flume in consultation with the resource agencies, to improve containment of fish passing through the flume; and (3) modify the existing fish downstream migrant pipe to improve its discharge angle into the spillway flume to limit potential injury to fish that are exiting the pipe, consistent with Interior's and Commerce's section 18 fishway prescriptions;

- Test the effectiveness of the proposed downstream fish passage measures for Atlantic salmon smolt passage at Ellsworth Dam for a 1- to 3-year period beginning in the year following implementation of the modifications, using a performance standard of 90 percent effectiveness for downstream passage;

- Continue to provide downstream passage for out-migrating Atlantic salmon and river herring at the Ellsworth Dam through the three existing surface weirs until the proposed modifications to the surface weir are operational;

Upstream Fish Passage Measures

- Design and install new upstream eel passage facilities at the Ellsworth and Graham Lake dams, and consult with the fisheries management agencies on the exact location of the upstream eel passage facilities at Graham Lake Dam, consistent with Interior's section 18 fishway prescription;

- Test the effectiveness of the existing fishway trap and truck facility at Ellsworth Dam for passing Atlantic salmon for a 1- to 3-year period using a performance standard of 90 percent effectiveness for upstream passage, to be conducted after downstream passage improvements have been implemented and smolts stocked upstream of Ellsworth Dam have had a chance to return as upstream migrating adults;

- Continue to implement and update as needed, a fish passage operation and maintenance plan that describes how Black Bear Hydro would operate and maintain the existing fish passage facilities, including: (1) the period in which the facilities are to be operated; (2) guidance on the annual start-up and shut-down procedures; (3) routine operating guidelines; (4) debris management; and (5) safety rules and procedures;

- Implement a sturgeon handling plan to reduce the potential for adverse effects on Atlantic and shortnose sturgeon that may be encountered during fish passage operation or routine maintenance activities at the Ellsworth Dam;

Recreation Measures

- Continue to operate and maintain the Shore Road boat launch on Lake Leonard, the Graham Lake boat launch near Graham Lake Dam, the canoe portage route around Graham Lake Dam, and the angler access trail at Graham Lake Dam;

- Replace the existing canoe portage facility at the east end of Graham Lake Dam with a new canoe portage trail located at the west end of Graham Lake Dam;

- Install a canoe take-out area on the existing Graham Lake Dam boat launch property that is separate from the hard surface ramp used by motorized watercraft;

- Improve drainage and stabilize existing erosion areas at the existing Graham Lake boat launch facility by grading and compacting the gravel section of the boat launch;

- Improve and maintain the existing angler access trail that is located on the east side of Graham Lake Dam; and

- Implement the proposed Recreation Facilities Management Plan that includes measures for maintaining the existing and proposed recreation facilities and directional and safety signage at each project recreation facility.

5.2.2 Additional Measures Recommended by Staff

In addition to Black Bear Hydro's proposed measures noted above, we recommend including the following measures in any license that may be issued for the Ellsworth Project.

Water Elevation and Minimum Flow Measures

- Operate Graham Lake between the elevations of 98.5 and 103.0 feet msl during normal operation;

- Pass minimum flows through the modified Alden weir at Graham Lake from April 1 through December 31, or ice-in;

Downstream Fish Passage Measures

- Prioritize operation of generating Units 1 and 4 over Units 2 and 3 throughout the entire downstream passage season for Atlantic salmon, alosines, and American eel (April 1 – December 31), as opposed to Black Bear Hydro's proposal to prioritize generating Units 1 and 4 during critical downstream passage seasons;

- Cease generation at the Ellsworth Development nightly (8 PM to 4 AM) from September 1 through October 31 to facilitate safe and timely downstream eel passage, as prescribed by Interior;

- Cease generation at the Ellsworth Development for three consecutive nights (8 PM to 4 AM) following each rain storm event exceeding 1-inch of rainfall in a 24-hour time period during the month of August, to facilitate downstream eel passage, as prescribed by Interior;

- Cease operation of generating Unit 1 during a 15-day period in the spring after water temperature in the Union River reaches 50° F to protect Atlantic salmon smolts from entrainment;

- Install a diversionary guidance boom at the Ellsworth Development, as proposed by Black Bear Hydro and prescribed by Commerce, with the following additional measures: (1) place the guidance boom in the headpond of Ellsworth Dam so that it extends at an angle from the western shore of the impoundment to a point on Ellsworth Dam that is located between the east end of the eastern powerhouse intake structure and the eastern surface weir; (2) design the panels of the guidance boom to have a maximum clear spacing of 0.12 inch; and (3) construct the guidance boom out of lightweight yet rigid panels.

- Eliminate discharge from the spillway flume to the ledges at the toe of the dam, as prescribed by Interior;

- Construct the proposed modifications to the temporarily-installed Alden weir at Graham Lake Dam within 2 years of license issuance, as prescribed by

Interior, and perform all construction activities outside of the downstream migration season of April 1 to December 31 (or ice-in) for Atlantic salmon, American eel, and alosines;

- Construct the proposed modifications to the downstream fish passage system at the Ellsworth Development (including a new diversionary guidance boom and modifications to the eastern surface weir, spillway flume, downstream migrant pipe, and plunge pool) prior to the third migration season after license issuance, as prescribed by Commerce;

- During the interim period between license issuance and implementation of the proposed and recommended modifications to the downstream fish passage facilities, monitor the forebay of Graham Lake Dam and the tailrace of Ellsworth Dam for out-migrating alosines during the downstream passage season (June 1 – November 30) and implement generation shut down procedures at the Ellsworth Development if: (1) a school of out-migrating alosines is observed at Graham Lake following a storm event that exceeds 17 percent of the total average monthly rainfall; or (2) dead or injured alosines are observed in the tailrace of Ellsworth Dam;

Upstream Fish Passage Measures

- Provide upstream passage for alosines and Atlantic salmon from May 1 to November 15 of each year by operating and maintaining the existing fishway trap and truck facility at Ellsworth Dam during the term of any new license;

- Design and construct the proposed upstream fish passage ramps for American eel using the FWS's Design Criteria Manual, including that the upstream eel passage facility should: (1) consist of a covered metal or plastic volitional ramp that is lined with a wetted substrate and angled at a maximum slope of 45 degrees, with one-inch-deep resting pools that are sized to the width of the ramp and spaced every 10 feet along the length of the ramp; and (2) be sized to accommodate a maximum capacity of 5,000 eels/day;

- Construct the proposed upstream eel ramp at the Ellsworth Dam at the bedrock outcrop adjacent to the eastern end of the dam, instead of consulting with FWS and Maine DMR on the exact location of the eel ramp;

- Operate the proposed upstream eel ramps on an annual basis from June 1 to October 31, consistent with Maine DMR's 10(j) recommendation and inclusive of Interior's prescription (June 1 to August 31);

- Construct the proposed new upstream eel passage facilities at the Ellsworth and Graham Lake dams within 2 years of license issuance, as prescribed by

Interior, and perform all construction activities outside of the upstream migration season of June 1 to October 31;

- Develop an upstream American eel effectiveness monitoring plan within six months of license issuance that includes provisions for evaluating: (1) attraction efficiency over a minimum of three nights during the first year of operation (*i.e.*, total number of migrating eels at the project versus the number of eels that pass upstream using the eel ramp); and (2) passage effectiveness (*i.e.*, whether 90 percent of eels pass from the entrance of the fishway to the exit of the fishway in 24 hours), as prescribed by Interior;

- If 90 percent of eels do not pass over the upstream fishway within 24 hours during the effectiveness test, then modify the upstream eel passage facility in consultation with FWS by, *e.g.*, changing the substrate, reducing the slope of the ramp, increasing the attraction flow, or modifying the conveyance flow, as prescribed by Interior;

- Develop and implement an effectiveness testing plan for the Atlantic salmon effectiveness testing studies proposed by Black Bear Hydro in the Species Protection Plan;

- Operate each new/modified fish passage facility for a one-season "shakedown" period and make adjustments to the facilities if they are not operating as designed;

- Modify the proposed fish passage operation and maintenance plan within 12 months of license issuance to include the following additional measures to help ensure that project fishways are operated and maintained in proper working order during the term of any new license: (1) a schedule of fishway operating times and minimum conveyance flows; (2) procedures for maintaining the downstream passage facilities in proper order and clear of trash, logs, and material that would hinder fish passage; (3) procedures for completing any anticipated maintenance before a migratory period such that fishways can be tested, inspected, and operational prior to the migratory periods, as prescribed by Interior and Commerce; and (4) provisions for updating the plan on an annual basis to reflect any changes in fishway operation and maintenance for the following year;

<u>Threatened and Endangered Species Measures</u>

- Avoid cutting trees between June 1 and July 31 to protect roosting northern long-eared bats; and

Recreation Measures

- Revise the recreational facilities maintenance plan to: provide additional detail on the recommended improvements to the fisherman access trail; include additional detail on Black Bear Hydro's proposal to correct the erosion problem at the Graham Lake boat ramp, including details on the size of the area that needs to be stabilized; and to require public notice of site access and the schedule for resolving issues concerning restrictions to public access to project waters and recreation facilities.

Cultural Resources Measures

- Implement the HPMP filed on December 30, 2015 to provide for management of historic resources throughout the term of any new license.

In addition to the measures above related to Interior's and Commerce's section 18 fishway prescriptions, we are recommending all other prescriptions submitted by Interior and Commerce, except for those discussed in section 5.2.3, *Measures Not Recommended*.

Below, we discuss the basis for the staff-recommended modifications and measures.

Graham Lake Water Elevation

Black Bear Hydro proposes to continue to seasonally draw down the water surface level of Graham Lake by 10.8 feet (between 93.4 feet msl and 104.2 feet msl) on an annual basis, whereby the impoundment is drawn down during the summer and winter and refilled in the fall and spring. Several commenters[259] recommend modifications to the existing minimum and maximum water surface elevations to: reduce the turbidity of Graham Lake and the Union River; protect littoral habitat; prevent mussels and fish from being stranded in the dewatered areas of Graham Lake; enhance spawning and reproductive success; improve recreational opportunities; and improve aesthetics along the shoreline. Table 44 provides a summary of the quantifiable costs and benefits associated with the proposed and alternative operating ranges.[260]

[259] In addition to the commenters listed here, several other commenters recommended reductions to the current 10.8-foot operating range, but did not provide a specific range or water elevations. Staff assumes that the alternatives evaluated herein would be acceptable to these commenters because the alternatives provide smaller ranges than the existing operating range.

[260] *See* section 3.3.2.2, *Aquatic Resources*, *Environmental Effects*, for additional information on staff's analyses of the alternative operating ranges.

Table 44. Effects of alternative Graham Lake operating ranges on developmental and non-developmental resources.

Alternative	Minimum Graham Lake Elevation (feet msl)	Maximum Graham Lake Elevation (feet msl)	Elevation Range (feet)	Annual Cost of Lost Generation	Storage Capacity of Graham Lake (acre-feet)	Turbidity (Percent of Samples with Secchi Depth Less than 2 Meters)	Aquatic Habitat Protection (Percent of Littoral Area Wetted at Minimum Elevation)	Recreation Access (Number of Public Boat Ramps at Minimum Elevation)	Extent of Mudflats (Acres of Land Dewatered at Minimum Elevation)
Black Bear Hydro	93.4	104.2	10.8	$0	108,000	53.2	5.0	0	2,668
Maine DFW	97.0	104.2	7.2	$49,230	72,000	53.2	30.0	1	1,966
Dunn	96.0	103.0	7.0	$51,990	70,000	48.5	31.5	1	1,756
Washburn and Friends	96.4	102.2	5.8	$68,370	58,000	47.8	41.1	1	1,441
BBH Alternative	98.5	104.2	5.7	$69,740	57,000	52.3	42.2	3	1,623
Whiting -1	98.5	103.0	4.5	$86,180	45,000	46.7	53.1	3	1,201
Bryant *et al.*	98.0	102.0	4.0	$93,010	40,000	50.0	57.4	3	1,030
DSF and Flower	99.0	103.0	4.0	$93,010	40,000	44.4	60.5	3	1,012
Cook *et al.*	102.0	103.0	1.0	$134,030	10,000	45.5	88.7	3	289

Turbidity and Erosion at Graham Lake

Several landowners requested alternative operating ranges to, *inter alia*, reduce turbidity and erosion at Graham Lake, including Richard Arnold, Kathy Cook, Edward Damm, Michelle Dawson, Gretchen Gardner, Craig Schoppe, and Mark Whiting.[261]

As discussed in sections 3.3.2.2 and 3.3.5.2, turbidity and sedimentation can have adverse effects on aquatic habitat, the feeding and reproductive success of fish, and aesthetics at Graham Lake. Graham Lake is one of the most turbid impoundments in Maine. Of the 900 lakes and impoundments monitored by the Lake Stewards of Maine, only 55 (*i.e.*, 6.1 percent) are more turbid than Graham Lake. As described in section 3.3.2.1 (*Aquatic Habitat- Affected Environment*), the shoreline of Graham Lake is composed of fine, erodible soils in many locations. The length and width of Graham Lake provides long fetches over which persistent winds can generate waves that erode soils and suspend sediment in the water column. When the impoundment is drawn down (*e.g.*, below 95.0 feet msl), large areas of unvegetated mudflats are dewatered and exposed. Runoff from rain events can carry sediment from the exposed mudflats into the impoundment. Sediment can also become suspended as water moves over the mudflats when the impoundment is refilled.

Operating Graham Lake within the current upper and lower water surface elevations (93.4 – 104.2 feet msl), as proposed by Black Bear Hydro, would continue the existing seasonal drawdowns in the impoundment, and turbidity levels would likely remain unchanged. As discussed in section 3.3.2.2, the greatest frequency of turbid conditions occurs above 103.0 feet msl (Table 12), which suggests that processes contributing to sediment suspension have a greater effect at water surface elevations greater than 103.0 feet msl, and that lowering the upper water surface elevation to 103.0 feet msl would reduce these effects. Secchi depth data from 2001 to 2017 show that the lowest frequency of turbid conditions occurs within the operating ranges recommended by DSF and Flower (99.0 – 103.0 feet msl), Whiting 1 (98.5 – 103.0 feet msl), and Cook *et al*. (102.0 – 103.0 feet msl) (see Table 13; Table 44).

In their comments, landowners recommend that the maximum lake level elevation of 104.2 feet msl be reduced by as much as 2 or more feet to reduce shoreline erosion from high water levels in the spring and the resulting turbidity in the impoundment.[262]

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[261] In addition to these landowners, DSF submitted 332 signed petitions on February 19, 2019 requesting new lake levels to, *inter alia*, reduce turbidity, enhance water quality, and protect the property of shoreland owners from erosion.

[262] *See* comments of Thomas P. Dunn, filed April 18, 2018; intervention request of the Frenchmen Bay Conservancy, filed April 9, 2018; comments of Michelle R. Dawson,

Reducing the maximum shoreline elevation could reduce erosion and turbidity by reducing inundation and wave action at the upper elevation levels. Bryant *et al.*'s recommended maximum elevation of 102.0 feet msl is the lowest of the proposed maximum elevations. At 102.0 feet msl, the maximum impoundment elevation would be 2.2 feet lower than the existing maximum impoundment elevation, which would reduce inundation and wave action between 102.0 and 104.2 feet msl. Similar to Bryant *et al*.'s recommendation, a maximum elevation of 103.0 feet msl (as recommended by Cook *et al.*, DSF and Flower, Dunn, and Whiting 1) would decrease erosion by reducing inundation and wave action at upper elevations relative to the environmental baseline.

Although reducing the maximum shoreline elevation could dewater the upper extent of existing wetlands in the project vicinity (*i.e.*, on land up to 104.2 feet msl) and reduce the amount of wetland vegetation at these higher elevations, upland vegetation would likely colonize these areas and stabilize any bare soil.

Graham Lake Littoral Habitat

Several landowners requested alternative operating ranges to, *inter alia*, improve aquatic habitat, including Richard Arnold, Kathy Cook, Edward Damm, Michelle Dawson, Gretchen Gardner, Craig Schoppe, and Mark Whiting.[263]

As discussed in section 3.3.2.2, *Aquatic Resources- Environmental Effects*, impoundment drawdowns can affect aquatic resources by dewatering littoral habitat used by fish, mussels, and macroinvertebrates for cover, foraging, and spawning. In addition, impoundment drawdowns can reduce the abundance of macroinvertebrates and affect the species composition of the macroinvertebrate community occupying the littoral zone. Seasonal impoundment drawdowns can also prevent the establishment of submerged aquatic vegetation.

The current operating range that Black Bear Hydro proposes to maintain would leave only 5 percent of the littoral zone wetted if the full operating range of 93.4 feet msl to 104.2 feet msl is used on an annual basis. Dewatering such a large proportion of the littoral zone adversely affects aquatic habitat for, and likely reduces the production of, fish and macroinvertebrates.

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filed April 6, 2018; intervention request of Friends of Graham Lake Association, filed March 26, 2018; comments of Richard Arnold, filed March 6, 2018; comments of Edward A. Damm, filed February 2, 2018; comments of Twyla Bryant, filed January 18, 2019; comments of Mark Whiting, filed February 4, 2019; and comments of Edward Damm, filed February 25, 2019.

[263] In addition to these landowners, DSF submit 332 signed petitions on February 19, 2019 requesting new lake levels to, *inter alia*, improve aquatic habitat.

The alternative reservoir elevations proposed by commenters would result in at least 30 percent of the littoral zone remaining wetted, increasing the amount of persistent littoral habitat 6.0 to 17.7 times over Black Bear Hydro's current 10.8-foot operating range. Cook *et al*.'s proposed elevation range would provide the greatest aquatic habitat protection by leaving approximately 89 percent of the littoral zone permanently wetted. The operating ranges recommended by Whiting 1, Bryant *et al*., and DSF and Flower would result in approximately 53 to 60.5 percent of the littoral zone remaining permanently wetted (see Table 44).

Increasing the amount of littoral habitat that remains wetted during the year relative to the existing reservoir operating regime would provide additional persistent adult, nursery, and foraging habitat for fish and potentially allow for the spread of submerged aquatic vegetation, which could stabilize the impoundment's substrate and reduce sediment resuspension. While increasing the amount of littoral zone would not necessarily prevent the stranding of mussels resulting from dewatering, the greater area of wetted littoral zone would provide additional habitat for mussels to colonize and could encourage the population to expand. Increasing the area of permanently wetted littoral zone could also allow existing beds of wetland vegetation to expand over time and colonize new areas with wetland vegetation, which could further stabilize sediment and reduce turbidity.

Recreation Access and Aesthetics at Graham Lake

Landowners and stakeholders filed several operational alternatives to reduce project effects on recreation and aesthetics by limiting drawdowns that expose mudflats. Several stakeholders state that lower lake levels in 2016 and 2017 made it difficult if not impossible to access the water from their shoreline properties due to expansive mudflats.[264] Commenters also complained that the mudflats and turbid lake water negatively affected the aesthetic qualities of their waterfront properties.[265] In addition, Maine DIFW filed a comment requesting that elevation drawdowns be reduced, and

[264] *See, e.g.,* April 5, 2018 filing from the Hancock County Planning Commission; April 9, 2018 filing from Kathryn Mullen; comments of Robert Miller; filed February 11, 2019; and comments of Ed Damm, filed February 25, 2019.

[265] *See, e.g.,* March 19, 2018 filing from Jeffrey Smith; April 3, 2018 filing from Kevin Bullard; April 9, 2018 filing from DSF; April 9, 2018 filing from the Native Fish Coalition; comments of Mark Whiting and Catherine Fox, filed on February 4, 2019; comments of Brad Perry, filed February 6, 2019; comments and signed petitions filed by DSF on February 19, 2019; and comments of Ed Damm, filed February 25, 2019.

specifically discussed the negative effect of the current allowable drawdown range on ice fishing.

As discussed in section 3.3.5.2, the effects of the seasonal reservoir drawdowns on recreation access and aesthetics at Graham Lake are more pronounced at lower elevations. In the fall of the 2016 and 2017 drought years, for example, water elevations at approximately 95 to 96 feet msl affected recreational use at Graham Lake by leaving docks dry and reducing access to boating, fishing, and swimming from public boat ramps and private properties. Fletcher's Landing and the Mariaville public boat ramps are unusable at approximately 97 feet msl, and Graham Lake Dam boat ramp becomes unusable below approximately 94 feet msl. In addition, large drawdowns in the winter season can dewater large areas of the lake bed under the ice, making it difficult for ice anglers to locate water, especially close to the shoreline. Shoreline erosion affects the aesthetic value of Graham Lake and damages lakefront properties at the interface between the land and the impoundment. As discussed above, erosion of soil along the shoreline also contributes to the turbidity of Graham Lake, which affects aesthetics.

Black Bear Hydro's proposal to maintain the existing 10.8-foot operating range could result in a 2,668-acre change in the surface area of the impoundment and the exposure of extensive areas of mudflats between 93.4 feet msl and 104.2 msl (see Table 39; Table 44). At a minimum impoundment elevation of 93.4 feet msl, the Fletcher's Landing boat ramp and the Graham Lake Dam boat ramp would be unusable. In comparison, all of the alternative recommended minimum elevation levels would increase the water depth along the shoreline. This would reduce the environmental effects of the seasonal drawdown on recreation use by keeping more shorelines, private docks, and public boat launches watered. All of the alternatives would also improve aesthetic values by decreasing the acres of exposed mudflats.

Conclusion on Graham Lake Elevation Limits

Each of the alternative operating ranges discussed above would help reduce the adverse effects of project operation on turbidity, littoral habitat, and recreation and aesthetic value relative to current 10.8-foot operating range (Table 44). The operating ranges recommended by DSF and Flower (99.0 – 103.0 feet msl), Cook *et al.* (102.0 and 103.0 feet msl), and Whiting 1 (98.5 – 103.0 feet msl) have the greatest potential to reduce adverse effects, including by reducing turbidity and erosion above 103.0 feet msl, protecting aquatic habitat, and improving recreation access and aesthetics along the shoreline. The operating range recommended by Bryant *et al*. would also provide significant benefits for aquatic habitat, recreation access, and aesthetics relative to the existing 10.8-foot operating range.

The benefits associated with the alternative operating ranges would be counterbalanced by the cost of lost generation and lost storage capacity under the alternatives (see Table 41; Table 42; and Table 44). Out of the four alternative operating ranges referenced directly above, Whiting 1 would have the lowest annual cost of lost generation ($86,180) and would result in the lowest reduction in storage capacity (63,000 acre-feet) relative to the existing 10.8-foot operating range. Reducing the storage capacity of the reservoir below the 108,000 acre-feet currently available under the 10.8-foot operating range could increase the potential for upstream and downstream flooding. Therefore, Commission staff is recommending Black Bear Hydro's proposal to temporarily deviate from the maximum elevation limit in the event extreme hydrologic conditions would be anticipated to result in flooding conditions at the project.

Altogether, relative to the current 10.8-foot operating range, Whiting 1's recommendation would provide Black Bear Hydro with greater operational flexibility and lower costs than Cook *et al.*'s, Bryant *et al.*'s, and DSF and Flower's recommendations during the term of any new license issued for the project. At the same time, Whiting 1's recommendation would provide greater collective benefits for water clarity, aquatic habitat, recreation access, and aesthetics than the alternative operating range included in Black Bear Hydro's WQC application and the operating ranges submitted by Washburn and Friends, Dunn, and Maine DIFW. In addition, Whiting 1's recommendation would allow Black Bear Hydro to maintain an operating range that is similar to the long-term average operating range for the project (see Figure 5). Therefore, Whiting 1's recommendation would best balance the developmental and non-developmental project resources. Accordingly, staff recommends that any license issued for the project require a change in the current operating range of Graham Lake from between 93.4 and 104.2 feet msl to between 98.5 and 103.0 feet msl in order to reduce project effects on turbidity and sedimentation, littoral habitat, recreation, and aesthetics in and around Graham Lake. Staff concludes that these environmental benefits would be worth the levelized annual cost of $86,180 resulting from lost generation.

Downstream Fish Passage

Black Bear Hydro proposes and Interior, Commerce, Maine DMR, and DSF recommend several modifications to the existing downstream fish passage facilities at the Graham Lake and Ellsworth developments. As discussed in section 3.3.2.2, *Aquatic Resources*, *Environmental Effects*, modifying the downstream fish passage facilities at the Graham Lake and Ellsworth Developments would significantly resolve adverse project effects on downstream fish passage and help ensure the safe, timely, and effective passage of out-migrating American eel, Atlantic salmon, and alosines. Staff recommends the following proposed measures to reduce the adverse effects of the project on downstream fish passage and finds that the benefits of the measures outweigh the cost, as discussed above: (1) providing downstream fish passage at the Graham Lake and Ellsworth dams from April 1 to December 31 of each year; (2) modifying the temporarily-installed Alden weir at Graham Lake to provide a 3-foot-deep flow over the full range of lake elevations allowed in any new license; (3) installing full-depth trashracks or trashrack overlays with 1-inch clear-spacing at the intakes for generating Units 2, 3, and 4; (4) installing a fish diversionary guidance system with a boom and 10- to 15-foot-deep, rigid panels at the Ellsworth Development to divert migrating fish to the entrance of the eastern surface weir; (5) modifying the eastern surface weir at Ellsworth Dam by installing tapered walls (*i.e.*, an Alden weir), increasing the weir capacity to pass up to 5 percent of station hydraulic capacity (123 cfs), and providing a 3-foot depth of flow over the weir; and (6) increasing the height of the walls of the spillway flume and realigning the downstream migrant pipe to limit potential injury to fish that are exiting the pipe. Below, we discuss additional staff-recommended measures that are not proposed by Black Bear Hydro, but that would further reduce adverse project effects on downstream fish passage.

<u>Graham Lake Development</u>

Passing Minimum Flows through the Graham Lake Alden Weir

Black Bear Hydro proposes to continue releasing a continuous minimum flow of 105 cfs from July 1 through April 30, and a continuous minimum flow of 250 cfs from May 1 through June 30 from the Ellsworth and Graham Lake developments during normal project operation, for the protection of fishery resources, as prescribed by Interior. As discussed in section 3.3.2.2, *Aquatic Resources, Environmental Effects, Minimum Flows*, the proposed minimum flows would continually water the majority of the Union River between Graham Lake and Lake Leonard, provide habitat for fish and aquatic resources between the two impoundments, and provide a sufficient zone of passage for Atlantic salmon, river herring, and adult eels migrating through the project. There would be no additional cost associated with Black Bear Hydro's proposal to continue release the minimum flows during the term of a new license, and staff recommend it.

Black Bear Hydro also proposes to modify the temporarily-installed Alden weir at Graham Lake to provide a 3-foot-deep flow over the full range of lake elevations allowed in any new license, as prescribed by Commerce. As discussed in section 3.3.4.2 (*Threatened and Endangered Species, Environmental Effects, Atlantic Salmon, Downstream Fish Passage*), a water depth of 2 or 3 feet through the Alden weir would provide a sufficient water depth to pass alosines, salmon, and eels to be fully submerged as they swim through the weir, thereby reducing the potential for adverse behavioral reactions (*e.g.*, avoidance behavior) that would occur at lower depths. Staff estimates that the annual levelized cost of modifying the Alden weir to allow either a 2- or 3-foot-deep flow over the weir under all water surface elevations included in any new license would be $14,600. Because the cost of a 2-foot and 3-foot depth would be equal, staff finds that the benefits of a 3-foot-deep flow over the Alden weir would outweigh the cost.

Interior's fishway prescription and Maine DMR's section 10(j) recommendation would require Black Bear Hydro to use the new downstream passage facility to pass the minimum flow required in any new license issued by the Commission. Releasing the proposed minimum flows through the modified Alden weir during the downstream fish passage season (April 1 to December 31, or until the impoundment freezes over) would help provide a stronger attraction flow for surface-oriented passage for Atlantic salmon and alosines. In the case of Atlantic salmon smolts, which migrate in May and June, passing the minimum flow of 250 cfs through the Alden weir would reduce the likelihood of downstream migration delays for this endangered species. Black Bear Hydro states that the combination of the 250 cfs minimum flow, the 3-foot depth requirement, and the staff-recommended lake level operating range may necessitate the replacement of the Alden weir, rather than just modification of the weir. Assuming that replacement of the Alden weir is necessary, staff finds that protecting endangered Atlantic salmon smolts would warrant the estimated annual levelized cost of $29,200.

Ellsworth Development

Generating Unit Prioritization

Black Bear Hydro proposes to prioritize the operation of Units 1 and 4 over Units 2 and 3 during the critical downstream passage seasons. Commerce's section 18 fishway prescription and Maine DMR's section 10(j) recommendation would also require Black Bear Hydro to prioritize operation of Unit 4 over Units 2 and 3, and curtail Unit 1 during critical downstream passage seasons.[266] Black Bear Hydro proposes and the agencies recommend that the critical downstream fish passage seasons be determined in consultation with the resource agencies.

As discussed in section 3.3.2.2, *Aquatic Resources, Environmental Effects, Downstream Fish Passage*, several turbine-related mortality events involving downstream migrating alosines have been observed since 2014. These events have occurred throughout the downstream fish passage season. Beginning with the 2017 fish passage season, Black Bear Hydro began prioritizing the operation of Units 1 and 4 over Units 2 and 3 at the Ellsworth Development to help reduce turbine-induced mortality, based on results from the 2016 Downstream Atlantic Salmon Passage Survival Study showing that test fish utilizing Units 1 and 4 for downstream passage had greater survival (81 percent survival) than test fish utilizing Units 2 and 3 (62.4 percent survival) for downstream passage.

Based on the survival rates from the downstream salmon passage study, unit prioritization has the potential to lower the mortality rate of downstream migrants that become entrained at the project when flows are less than the combined hydraulic capacity of Units 1 and 4 (1,370 cfs). Although the evidence of continued fish kills in the 2017 and 2018 passage seasons demonstrates that turbine passage at the project continues to be

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[266] Commerce's and Maine DMR's recommendations to curtail Unit 1 are discussed directly below.

an issue under existing conditions, the additional staff-recommended measures related to downstream fish passage should reduce the magnitude and frequency of turbine-induced mortality on downstream migrating fish, including by excluding fish from the generator intakes through the use of trashrack overlays with narrower spacing than the existing trashracks and a fish guidance system for guiding fish to a modified eastern surface weir. However, to the extent that any fish are entrained at the Ellsworth Development, prioritizing the operation of Units 1 and 4 over Units 2 and 3 would reduce the risk of mortality.

Although the agencies recommend that unit prioritization only occur during the critical downstream passage seasons, fish kill events have historically occurred from June through October. Implementing unit prioritization during the entire downstream fish passage season for Atlantic salmon, alosines, and American eels (April 1 to December 31, or ice-in) would reduce the risk of turbine-induced mortality. In addition, unit prioritization from April 1 to December 31 (or ice-in) would not restrict energy production or otherwise result in additional costs to Black Bear Hydro. Accordingly, staff recommends prioritizing the operation of Units 1 and 4 over Units 2 and 3 during the entire downstream passage season from April 1 to December 31.

Generator Shutdown

Protection Measures for American Eel

Interior's fishway prescription and Maine DMR's section 10(j) recommendation would require Black Bear Hydro to cease operation at night from September 1 through October 31, and for three nights following significant rain events in August (*i.e*., a rain event that produces more than 1 inch of rainfall) to provide out-migrating American eels with safe and timely downstream passage.

As discussed in section 3.3.2.2, *Aquatic Resources, Environmental Effects, Downstream Eel Passage,* shutting down all generation at night from September through October 31 and after August storm events that produce rainfall exceeding 1 inch of precipitation would significantly reduce turbine-induced injury and mortality at the project because both periods represent critical times of the downstream passage season where migrating eels could be affected by the project operation. The peak of eel migration generally occurs between September 1 and October 31. In addition, storm events during the month of August that produce significant rainfall (exceeding 1 inch of precipitation) provide environmental cues that would signal downstream migration, particularly in mid-August when eels begin their migration in Maine. In addition, peak movements of eels occur at night, and the nights following periods of increasing river flow (Richkus and Whalen, 1999).

Shutting down the generators during the peak of the eel migration season during the term of any new license would reduce the risk of impingement and entrainment and increase the potential for eels to detect the attraction flows from the surface bypass weirs and use the weirs for a safer route of passage. Even with trashracks covering Units 2-4, the 1-inch clear spacing would not exclude entrainment of all adult eels, as previous studies in New England have documented the width of adult eels as ranging from 0.9 to 1.1 inches wide. The estimated annual levelized cost of shutting down the generators at the project on a nightly basis (8 PM to 4 AM) from September 1 to October 31 and in August following each storm event that produces more than 1-inch of rainfall would be $56,240. Staff believes that the benefits of shutting down the generators during the critical periods of downstream passage for out-migrating eels would outweigh the cost.

Protection Measures for Atlantic Salmon

Commerce's fishway prescription and Maine DMR's section 10(j) recommendation would require Black Bear Hydro to shut down Unit 1 during "critical" downstream passage seasons for anadromous fish species. However, Commerce and Maine DMR do not define the "critical" passage seasons for Atlantic salmon smolts; instead, the resource agencies state that the critical passage season would be determined in consultation with resource agencies. Nonetheless, data provided by Black Bear Hydro and collected by NMFS indicate that the critical downstream passage season for smolts occurs during a 15-day period after water temperature in the Union River reaches 50° F in the spring, as discussed in section 3.3.4.2, *Threatened and Endangered Species, Environmental Effects, Atlantic Salmon*.[267]

Although several staff-recommended measures would reduce project effects on downstream Atlantic salmon migration, smolts could still be entrained into the unit intakes if they pass under or through the staff-recommended fish guidance system. As discussed in section 3.3.4.2, the overall effectiveness of similar fish guidance systems installed at other projects ranges from 33.1 to 69.2 percent, with an overall average across projects of 57.6 percent. Therefore, some smolts would still be expected to gain access to the intake facilities for generating Unit 1 or Units 2-4.

The potential for smolt entrainment would be highest at Unit 1 based on the proximity of Unit 1 to the eastern surface weir and the use of the eastern surface weir as the primary means of downstream passage for out-migrating fish. Ceasing operation of Unit 1 during the critical smolt downstream migration season defined above would reduce the potential for the flow from Unit 1 to attract smolts to its intake and for smolts to be entrained. Staff estimates the annual levelized cost of shutting down Unit 1 during a 15-day period after water temperature in the Union River reaches above 50° F in the spring during the term of a new license would be $25,910. Staff believes the benefits of

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[267] Staff's conclusions on the recommendations to shut down Unit 1 during the critical downstream fish passage season for Atlantic salmon kelts and alosines are discussed below in section 5.1.3, *Measures Not Recommended*.

shutting down Unit 1 during the critical downstream passage season for out-migrating salmon smolts would outweigh the cost.

Fish Passage through the Surface Bypass Facilities at the Ellsworth Development

Diversionary Guidance Boom at the Ellsworth Development

The existing downstream fish passage facility does not have any means to guide migrating fish to the downstream surface bypass weirs and away from the intakes. As discussed in section 3, downstream migrants have not been able to successfully locate the entrances to the downstream fish passage facility because of weak attraction flows relative to the station hydraulic capacity. Any migrants that do not locate the entrances to the downstream fish passage facility are attracted to the intakes where they have historically been entrained and subsequently injured or killed by turbine passage. Consistent with Commerce's fishway prescription and Maine DMR's and DSF's recommendation, Black Bear Hydro proposes to install a fish guidance system consisting of 10- to 15-foot deep rigid panels that are suspended inline from a series of large floats (*i.e.*, "diversionary guidance boom"). Only Maine DMR provides additional details regarding the design and approximate location of the guidance boom, including that the boom should have a maximum depth of 15 feet and that it should "extend from the eastern end of the intake structure to the western shore of the impoundment."

A diversionary guidance boom could reduce entrainment at the project intakes if the boom curtain is placed at an appropriate location and sufficient depth to divert all species of migrating fish from the turbine intakes and guide them to the eastern surface weir. Increasing the attraction flow to 5 percent of station capacity at the eastern surface weir would provide a stronger hydraulic signal and increase the safety, timeliness, and effectiveness of passage relative to the existing environment. However, fish that are migrating downstream on the western side of the Union River would still be susceptible to entrainment due to the strong hydraulic signal associated with Units 2 – 4, which have a total maximum hydraulic capacity of 1,775 cfs. A diversionary guidance boom that extends from the western shore of the impoundment to the eastern end of the Unit 1 intake, could be used to divert out-migrating fish from the generator intakes to the eastern surface weir on the other side of eastern powerhouse intake.

Black Bear Hydro did not propose a mesh size for the diversionary guidance boom panels; however, if the mesh size of the panels is less than the range of body widths for juvenile alewives (0.12 to 0.18 inch), then the potential for adult eels, adult and juvenile alosines and salmon smolts to be impinged and entrained at the project would be minimized and these species should be effectively guided to the downstream fish passage facility.

Black Bear Hydro proposes to operate the downstream fish passage facility from April 1 to December 31. During this period, high flow events can transport debris, which could become entangled in the diversionary boom to the extent netting is used as part of the curtain design. Debris entangled on the boom netting during a high flow event could possibly damage netting and create gaps that allow fish to escape. A diversionary boom with lightweight yet rigid panels designed to withstand debris loading during high flow events could improve the effectiveness of the fish guidance system and reduce the chance of escapement.

Reducing entrainment and enhancing passage efficiency would directly benefit alosines, Atlantic salmon, and adult eels by enhancing downstream passage safety, timeliness, and efficiency, which could increase the number of adult fish returning to spawn and the number of juvenile eels returning to rear in freshwater in the following years for the duration of any new license. We recommend installing a diversionary boom that extends from the eastern surface weir end of the intake structure to the western shore of the impoundment with curtains constructed of lightweight yet rigid panels that have clear spacing of no more than 0.12 inch. We estimate that the annual levelized cost of constructing and operating a diversionary boom with this design would be $14,600 and conclude that the benefits of constructing and operating the upstream passage facility outweigh the cost.

<u>Plunge Pool at the Ellsworth Dam</u>

DSF recommends that Black Bear Hydro operate a spillway plunge pool at the Ellsworth Development. In addition, Interior's fishway prescription would require Black Bear Hydro to modify the spillway flume to "eliminate discharge to ledges at the toe of the dam."

As discussed in section 3.3.2.2 (*Aquatic Resources, Environmental Effects, Downstream Fish Passage*), Black Bear Hydro proposes to continue operating the downstream fish passage facility at the Ellsworth Development on an annual basis from April 1 to December 31, including the existing spillway plunge pool located at the toe of the dam. As discussed above, staff recommends that Black Bear Hydro continue operating the downstream fish passage facility annually from April 1 to December 31. There is no additional cost associated with operating the spillway plunge pool in this manner

As for Interior's prescription, rocky outcrops are located in the plunge pool immediately adjacent to the exit of the spillway flume, and could pose a safety risk to out-migrating fish that are using the spillway flume for downstream passage from the surface bypass weirs to the Union River below the Ellsworth Dam. Low tide exposes these rocky outcrops, such that discharge from the spillway flume at low tide could impact the rocky outcrops and injure or kill migrating fish. Modifying the plunge pool by removing the rocky outcrops (*i.e.*, “ledges”) would protect downstream migrants from being injured or killed from impacting the outcrops during passage. We estimate that modifying the spillway flume exit to eliminate discharge to the rocky outcrops (ledges) at the toe of the dam would have an annual levelized cost of $1,620 and find that the benefits outweigh the cost.

Downstream Fish Passage Facility Construction Schedule

Graham Lake

Black Bear Hydro proposes to modify the temporarily-installed Alden weir by May 1 of the third year following issuance of any new license. Commerce’s section 18 fishway prescription would require Black Bear Hydro to modify the Alden weir by May 1 of the third year of any new license. Interior’s fishway prescription and Maine DMR’s section 10(j) recommendation would require Black Bear Hydro to modify the existing downstream passage surface weir at the Graham Lake Dam within 2 years of license issuance.

Construction during the migration season would negatively affect fish migration. Adjusting the completion timing for the new downstream fish passage facility around migration seasons would ensure that construction activities are completed outside of the downstream migration period for Atlantic salmon, American eel, and alosines, which would minimize the effects of construction on migrating fish. The new facilities would also need to be checked for safe and effective passage before the migration seasons begin. We recommend that Black Bear Hydro complete the recommended modifications within 2 years of license issuance, and perform all construction activities outside of the downstream migration season of April 1 to December 31 (or ice-in) for Atlantic salmon, American eel, and alosines. Constructing the new facilities at the Graham Lake Development within 2 years of license issuance, and performing construction activities outside of the downstream migration season of April 1 to December 31 (or ice-in) would not be expected to increase the cost of constructing the facilities.

Ellsworth Development

Black Bear Hydro proposes to complete the installation of the downstream passage measures (Worthington fish guidance boom, modified eastern surface weir, modified spillway flume walls, realigned downstream migrant pipe, and installation of the trashracks) at Ellsworth Dam by May 1 of the third year after license issuance. Commerce’s fishway prescription would require the downstream fish passage facility to be operational by May 1 of the third year of any new license. Maine DMR recommends that Black Bear Hydro complete the modifications to the downstream fish passage facility within 3 years of license issuance. Interior’s prescription would require and DSF recommends that Black Bear Hydro complete the modifications to the downstream fish passage facility within 2 years of license issuance.

There are a number of staff-recommended measures related to the downstream fish passage facility at the Ellsworth Development, including a new fish guidance system and modifications to the eastern surface weir, spillway flume, downstream migrant pipe, trashracks, and plunge pool. Based on the time needed to properly design, construct, install, and test the facilities prior to operation, Interior's prescription and DSF's recommendation to complete the modifications within 2 years of license issuance may not provide enough time to complete construction outside of the downstream passage season. As stated above, performing construction activities during the fish passage season could negatively affect migrating fish by creating passage delays or by forcing migrating fish to utilize unsafe means of downstream passage such as turbine passage or inadequate spill, known to injure and kill migrating fish. Also, if a new license for the project was issued during a migration season, then the 3-year timeline recommended by Maine DMR would end during a migration season. Adjusting the completion timing for the modified downstream fish passage facility around migration seasons, as required in Commerce's prescription, would provide additional time for construction activities to occur outside of the fish migration period. Avoiding construction during downstream migration periods would minimize the effects of construction on migrating fish and also provide the necessary time to design, construct, install, and test the newly modified downstream fish passage facility. To provide time for facility testing and any minor alteration prior to the migration season, we recommend that construction of the facilities be completed prior to the third migration season after license issuance, and no later than the beginning of April. Constructing the new facilities at the Ellsworth Development before the third passage season would not be expected to increase the cost of constructing the facilities.

Interim Passage Measures

Although the staff-recommended modifications to the downstream fish passage facilities would largely reduce the level of entrainment and turbine-induced mortality at the project, the staff-recommended measures would not be implemented for up to two passage seasons following license issuance. As discussed in section 3.3.3.2, *Aquatic Resources, Environmental Effects, Downstream Passage*, Black Bear Hydro currently performs voluntary measures to help reduce the impact of the project on downstream migrating fish. Beginning in October 2107, Black Bear Hydro began ceasing operation of the generating units at the Ellsworth Development when large numbers of out-migrating river herring are observed at the project.

As part of its operational shut-down procedure, Black Bear Hydro monitors the tailrace on a daily basis during the downstream fish passage season for dead or injured fish. If Black Bear Hydro observes an average of 10 or more dead or injured fish per minute in the tailrace, then it releases approximately 700 cfs from Graham Lake Dam to provide a sufficient amount of flow to Lake Leonard for downstream fish passage over the spillway and for minimum flow compliance at Ellsworth Dam. Once the increased flow from Graham Lake reaches Lake Leonard and begins to spill over the Ellsworth Dam flashboards, Black Bear Hydro ceases generation. This process normally takes between 1 to 2 hours between the Graham Lake Dam release and generator shutdown. A target flow release from Graham Lake Dam of 700 cfs provides an approximately 8-inch-deep spill flow over the Ellsworth Dam flashboards until the wave of migrating river herring have cleared the area, at which time Black Bear Hydro brings the generating units back online and resumes normal operating conditions.

While these measures help reduce the extent of mortality and injury on downstream migrants once a fish kill has occurred, the benefit of these measures to out-migrating fish heavily depends on timely generator curtailment once a fish kill occurs. As designed, the existing operational response procedures are delayed because Black Bear Hydro only monitors the tailrace on a daily basis and does not implement generator shut down until up to 2 hours after becoming aware of the fish kill. In its October 23, 2018 letter providing additional information on fish mortality events, Black Bear Hydro explained that approximately 1,200 juvenile river herring were killed between September 13 and September 14, 2018 while implementing these operating procedures.

Modifying Black Bear Hydro's operation response procedures to provide for timelier generator curtailment and implementing the modified response procedures would reduce the extent of turbine-induced mortality and injury at the project during the interim between license issuance and operation of the modified downstream fish passage facilities. To increase the effectiveness of the operation response procedures, Black Bear Hydro could: (1) monitor the tailrace for dead and injured fish on an hourly basis during the downstream alosine passage season (June 1 to November 30); and (2) immediately reduce generator output to the minimum hydraulic capacity needed to pass minimum flows at the project, upon observing injured or dead fish in the tailrace. The cost associated with continuing these operation response procedures and implementing more frequent monitoring and generator down-ramping during the interim period would be minimal.

Project effects could be further reduced if Black Bear Hydro could identify waves of out-migrating fish before they are entrained at the turbines. Ceasing project operation before a wave of migrating fish arrives at Ellsworth Dam would reduce project effects by protecting migrating fish from injury and mortality from turbine passage, provided Black Bear Hydro can take action in a timely manner.

In determining how Black Bear Hydro could optimize its operational response procedures, Commission staff evaluated whether storm events may have contributed to alosine outmigration. Based on a review of historic weather data and fish kills, significant rain events appear to trigger outmigration at the project, as there was a storm event prior to each reported fish kill between October 2014 and September 2018. For all storm events associated with fish kills, the total storm event rainfall ranged from 0.51 to 5.27 inches, with an observed mode of 0.7 inch. Storm intensity also affected outmigration with storms producing total rainfall that is 17 percent or more of the total average monthly rainfall during the alosine migration season appear to trigger an outmigration.

With regard to timing of fish kills, alosine have arrived at the Ellsworth Development between 1 and 5 days after a storm event, with the majority of the fish kills occurring 3 to 4 days after a storm. There was only one fish kill that occurred 5 days after a rain event and there were two fish kills that occurred 1 day or less after a rain event. The two fish kills that happened one day or less after a storm event occurred in July and August during what is normally a dry period. It is possible that alosines are more sensitive to environmental cues such as rainfall during dry periods than they are during other hydrologic periods.

Optimizing Black Bear's operational response procedures for station shut down based on heavy rainfall during the interim period between issuance of any new license and implementation of the staff-recommended modifications to the downstream fish passage facilities could provide a protection measure that precedes the arrival of a wave of out-migrating alosines, and decreases injury and mortality associated with turbine passage. Because alosines are surface-oriented, pelagic fish, schools of out-migrating fish should be visible in the forebay. Monitoring the forebay of Graham Lake for schools of fish on an hourly basis during the day for 3 to 4 days after a storm event that exceeds 17 percent of the total average monthly rainfall during the alosine downstream migration period (*i.e.*, June 1 through November 30), and ceasing generation operation upon observing schools of migrating fish in the forebay, would reduce the risk of river herring being injured or killed by turbine passage at the Ellsworth Development. As discussed above for the existing operation response procedures, Black Bear Hydro could immediately reduce generator output to the minimum hydraulic capacity needed to pass minimum flows at the project, upon observing a wave of out-migrating fish at Graham Lake. At the same time, Black Bear Hydro could release approximately 700 cfs from Graham Lake Dam to provide a sufficient amount of flow to Lake Leonard for downstream fish passage over the spillway and for minimum flow compliance at Ellsworth Dam. Once the increased flow from Graham Lake reaches Lake Leonard and begins to spill over the Ellsworth Dam flashboards, then Black Bear Hydro could cease generation. To provide sufficient time for a school of out-migrating fish to pass from Graham Lake to the Union River downstream of Lake Leonard, Black Bear Hydro could cease generation for a 4-hour period following the observation of out-migrating fish, unless additional waves of out-migrating fish are observed in the forebay of Graham Lake during the 4-hour generator shutdown. If additional waves of out-migrating fish are observed in the forebay, then another 4-hour shutdown could be implemented to accommodate fish passage.

To protect alosines from turbine passage mortality during the interim period between license issuance and implementation of the proposed and recommended modifications to the downstream fish passage facilities, staff recommends that Black Bear Hydro: (1) monitor the forebay of Graham Lake Dam on an hourly basis during daylight hours for the 4-day period following a storm event that exceeds 17 percent of the total average monthly rainfall; (2) monitor the tailrace of Ellsworth Dam on an hourly basis throughout the alosine downstream passage season (June 1 – November 30); and (3) implement generation shut down procedures at the Ellsworth Development if it observes a school of out-migrating alosines passing through the Alden weir[268] at Graham Lake or dead or injured alosines in the tailrace of Ellsworth Dam. Monitoring the forebay of Graham Lake Dam and the Alden weir for schools of alosines during the interim period would have a levelized annual cost of $580, and continuing to implement the existing operational shut-down procedures along with more frequent monitoring and generator down-ramping during the interim period would only result in minimal additional costs. Therefore, staff concludes that monitoring the forebay of Graham Lake Dam for schools of alosines and continuing to implement the existing operational shut-down procedures along with more frequent monitoring and generator down-ramping during the interim period, would be worth the levelized annual cost of $580.

Upstream Fish Passage

Anadromous Species

Commerce's fishway prescription would require Black Bear Hydro to continue operating and maintaining the existing fishway track and truck facility to pass alosines, but at the same time test the effectiveness of the existing facility for upstream Atlantic salmon passage and potentially modify or replace the existing facility with a volitional passageway for salmon. As discussed below in section 5.2.3, until the effectiveness of the existing upstream fishway and trap for passing salmon can be determined, Commission staff does not have a basis for requiring the construction of new volitional fishways. The existing fishway track and truck facility successfully passes thousands of river herring each year, as discussed in section 3.3.2.2, *Aquatic Resources, Environmental Effects, Upstream Fish Passage*. A detailed discussion of Commerce's prescription for volitional passage is located in section 5.2.3 under "*Volitional Fishway*

[268] As described in section 3.2.2, we recommend that Black Bear Hydro consult with the agencies to determine the best method and criteria for determining what school size should trigger a generation shutdown.

for Atlantic Salmon," and a detailed discussion on the agency-recommended effectiveness plans is located in section 5.2.3 under "*Effectiveness Testing of Fish Passage Facilities*." Continuing to operate the existing facilities would not result in any additional costs. Accordingly, staff recommends that Black Bear Hydro continue to operate the existing fishway trap and truck facility to provide upstream passage for Atlantic salmon and alosines until additional information becomes available.

Catadromous Species

The ability to climb over and around dams is well-documented for juvenile eels (GMCME, 2007). However, at 57 – 71 feet tall and 45 – 58 feet tall, the respective Ellsworth and Graham Lake dams could delay and potentially block juvenile eels from moving further upstream. A 2014 juvenile American eel upstream passage study documented several hundred juvenile eels actively attempting to ascend both project dams. As discussed in section 3.3.2.2, *Aquatic Resources, Environmental Effects, Upstream Eel Passage,* providing upstream eel passage ramps at the project dams would increase upstream passage effectiveness relative to the existing incidental passage over wetted project structures and adjacent bedrock outcrops. We estimate that the annual levelized cost of installing upstream eel passage ramps at Ellsworth and Graham Lake dams would be $42,740, and conclude that the benefits outweigh the cost. Below, we discuss the siting, construction, and operation of the eel ramps.

Upstream Eel Passage Design

Black Bear Hydro does not include design specifications in its proposal to install upstream eel passage facilities. Interior prescribes and Maine DMR recommends that the upstream eel passage facility be designed in a manner that is consistent with the eel passage design criteria contained in the FWS's Design Criteria Manual. The Design Criteria Manual was developed by FWS's Fish Passage Engineering Team to establish, among other things, general guidance on baseline design criteria, operation, and maintenance of fishways throughout the northeastern U.S. The Design Criteria Manual recommends an upstream eel passage facility consisting of a covered metal or plastic volitional ramp that is lined with a wetted substrate and angled at a maximum slope of 45 degrees, with one-inch-deep resting pools that are sized to the width of the ramp and spaced every 10 feet along the length of the ramp. The Design Criteria Manual further recommends sizing the ramp width to accommodate a maximum capacity 5,000 eels/day. We recommend using these design guidelines to help ensure the safe, timely, and effective movement of eels over the project dams. The cost of these design specifications are included in the estimated annual cost of installing the upstream eel passage ramps.

Location of Upstream Eel Ramp at Ellsworth Dam

Black Bear Hydro proposes to consult with Interior and Maine DMR to determine the exact location of the upstream eel ramps at both dams, consistent with Interior's prescription and Maine DMR's section 10(j) recommendation. As our analysis in section 3.3.2.2 explains, the upstream eel passage study clearly identified that the majority of juvenile eels congregated along the bedrock outcrop adjacent to the eastern end of the Ellsworth Dam to pass over the dam. Black Bear Hydro's 2014 study provides useful information about the location where the eel ramps could be installed at the Ellsworth Development to most effectively pass eels upstream of the Ellsworth Dam, and there does not appear to be any need or benefit to consulting on the location of the eel ramp, especially because we also recommend that the eel ramps be subject to a shakedown period and effectiveness testing so that any problems with initial eel ramp performance can be identified and corrected. Accordingly, we recommend that the proposed upstream eel ramp be installed at the bedrock outcrop that is located adjacent to the eastern end of the dam.[269] There is no additional cost associated with specifying the exact location now rather than following consultation with the agencies.

Operational Season of Upstream Eel Ramps

Interior's fishway prescription specifies that the upstream eel ramps be operated from June 1 to August 31, whereas Maine DMR's recommends (10(j) recommendation No. 2) that the eel ramps to be operated until October 31.

The juvenile eel catch rate at both dams starts declining in late July, as observed in the 2014 upstream passage study. Therefore, operating the ramps from June 1 to August 31, as recommended by Interior, would be consistent with the juvenile eel upstream migration season observed at the project. Operating the ramps until the end of October, as recommended by Maine DMR, is unlikely to provide much additional benefit. However, because the lost generation associated with the operation of the upstream eel ramps is not measurable and there is only minimal cost differences between Interior's prescribed and Maine DMR's recommended operational seasons, we recommend that the upstream eel passage facility be operated from June 1 to October 31.

Timing of Upstream Eel Ramp Installation

Black Bear Hydro proposes to construct the upstream eelways within 2 years of license issuance, consistent with Interior's prescription and Maine DMR's 10(j)

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[269] The most appropriate location for an eel ramp at Graham Lake Dam is more difficult to identify with the information provided in the record because of the location where eels were identified during the 2014 study and because of potential changes that could occur to attraction flows following the issuance of any new license. Constructing the eel ramp at a location that accounts for project operation and potentially changing attraction flows during the term of any new license, in consultation with resource agencies, would increase the safety and effectiveness of upstream eel passage at the Graham Lake Development.

recommendation No. 2. DSF recommends that the ramps be operational within 1 year of license issuance. As discussed in section 3.3.2.2, juvenile eels would benefit the most from improved passage efficiency by installing the ramps in the first post-licensing migration season practicable. However, this could complicated depending on the season of the year in which a new license is issued, which is not entirely predictable. For example, if the license is issued in the fall or winter of a given year, then the first migration season would begin in June, considerably less than 1 year into any new license term, and probably not enough time to allow for siting and design consultation with the agencies, approval by the Commission, and fabrication and installation by Black Bear Hydro. On the other hand, if a new license was issued during the migration season, then the 1-year timeline recommended by DSF would end during a migration season. Construction during the migration season would negatively affect upstream migration. Therefore, we recommend that the eel ramps be installed and operational within 2 years of license issuance, and that construction activities occur outside of the upstream migration season of June 1 to October 31. This timing would include no additional cost to the eel ramp measure, but would allow enough time for adequate consultation and design approval so that the eel ramps can be most effective. In addition, this requirement would not preclude Black Bear Hydro from installing the eel ramps before the first migration season, if time allows for adequate consultation and approval.

Upstream Eel Ramp Effectiveness Testing

Black Bear Hydro does not propose to test the effectiveness of the new upstream eel ramps. Interior's fishway prescription would require Black Bear Hydro to develop an upstream American eel effectiveness monitoring plan in consultation with FWS within six months of license issuance that includes standard methods previously required by FWS and Maine DMR for eel ramp fishways at Maine hydroelectric projects (*citing*, FERC Project No's. 2555, 2556, 2364, 2365, 2611, 2574, 2322, 2325, 5073, 2942, 2984, 2931, 2941, and 2932), including measures for evaluating: (1) attraction efficiency over a minimum of three nights during the first year of operation (*i.e.*, assessing the total number of migrating eels at the project versus the number of eels that successfully pass upstream using the eel ramp); and (2) passage effectiveness (*i.e.*, whether 90 percent of eels at the base of Ellsworth Dam successfully pass from the entrance of the fishway to the exit of the fishway within 24 hours). If 90 percent of eels do not pass over the upstream fishway within 24 hours during the effectiveness test, then Black Bear Hydro would be required to modify the upstream eel passage facility in consultation with FWS by, *e.g.*, changing the substrate of the ramp, reducing the slope of the ramp, increasing the attraction flow, or modifying the conveyance flow, as prescribed by Interior. Maine DMR's section 10(j) recommendation includes the same eel ramp effectiveness testing as Interior's fishway prescription.

Although the upstream eel passage facilities would already be designed, operated, and maintained in accordance with proven fish passage standards and operating procedures from FWS's Design Criteria Manual, a performance standard of 90 percent passage within 24 hours could be used to assess whether there are potential site-specific factors that could result in the facilities not operating as well as anticipated. For example, a 90 percent performance standard could be used to identify whether the base of the ramp where it is anchored to the substrate is inadvertently creating an eddy or other hydraulic feature that decreases the attraction efficiency of the ramp.

Observing the effectiveness of the installed eel ramps would allow verification that no such site-specific anomalies exist and, as necessary, would help identify any modifications that are needed to ensure that the eel ramps operated as intended. We estimate that the annual levelized cost of developing and implementing an upstream American eel effectiveness monitoring plan in consultation with FWS and Maine DMR would be $1,620, and conclude that the benefits outweigh the cost.

Shakedown Period for New and Modified Fishways

To ensure that the modified downstream fish passage facilities, the upstream eel passage facilities, and any future modified fish passage facilities[270] are operating as designed and to make minor adjustments to facilities and operations, as needed, we recommend that Black Bear Hydro operate new and modified fishways for a one season "shakedown" period. We estimate that the levelized annual cost of the "shakedown" would be included in routine operation and maintenance, and thus the cost would be negligible. Therefore, the benefits of the measure outweigh the cost.

Effectiveness Testing Study Plan for Atlantic Salmon Passage

Black Bear Hydro proposes a 3-stage effectiveness testing protocol for upstream and downstream Atlantic salmon passage, including testing: (1) the effectiveness of the staff-recommended modifications to the downstream fish passage facilities using stocked and marked Atlantic salmon smolts at both project dams; (2) the effectiveness of the existing upstream fishway trap and truck facility for adult Atlantic salmon that return to the Union River as a result of the stocked and marked smolts; and (3) if necessary, the effectiveness of new upstream swim-through fishways at both project dams. Black Bear Hydro's proposed effectiveness studies contain performance standards and detailed methodologies that are sufficient for our analysis, as discussed in section 3.3.2.2, *Aquatic Resources, Environmental Effects, Fishway Effectiveness Testing*. As provided in section 5.2.1, staff recommends Black Bear Hydro's proposed upstream and downstream effectiveness studies for Atlantic salmon to help ensure that the fish passage facilities are

[270] The project's fish passage facilities could be further modified based on the results of the effectiveness testing.

operating as expected, and finds that the benefits of the studies outweigh the estimated annual levelized cost of $170,380.

Additional study details are needed to provide clarity on Black Bear Hydro's proposed study methodology, including the marking, tagging, and tracking techniques that would be used in the upstream and downstream passage effectiveness studies, and the appropriate timing for stocking marked and tagged smolts. An effectiveness testing study plan could be developed in consultation with Commerce and Maine DMR to outline the measures that would be used for the effectiveness testing, including the schedule, materials, and methodology. The estimated annual levelized cost of an effectiveness testing study plan would be $810. The benefits of providing additional clarity on Black Bear's proposal to test the effectiveness of the upstream and downstream passage facilities for Atlantic salmon outweigh the cost, and staff recommends it.

Fish Passage Operation and Maintenance

Fishways need to be properly operated and maintained to provide safe, timely, and effective fish passage. Black Bear Hydro's proposed operation and maintenance plan for the upstream and downstream fish passage facilities describes how Black Bear Hydro would operate and maintain the existing fish passage facilities, including: the period in which the facilities are to be operated, guidance on the annual start-up and shut-down procedures, routine operating guidelines, debris management, and safety rules and procedures. The plan also includes a daily checklist and a list of on-site spare parts to help ensure that the upstream and downstream fishways are operating properly. Interior's fishway prescription and Maine DMR's section 10(j) recommendation require the development of a fishway operation and maintenance plan that includes measures for operating and maintaining upstream and downstream fish passage facilities. Commerce's fishway prescription and Maine DMR's section 10(j) recommendation would require Black Bear Hydro to: (1) keep the fishways in proper working order and clear of trash, logs, and material that would hinder passage; and (2) perform routine maintenance sufficiently before a migratory period so that fishways can be tested, inspected, and operational during the migratory periods.[271]

[271] Interior and Commerce also prescribe several administrative requirements that document actions among the resource agencies, applicant, and the Commission, and do not have a specific effect on environmental and developmental resources that warrant analysis. Specifically, Interior prescribes that Black Bear Hydro: (1) provide information on fish passage operation and project generating operation that may affect fish passage, upon written request from FWS; and (2) provide FWS personnel and FWS-designated representatives with timely access to the fish passage facilities and to pertinent project records for the purpose of inspecting the fishways and determining compliance

After completing modifications to the Graham Lake and Ellsworth development's fish passage facilities, there would likely be new operation and maintenance procedures necessary to ensure that the modified fishways operate as designed. A fish passage operation and maintenance plan that incorporates Interior's and Commerce's requirements and Maine DMR's recommendations would provide Black Bear Hydro with procedures necessary to ensure that the project fishways are maintained and in proper working order before and during the migratory fish season, including procedures for routine cleaning and maintenance, including debris removal. In addition, the plan could include provisions necessary to ensure that any fishways constructed at the project would be operated during the appropriate times of the day and year, and with an appropriate conveyance flow. Completing all maintenance on fishways before a migratory season, as recommended by Maine DMR would ensure that maintenance is completed in a timely fashion and that all fish passage facilities would operate as designed over the course of a migration season. We estimate that the levelized annual cost of the plan would be $810 and conclude that the benefits of the measure outweigh the cost.

Northern Long-Eared Bat

As discussed in section 3.3.4, *Threatened and Endangered Species*, maintenance of recreation facilities could periodically require the removal of vegetation, including trees within the project boundary. Trees provide valuable habitat for NLEB during their roosting reproductive phase, which takes place in the summer months, and tree removal during these months may disturb NLEB. Implementing a seasonal clearing restriction for trees greater than 3 inches in width at breast height, between June 1 and July 31, would avoid the time period when NLEB may be occupying nearby roosting trees, at no additional cost to Black Bear Hydro.

Recreation Facilities

Black Bear Hydro currently operates and maintains project recreation facilities that provide opportunities for boating and fishing in the project impoundments, including

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with the fishway prescription. Commerce prescribes that Black Bear Hydro: (1) submit design plans for trashrack overlays at the Ellsworth Development to the resource agencies for review and approval at least 6 months prior to the first passage season following issuance of any new license; (2) meet with resource agencies annually to discuss fish passage operation, study results, and the siting, design, and construction of upstream fishways for Atlantic salmon; (3) submit design plans for alosine and Atlantic salmon fishways to the resource agencies for review and approval no later than 2 years before the anticipated operational date; and (4) file final as-built drawings for any new fishways with Commerce and FWS after construction is complete.

(1) the Shore Road carry-in boat launch on Lake Leonard that includes a 2-vehicle parking area and a 6-foot-wide concrete plank ramp for carry-in boats; (2) the Graham Lake boat launch near the Graham Lake Dam that includes an 8-vehicle parking area and a 12-foot-wide concrete plank ramp for motorized boats; and (3) an approximately 360-foot-long canoe portage trail around the east side of Graham Lake Dam.

Black Bear Hydro is proposing improvements to enhance access and use of the project for recreation that include: relocating and extending the existing canoe portage trail at Graham Lake Dam; improving the downstream shoreline access trail for fishermen on the east side of the Graham Lake Dam; and correcting a drainage and erosion problem at the top of the boat ramp at the Graham Lake boat launch. Black Bear Hydro is also proposing to maintain directional and safety signage at the project. Black Bear Hydro is proposing to implement a Recreation Facilities Management Plan that includes measures for management of project recreation facilities during the term of any new license, and measures for developing proposed recreational improvements.

Interior recommends under section 10(a) of the FPA that Black Bear Hydro post notices that inform the general public as to the availability of access routes to project water for recreation and other uses.

The existing project recreation facilities are used at only a fraction of their capacity, and therefore appear to be sufficient to meet the demand for recreation in the project vicinity for the foreseeable future. Black Bear Hydro's proposal to relocate the existing canoe portage trail would result in safer portage for boaters because the take-out for the new portage trail would be located further from the dam gates. The new portage trail would also provide easier portage along a grassy and more gently-sloping route compared to the existing portage route that is steeper and forested. Also, correcting the drainage problem near the top of the Graham Lake boat ramp would help to protect the boat ramp from erosion damage and thereby ensure public access in future years. Commission staff estimates that the annual levelized cost of making the improvements to the canoe portage trail would be $15,112, and conclude that the benefits outweigh the cost.

Black Bear Hydro's proposal to improve the fisherman's downstream access trail would likely improve the user experience for anglers visiting the project because the trail is heavily vegetated with overhanging tree limbs and the existing trail is steep, with uneven footing and areas of erosion. However, Black Bear Hydro does not describe the actual improvements that it is proposing to make to the access trail. Based on the description of the trail as steep and uneven, and photographs showing that the trail is heavily vegetated by shrubs and small trees, the improvements that would need to be made to the trail to provide safer access to the Union River downstream of the Graham Lake Dam include, at a minimum, vegetation clearing, trail grading, and installing erosion control mechanisms. With these improvements, Commission staff estimates that the annual levelized cost of improving the access trail would be $4,340, and concludes that the benefits outweigh the cost.

Interior's recommendation to post notices describing the availability of access routes would help inform the public of recreation opportunities and access to different recreation sites around the project. The notifications could be posted on a website maintained by the licensee, and could include information involving: (1) any planned maintenance at project recreation facilities that would limit public access to the project water and recreation facilities; (2) ongoing accessibility issues involving maintenance events or extreme hydrologic conditions; and (3) estimated schedules for when inaccessible project facilities are expected to be accessible by the public.

Black Bear Hydro's proposed Recreation Facilities Management Plan includes measures for improving and maintaining existing project recreation facilities, which will help to ensure that the facilities are properly maintained and accessible during the term of any new license issued for the project. Revising the Recreation Facilities Management Plan to describe the recommended improvements to the fisherman access trail would help to ensure that the improvements are made in a timely manner and that the trail remains accessible for anglers during the term of any new license. Similarly, revising the Recreation Facilities Management Plan to provide additional detail on Black Bear Hydro's proposal to correct the erosion problem at the Graham Lake boat ramp, including details on the size of the area that needs to be stabilized, would help to ensure that the improvements are made in a timely manner and that facilities remain accessible during the term of any new license. Finally, revising the proposed Recreation Facilities Management Plan to require public notice of site access would help ensure that the public is informed about ongoing and future access limitations, and the schedule for resolving any access issues to project water and recreation facilities. We estimate that the annual levelized cost of a revised recreation plan would be $5,450, and conclude that the benefits outweigh the cost.

5.2.3 Measures Not Recommended

Some of the measures proposed by Black Bear Hydro and recommended by other interested parties would not contribute to the best comprehensive use of Union River water resources, do not exhibit sufficient nexus to the project environmental effects, or would not result in benefits to non-power resources that would be worth their cost. The following discussion includes the basis for staff's conclusion not to recommend such measures.

Run-of-River Operation

DSF recommends that Black Bear Hydro operate the Ellsworth Project in run-of-river mode. In addition, DSF recommends prohibiting peaking, cycling, or pulsing operation unless necessary for upstream or downstream fish passage. Similarly, Cook *et* *al*. recommend that Black Bear Hydro maintain a stable impoundment elevation for Graham Lake, which would result in run-of-river operation since storage in Graham Lake would be minimal.[272] As discussed in section 3.3.2.2, *Aquatic Resources, Environmental Effects, Minimum Flows,* operating the project in run-of-river mode would reduce rapid fluctuations in streamflow in the approximately 3.1-mile-long riverine reach of the Union River between Graham Lake Dam and Lake Leonard, relative to the existing flow releases from Graham Lake that are used for peaking operation at the Ellsworth Development. As discussed in section 3.3.2.2, rapid fluctuations in streamflow can adversely affect aquatic habitat and organisms downstream of the dam by potentially displacing fish and aquatic macroinvertebrates and disrupting spawning behavior.

However, using Graham Lake for water storage produces a more stable seasonal hydrograph than run-of-river operation and increases aquatic habitat availability in the Union River between Graham Lake Dam and Lake Leonard from May to October when alosines, eels, and salmon are migrating upstream and downstream through the project. Furthermore, flow could drop below 105 cfs in August and September (See Table 18) under run-of-river operation, which could adversely impact fish and aquatic resources and potentially reduce the availability of safe passage routes for adult salmon during those months by reducing the depth and habitat availability in the Union River between Graham Lake Dam and Lake Leonard.

We do not recommend run-of-river operation because it could negatively affect aquatic habitat availability during low-flow periods compared to current operation and would not be worth the annual levelized cost of $134,030 for Cook *et al*.'s recommendation or $147,700 for DSF's recommendation.[273]

Stream Gage Monitoring

DSF recommends that Black Bear Hydro install and operate in conjunction with USGS a set of electronic stream gages at the West and East branches of the Union River and at the project dams.

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[272] In section 3.3.2.2, *Aquatic Resources, Environmental Effects, Impoundment Levels,* staff assumed maintaining the water surface elevation of Graham Lake within 6 inches of 102.5 feet msl would satisfy Cook *et al*.'s recommendation.

[273] The $13,670 difference between annual levelized cost of Cook *et al*.'s recommendation and DSF's recommendation is because Black Bear Hydro could potentially use the 1-foot difference in Cook *et al*.'s recommended water surface elevations to provide some peaking generation.

Under the existing license Black Bear Hydro monitors compliance with project operation and minimum flows with sensors that monitor water levels at the project and control the reservoir levels and discharges from the Ellsworth and Graham Lake developments. Black Bear Hydro proposes no changes to its use of water level sensors to monitor and operate the project.

As discussed in section 5.2.2, staff recommends that Black Hydro operate Graham Lake between the elevations of 98.5 and 103.0 feet msl during normal operation. Installing and operating stream gages at the confluence of the east and west branches of the Union River within Graham Lake would not provide any information that Black Bear Hydro could use to monitor water levels within Graham Lake and ensure compliance with any license requirements. A stream gage in this location would only provide information on the amount of inflow to Graham Lake from the east and west branches of the Union River on a daily basis to determine compliance with a run-of-river mode of operation, which staff do not recommend.

Black Bear Hydro proposes to continue to use water level sensors, Tainter gate and turbine gate settings to maintain compliance with minimum flow releases and reservoir elevations at the Graham Lake and Ellsworth developments. Black Bear Hydro also proposes to formalize its monitoring protocols in an operation compliance monitoring plan. Stream gages at the project dams would only provide information on flow releases from each of the developments; however, this information would be duplicative in nature to the existing sensors and operational mechanisms that Black Bear Hydro already has in place. Therefore, stream gages at the project dams would not provide any additional information for documenting compliance with reservoir level elevations and minimum flows.

Accordingly, staff does not recommend the installation of stream gages at the confluence of the east and west branches of the Union River and at the project dams at this time. We estimate that the annual levelized cost of installing stream gages at these locations would be $30,800, and conclude that the benefits do not outweigh the cost.

Bass Spawning Habitat

As discussed in section 3.3.2.2, *Aquatic Resources, Environmental Effects*, drawing down the water surface of Graham Lake between May 20 and June 25 could disrupt largemouth and smallmouth bass spawning and nest guarding and dewater nests. To enhance bass spawning and reproductive success, Maine DIFW recommends maintaining the upper water surface elevation within 1 foot of 104.2 feet msl during the bass spawning season. However, the water surface elevation currently varies more than 1 foot during the bass spawning season approximately 44 percent of the time without any apparent effects on the bass population. Therefore, Maine DIFW's recommendation would not significantly reduce the effects of project operation on aquatic resources, and Commission staff does not recommend it.

Installation of a Deep Gate for Eel Passage at the Ellsworth Development

DSF recommends installing a deep gate at Ellsworth Dam to provide an additional route of downstream passage for out-migrating eels. As discussed in section 3.3.2.2, *Aquatic Resources, Environmental Effects*, there are no dedicated downstream eel passage facilities at the Ellsworth Development and only 51.1 percent of test eels survived downstream passage through the Ellsworth Development during the downstream eel passage study conducted in 2015.

As discussed above in section 5.2.2, Commission staff recommends several measures to reduce the adverse effects of the project on downstream eel passage. First, staff recommends screening the intakes of generating units 2, 3, and 4 at the Ellsworth Development with trashrack overlays that have 1-inch clear spacing, which will reduce the risk of eel entrainment, as the width of adult eels ranges from 0.9 to 1.1 inches. Second, staff recommends that Black Bear Hydro cease generation at the Ellsworth Development nightly (8 PM to 4 AM) from September 1 to October 31 to facilitate safe and timely downstream eel passage, as prescribed by Interior. Third, staff recommends that Black Bear Hydro cease generation at the Ellsworth Development for three consecutive nights (8 PM to 4 AM) following each rain storm event exceeding 1-inch of rainfall in a 24-hour time period during the month of August, to facilitate downstream eel passage, as prescribed by Interior. Altogether, these measures would significantly reduce turbine entrainment that is causing eel injury and mortality at the project.

Although downstream migrating eels are attracted to a submerged bypass more readily than a surface-oriented bypass, as discussed in section 3.3.2.2, *Aquatic Resources, Environmental Effects, Downstream Eel Passage*, eels are not strictly bottom-oriented during migration (Haro *et al*., 2000) and will utilize a surface-oriented downstream fish passage facility (Brown *et al*., 2009), particularly when a hydropower facility is not generating. As proposed by Black Bear Hydro and recommended by the resource agencies, Commission staff recommends modifying the entrance of the eastern surface weir to increase the attraction flow of the weir from 16 cfs to 123 cfs, which would better attract eels to the eastern surface weir.

As proposed by Black Bear Hydro and recommended by the resource agencies, staff also recommends modifying the spillway flume to prevent conveyance flows from overtopping the spillway flume walls and modifying the plunge pool to eliminate discharge to the rock ledges at the toe of the dam, both of which would improve passage safety by preventing eels from injury and mortality from insufficient spill or from impacting rocks at the toe of the dam during downstream passage. Passage safety would also be enhanced by realigning the downstream migrant pipe to eliminate shear forces from water flowing in opposing directions, as proposed by Black Bear Hydro, and recommended by the resource agencies and Commission staff.

Collectively, the modifications to the downstream fish passage facility, narrower trashrack screening at the intakes, and generation shutdown during the downstream eel passage season would significantly reduce the effects of project operation on adult eels and enhance downstream passage safety, timeliness, and efficiency. While installing a deep gate at the Ellsworth Development could reduce passage delay at the project, the increased attraction flows at the eastern surface weir, combined with generator shutdowns during the downstream passage season, would likely be sufficient to pass eels in a timely manner. Further, installing a deep gate would require significant modification to the Ellsworth Dam. We estimate that the annual levelized cost of constructing and operating a deep gate for downstream eel passage would be $86,810. Because the staff-recommended protection measures and modifications to the downstream fish passage facility would enhance downstream eel passage safety, timeliness, and efficiency, we do not recommend installing a deep gate for downstream passage and conclude that the benefits of constructing and operating the deep gate would not outweigh the cost.

Generator Shutdown during Downstream Passage Season

Commerce's fishway prescription and Maine DMR's section 10(j) recommendation would require Black Bear Hydro to shut down Unit 1 during critical downstream passage seasons for anadromous fish species.[274] In addition, DSF recommends that Black Bear Hydro not operate Units 2 and 3 at the Ellsworth Development during downstream migration periods.

As discussed in section 3.3.4.2, *Threatened and Endangered Species, Environmental Effects, Atlantic Salmon*, kelts have burst swim speeds that are high enough (16.5 – 19.7 fps) to overcome impingement at trashracks with clear bar spacing of 2.44 inches. Therefore, shutting down Unit 1 would not likely benefit downstream kelt passage. Shutting down Unit 1 during the downstream alosine migration season would likely provide similar benefits as those discussed in section 5.2.2, *Additional Measures Recommended by Staff*, for salmon smolts.

However, Commerce and Maine DMR do not provide any information about what would constitute critical passage seasons for alosines or Atlantic salmon kelts; instead, the resource agencies state that the critical passage seasons would be determined in consultation with resource agencies. The downstream passage season for kelts runs from

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[274] Staff's conclusion on the recommendations to shut down Unit 1 during the critical downstream fish passage season for Atlantic salmon smolts is discussed above in section 5.1.2, *Additional Measures Recommended by Staff*.

April 1 to June 15 and from October 17 to December 31 (or ice-in). The downstream passage season for alosines runs from June 1 to November 30. Without any information in the record to estimate the time period for the critical passage seasons for these species or the associated costs in lost generation that would occur if Unit 1 were shut down for kelt and alosine passage, staff cannot determine whether the benefits of a Unit 1 shutdown for these species outweigh the cost. Accordingly, staff does not have a basis for recommending that these measures be included in a new license issued for the project.

As discussed in section 3.3.2.2, *Aquatic Resources, Environmental Effects*, DSF's recommendation to shut down Units 2 and 3 during the downstream migration period would prevent out-migrating fish from being entrained into generating units that have been shown to cause a high rate of mortality. However, as discussed above in section 5.2.2, staff already recommends several measures at the Ellsworth Development to reduce the risk of entrainment at the project, including but not limited to: (1) installing a fish diversionary guidance system with a boom and 10- to 15-foot-deep, rigid panels to divert migrating fish away from the generating units and toward the entrance of the eastern surface weir; (2) modifying the eastern surface weir by installing tapered walls for more efficient passage, increasing the weir capacity to pass up to 5 percent of station hydraulic capacity (123 cfs), and providing a 3-foot depth of flow over the weir; (3) ceasing generation at night during the critical passage season for American eel; (4) ceasing generation during the 15-day critical passage season for Atlantic salmon smolts; (5) installing full-depth trashrack overlays with 1-inch clear spacing at the intakes for generating Units 2, 3, and 4; and (6) implementing generation shutdown procedures during the interim period between license issuance and the implementation of the staff-recommended modifications to the downstream fish passage facilities. Altogether, these measures would significantly resolve the ongoing adverse project effects associated with entrainment and help ensure the safe, timely, and effective passage of out-migrating American eel, Atlantic salmon, and alosines, and ceasing operation for the duration of the passage season would not likely provide any additional significant benefit to out-migrating fish. We estimated the annual levelized cost of shutting down Units 2 and 3 during the migration season to be $530,190 and conclude that the benefits do not outweigh the costs.

Atlantic Salmon Smolt Loss in Graham Lake

Black Bear Hydro proposes to conduct a 1-year study in Graham Lake to investigate the potential causes of "smolt losses in the downstream most reaches of the impoundment to continue the research of existing downstream passage conditions at Graham Lake Dam." In comments on the draft EA, NMFS requests that the Commission require Black Bear to conduct the study because smolts experience excessive mortality as they migrate downstream through Graham Lake. NMFS further states that predators may have caused high levels of smolt mortality, and that the impoundment increases the amount of habitat for predators. NMFS also states that Commission staff should consider that the mortality that occurs in Graham Lake is a project effect because the impoundment provides additional habitat for predators.

As discussed in section 3.3.4.2, *Aquatic Resources, Environmental Effects, Atlantic Salmon*, Black Bear Hydro does not define the "downstream most reaches" of Graham Lake. Staff assumes that Black Bear Hydro is referring to the region of Graham Lake between the Graham Lake release site for the 2016 and 2017 studies (approximately 0.75 mile upstream from Graham Lake Dam) and Graham Lake Dam. While the per-mile mortality rate in this reach was much higher in 2017 than 2016 (17.4 percent per mile versus 2.2 percent per mile), the observed range in mortality rates between years in Graham Lake was similar to the range of mortality rates that Stich *et al*. (2015c) reported for the Howland Project (FERC No. 2721) impoundment prior to its decommissioning (*i.e.*, 0.32 to 15.2 percent per mile). The per-mile mortality rates that Black Bear Hydro reported for 2017 were higher in all of the study reaches compared to 2016 (see Table 31 mortality rates). Lastly, the per-mile mortality rates observed in Graham Lake and the mainstem Union River in 2016 and 2017 were similar to the per-mile mortality rates that Stich *et al*. (2015c) reported for free-flowing and impounded reaches of the Penobscot River. Therefore, it is unclear why the lower reach of Graham Lake requires additional study.

Furthermore, Black Bear Hydro did not specify a methodology for the study or a target survival rate. In addition, the proportion of mortality in the impoundment caused by the project would be difficult to identify because estimates of mortality in the impoundment could be the result of other sources that may or may not be related to project operation. Most notably, mortality could also be caused by any number of freshwater fish or bird predators found in the Union River watershed. Except for the mortality rates observed in the West Branch Union River in 2016 and lower Graham Lake in 2017, all the per-mile mortality rates observed during the two study years were fairly similar among the impounded and free-flowing reaches. This similarity suggests that the per-mile mortality rate in Graham Lake is not consistently higher than the per-mile mortality rate in the free-flowing reaches of the Union River.

Based on the information discussed above, there is no consistent evidence for a significant adverse project effect on smolt mortality in the impoundment. For this reason, there is no justification for conducting a post-licensing impoundment mortality study. Because Black Bear Hydro did not provide a methodology or target survival rate for the study, staff cannot estimate a cost or assess whether the benefits of the study outweigh the cost. Altogether, staff does not have a sufficient basis to recommend including the smolt loss study as part of a new license for the project.

Volitional Fishway for Atlantic Salmon

In its fishway prescription, Commerce would require that Black Bear Hydro design and install a "state of the art swim-through fishway" to replace the trap and truck facility at the Ellsworth Dam, such as a vertical slot, Denil, or Ice Harbor fishway, or a fish lift. The prescription requires installation and operation of effective upstream swim-through passage structures for Atlantic salmon at the Graham Lake Dam and Ellsworth Dam no later than year 15 of any new license, respectively. Commerce states that Black Bear Hydro must continue to operate the existing fishway trap and truck facility until the new fishways are operational. However, Commerce states the following in the rationale for its prescription:

> "effectiveness studies at the Ellsworth Dam will be required to test the efficiency of the existing fishway entrance to attract adult salmon. If the existing entrance cannot attract and successfully pass the required proportion of adults than [*sic*] a new fishway should be sited based on the results of the telemetry studies and constructed as required."

In the draft EA, staff interpreted Commerce's prescription to mean that a new fishway would only be required if the existing trap and truck facility was shown to be inefficient at attracting and passing adult salmon. However, in comments filed by Commerce on February 15, 2019, it clarified that this interpretation of its section 18 prescription was incorrect. Commerce stated that even if the existing trap and truck facility entrance is determined to be highly effective at attracting salmon, only the entrance of the existing facility could be incorporated into the new fishway design. The existing trap and truck facility would not be permitted by Commerce to continue operating in lieu of the new fishway prescribed.

As listed in section 5.2.1, Commission staff recommends Black Bear Hydro's proposed effectiveness studies for upstream and downstream Atlantic salmon passage. Additionally, while staff now understands that Commerce is not making the requirement of the new volitional fishways conditional upon the effectiveness testing of the existing fishway entrance, staff's analysis and recommendation regarding the connection between the effectiveness studies and the necessity of the new volitional fishways has not changed. To the extent that the proposed effectiveness studies demonstrate that the existing fishway trap and haul facility is effective at attracting and passing adult salmon the project, or that modifications could be made to the existing trap and haul facility to render it effective at attracting and passing adult salmon, then new upstream swim-through fish passage facilities would not be needed to provide safe, timely, and effective upstream passage for salmon. Under these circumstances, there would be no justification for recommending the installation of a new upstream fishway or even modifying the existing fishway trap and haul facility.

On the other hand, if the effectiveness studies demonstrate that the existing trap and haul facility does not currently attract and successfully pass adult salmon, and that the facility could not be modified to effectively pass salmon, then new swim-through fishways could be needed to increase the effectiveness of upstream passage for Atlantic salmon returning to the Union River. In the event that the existing fishway trap and haul facility is not effective at attracting and successfully passing adult salmon, then the costs of alternatives for improving upstream Atlantic salmon passage could be considerable. For example, Denil fishways cost about 25-30 thousand dollars per vertical foot of dam head, or about 1.5 to 1.8 million dollars per 60-foot of dam height. Thus, providing new swim-through fishways at both dams could cost between approximately 3.0 and 3.6 million dollars. Additional costs would be associated with operation and maintenance of the fishways. Separately, modifying the existing fishway and trap to provide volitional passage could also be expensive because the vertical slot portion of the fishway would need to be extended so that fish could swim from the tailrace of Ellsworth Dam to Lake Leonard. Given the height of Ellsworth Dam at approximately 60 feet, several turn pools would likely be necessary. Then, Black Bear Hydro would still have to build a fishway at Graham Lake Dam or else the fish would be trapped in the habitat between the two project dams, and habitat upstream of Graham Lake could not be accessed by Atlantic salmon.

The extent of potential adverse effects associated with the upstream fish passage facilities cannot be reconciled until sufficient salmon returns are available to use the upstream facilities. Considering that Black Bear Hydro is currently using these same facilities to successfully pass thousands of river herring each year[275] , the primary problem with Atlantic salmon upstream passage could simply be that there are no adult salmon returning to the Union River to use the facilities. Therefore, the issue might not be related to the effectiveness of the existing facilities. On the other hand, as we discuss in section 3.3.4.2, *Threatened and Endangered Species, Environmental Effects, Atlantic Salmon*, there could be performance issues and ongoing effects associated with the existing upstream fishway and trap that cannot be quantified until a run of adult salmon is available for study. These potential effects include attraction to the fishway entrance, efficiency of passage through the fishway and trap, and the effects of migration delay caused by inoperation of the fishway and trap during periods when water temperature is above 73.4 degrees Fahrenheit or when a trap operator is not available.

[275] Our analysis for alosines in section 3.3.2.2 (*Aquatic Resources, Environmental Effects, Upstream Fish Passage*) shows that the targeted harvest and escapement of alosines is being met with the existing trap and haul facility. Therefore, from a fisheries management perspective, the new swim-through fishways are not necessary for alosines. Indeed, Commerce's prescription for alosines requires Black Bear Hydro to continue operating and maintaining the upstream truck and haul facilities for passing alosines and states that the facility is effective for meeting upstream stocking goals.

Implementing Black Bear Hydro's proposed 3-stage effectiveness testing protocol for Atlantic salmon would provide a pathway for determining whether the existing fishway and trap provides a safe, timely, and effective means of passage for Atlantic salmon, or whether modifications to the existing facilities or new swim-through fishways are warranted. Therefore, we recommend the continued operation of the existing fishway and trap, in combination with Black Bear Hydro's 3-stage effectiveness testing protocol. We acknowledge that construction and operation of swim-through fishways at Ellsworth and Graham Lake Dams may ultimately be warranted and required in order to provide safe, timely, and effective upstream passage of adult Atlantic salmon at the project. However, until the effectiveness of downstream passage improvements and the existing upstream fishway and trap can be determined, Commission staff does not have a basis for requiring the construction of new swim-through fishways as proposed by Black Bear Hydro and required by Commerce's prescription. To the extent that a new volitional fishway is needed for safe, timely, and effective upstream passage of Atlantic salmon, any new license issued for the project would include reopener provisions that allow the Commission to alter license requirements in response to changed environmental conditions.[276] The estimated capital cost of the new fishway is $3.45 million, which is discounted to account for the 15 year implementation schedule. Accordingly, the estimated discounted annual levelized cost of the new fishways ($53,720) is not currently justified given the speculative benefits.

Effectiveness Testing of Fish Passage Facilities

Modifying the existing downstream fish passage facilities for Atlantic salmon, alosines, and eels, and constructing new upstream passage facilities for eels would reduce adverse projects effects, such as turbine mortality and passage delay during migration, as discussed in section 5.2.2 and section 3.3.2.2, *Aquatic Resources, Environmental Effects*.

Interior's fishway prescription would require Black Bear Hydro to develop a downstream American eel effectiveness monitoring plan for the downstream passage modifications at Ellsworth and Graham Lake dams. The prescription does not define a specific performance standard that would be used to assess passage effectiveness for downstream migrating eels, but would require Black Bear Hydro to monitor the

[276] *See, e.g.,* Article 15 (fish and wildlife resources), reported at 54 FPC 1858 (1975) (Form L-5), stating that the "Licensee shall, for the conservation and development of fish and wildlife resources, construct, maintain, and operate, or arrange for the construction, maintenance, and operation of such reasonable facilities, and comply with such reasonable modifications of the project structures and operation, as may be ordered by the Commission upon its own motion or upon the recommendation of the Secretary of the Interior or the fish and wildlife agency or agencies of any State in which the project or a part thereof is located, after notice and opportunity for hearing."

effectiveness of silver eel passage at the two project dams using radio telemetry methods in order to determine migratory delay, route of downstream passage, and immediate and latent survival. According to the prescription, if downstream passage is not safe, timely, and effective, then FWS would assess the need for passage enhancements, including but not limited to an extended passage season, time of day restrictions, 0.75-inch trashrack spacing, a deep bypass gate, and/or new downstream eel passage facilities that use angled trash racks. Maine DMR's section 10(j) recommendation is the same as Interior's in that it specifies the same methods to be used and does not include a performance standard for defining what would constitute safe, timely, and effective passage.

Commerce's fishway prescription would require Black Bear Hydro to monitor upstream and downstream fishways at both project dams for alosine species and Atlantic salmon, to ensure they are functioning as intended for the safe, timely, and effective passage of migratory fish. The monitoring would begin at the start of the first migration season after each fishway facility is operational and would continue for up to three years, "or as otherwise required through further consultation." Commerce does not provide specific fishway performance standards, but indicates that it is developing standards that will likely require a "total project survival of approximately 90 [percent]." The prescription states that the licensee must develop study design plans for monitoring the effectiveness of fishways for juvenile and adult life stages of alosines and Atlantic salmon in consultation with NMFS and state and federal resource agencies, and must file study reports to the resource agencies for review and consultation.

Although effectiveness testing can be used to ensure that fish passage facilities are operating as expected, Commerce and Maine DMR did not include any specific methodology or performance standards for testing the effectiveness of the fish passage facilities for Atlantic salmon and alosines. Instead, they would require the development of study plans and performance standards post-licensing, in consultation with resource agencies. Although Commerce suggests that the standards may include a total project survival of approximately 90 percent, Commerce states that it is still developing specific performance standards for Atlantic salmon and alosines. Similarly, Interior's prescription and Maine DMR's recommendation do not include performance standards for assessing the effectiveness of downstream eel passage.

Without specific performance standards from the resource agencies that are responsible for establishing management goals and objectives for fisheries resources, Commission staff cannot assess the benefits of effectiveness testing for fish passage and determine whether effectiveness testing would or would not provide benefits to Atlantic salmon, alosines, and eels. This is especially true because the prescribed and recommended facilities would already be designed, operated, and maintained in accordance with proven fish passage standards and operating procedures, including the FWS's Design Criteria Manual. Therefore, on the basis of information provided by

Interior,[277] Commerce, and Maine DMR, there is insufficient justification for recommending license conditions that would require effectiveness testing and the potential modification of the upstream fish passage facilities for Atlantic salmon and river herring, and the downstream passage facilities for American eel.[278]

However, in its September 28, 2018 Atlantic salmon draft biological assessment and Species Protection Plan, Black Bear Hydro proposes to consult and coordinate with resource agencies to conduct effectiveness testing for Atlantic salmon at the existing trap and truck facility, the proposed downstream passage facilities at Ellsworth and Graham Lake dams, and the proposed new upstream fish passage facilities at Ellsworth and Graham Lake dams. Black Bear Hydro also proposes to coordinate with the resource agencies on any modifications to project facilities as a result of the effectiveness testing. Black Bear Hydro's proposal includes performance standards and detailed methodologies that are sufficient for an analysis of potential effects, as described in section 3.3.2.2, *Aquatic Resources, Environmental Effects, Fishway Effectiveness Testing*. As provided in section 5.2.1, staff recommends Black Bear Hydro's proposed upstream and downstream effectiveness studies for Atlantic salmon to help ensure that the fish passage facilities are operating as expected, and find that the benefits of the studies outweigh the estimated annual levelized cost of $170,380. These studies appear to be consistent with Commerce's fishway prescription and Maine DMR's section 10(j) recommendation pertaining to the effectiveness testing of Atlantic salmon upstream and downstream passage at the project.

In the event the resource agencies develop performance standards for testing the effectiveness of upstream and downstream alosine passage or downstream eel passage prior to the issuance of a final environmental assessment for the project, then Commission staff could assess the potential benefits of effectiveness monitoring for these passageways. Otherwise, as discussed above in section 5.2.2, staff recommends operating each new or modified fishway for a one-season "shakedown" period to ensure that the fishways are generally operating as designed, and if not, making adjustments to increase the likelihood of safe, timely, and effective passage for these species.

Adaptive Management Measures following Effectiveness Testing

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[277] As discussed above in section 5.1.2, staff recommends developing and implementing Interior's prescribed upstream American eel effectiveness monitoring plan based on the performance measures and detailed methodology proposed by Interior for the effectiveness testing.

[278] *See also Yakima Indian Nation v. FERC*, 746 F.2d 1451 (9th Cir. 1984) (noting that FERC must consider fishery issues before, not after, issuance of a license.)

As discussed above, staff recommends testing the effectiveness of Interior's prescribed upstream eel ramps and Black Bear Hydro's proposed modifications to the downstream passage facilities for Atlantic salmon passage. Although the effectiveness study would help identify whether modifications to the facilities are needed, it is not clear what measures would be implemented if the facilities fail to meet the 90-percent performance standard, despite being designed and operated according to the best available information.

Interior recommends that, if the 90 percent criterion is not met, then Black Bear Hydro would need to consult with FWS and modify the upstream eel ramps by changing the substrate, reducing the slope, increasing the attraction water, or modifying the transport flow. As another example, Black Bear Hydro proposes to modify the "existing fishway entrance or location and/or attraction water system or other changes," if the fishway truck and haul facility does not meet the 90 percent performance standard. Black Bear Hydro also proposes a variety of potential adaptive management measures that could be implemented if the downstream passage facilities at the Ellsworth Development do not meet the 90 percent performance standard, including: (1) adding panels or curtains to deepen the fish guidance system; (2) increasing flows over the spillway by reducing generation or shutting down turbines at night for two weeks during May; or (3) modifying the spillway ledge, plunge pool, or spillway surface to reduce injury to fish passing over the spillway.

The exact measures that would be implemented in the event of low performance would depend on the observations that are made and the performance issues that are identified during the effectiveness testing. Staff cannot anticipate whether modifications would be needed in the first place, or whether any subsequent modifications to the fish passage facilities would significantly improve fish passage facility, especially since the facilities would already be constructed according to design specifications in the FWS Design Criteria Manual. Therefore, there is no justification for recommending license conditions that would require modification of the fish passage facilities.

Operational Schedule for Downstream Eel Passage Facilities

Maine DMR states that the seasonal schedule for downstream eel passage operations may be modified in consultation with agencies based upon empirical passage timing data developed for the project or a predictive model for eel movement through the project waters. However, Maine DMR's recommendation does not include limits regarding the number of days (earlier or later) that the eel passage facilities should be able to operate beyond the recommended schedules. In the absence of recommended limits on operating schedule modifications, we have no information to determine whether a particular schedule modification would or would not provide benefits to American eel. Therefore, we are unable to determine whether the schedule modifications would be in the public interest. Thus, we do not recommend a license requirement that allows the operating schedules of the fishways to be modified without limits. However, the Commission's standard terms and conditions, which would be included in any subsequent license issued for the project, provide that the Commission can modify project structures and project operation for the conservation and development of fish and wildlife resources upon the Commission's own motion or upon the recommendation of resource agencies, after notice and opportunity for hearing.

Guaranteed Access to Project

Interior recommends under section 10(a) of the FPA that Black Bear Hydro ensure reasonable access to the project waters for recreation and other uses. Interior recommends that Black Bear Hydro develop an access plan in consultation with Interior and the State of Maine showing the routes over which access will be guaranteed, and the mechanism for such guarantee, including any associated fees and the basis for these fees. The recommended plan would focus on Graham Lake, but would also include the Ellsworth impoundment and the tailrace waters.

Black Bear Hydro proposes to continue to maintain existing boat access sites within the project boundary for the duration of the license, and to improve the portage route around Graham Lake Dam.

Multiple points of public access to project waters for recreation and other uses exist at the project. There are five boat access points to project water: two are owned and operated by the licensee, one is owned and operated by the state, and two are owned and operated by municipalities. There is also an informal boat access point to Lake Leonard, and fishing access downstream of each dam. The existing canoe portage trail around the Graham Lake Dam provides access to fishing downstream of the Graham Lake Dam, and Black Bear Hydro proposes to improve this trail. In addition, project water can be accessed at numerous informal access points located adjacent to roads that run alongside the water.

Black Bear Hydro proposes to continue to operate and maintain existing recreation facilities (*e.g.*, the Graham Lake Dam boat launch, the existing portage trail around Graham Lake Dam, and the Shore Road carry-in boat launch on Lake Leonard) that provide public access to project water. Black Bear Hydro is also proposing recreation improvements (*e.g.*, constructing a new portage trail around Graham Lake and improving the Graham Lake Dam boat launch and the existing fisherman's access trail) that would help to ensure continued public access. Black Bear Hydro's formal access sites, along with the state and municipal access, would provide guaranteed access to project water at least through the term of any new license. Access to the water at all normal operating elevations would be provided by the Graham Lake Dam boat ramp.

Interior's access plan would not change the availability of access because it would not result in any new access sites or greater accessibility at existing sites. The

Commission's standard terms and conditions for a hydropower license already require a licensee to maintain and operate reasonable access to project recreation facilities, including access roads and launching ramps. As far as it is consistent with the proper operation of the project, the standard terms and conditions for a hydropower license also require a licensee to provide the public with free access, to a reasonable extent, to project waters and adjacent project land owned by the licensee for the purpose of full public utilization of such lands and waters for navigation and for outdoor recreational purposes, including fishing and hunting. In addition, Black Bear Hydro's proposed Recreation Facilities Management Plan includes a map showing the existing and proposed recreation facilities and a description of each of the recreation facilities (including the location and accessibility). With the Commission's standard terms and conditions, and the proposed Recreation Facilities Management Plan, Interior's recommended access plan would result in little to no benefit for recreational access and use. We estimate that Interior's access plan would have an estimated levelized annual cost of $480, but we do not recommend including it any license that is issued for the project because it is not necessary and would not be worth the cost.

5.2.4 Conclusion

Based on our review of the agency and public comments filed on the project and our independent analysis pursuant to sections 4(e), 10(a)(1), and 10(a)(2) of the FPA, we conclude that licensing the Ellsworth Project, as proposed by Black Bear Hydro with the additional staff-recommended measures, would be best adapted to a plan for improving the Union River Basin.

5.3 UNAVOIDABLE ADVERSE IMPACTS

Some entrainment mortality is likely unavoidable for juvenile river herring and Atlantic salmon smolts migrating downstream, even with downstream passage for these species. For resident fish species, most large fish could avoid involuntary entrainment, but entrainment of some small fish could still occur. Some adult salmon migrating upstream might experience delay if water temperature exceeds 73° F, when operation of the trap and truck facility for salmon transport would be prohibited. Similarly, some salmon smolts and adult American eels might experience some delay at the project dams during downstream migration. In addition, the project would continue to operate in peaking mode, and sudden increases in flow could displace some fish and macroinvertebrates and disrupt fish spawning behavior. Lastly, fluctuating the water surface elevation of Graham Lake between 98.5 and 103.0 feet msl will prevent aquatic and terrestrial plants from becoming established between the two elevations, which could allow some erosion to continue.

5.4 SUMMARY OF SECTION 10(J) RECOMMENDATIONS

Under the provisions of section 10(j) of the FPA, each hydroelectric license issued by the Commission shall include conditions based on recommendations provided by federal and state fish and wildlife agencies for the protection, mitigation, or enhancement of fish and wildlife resources affected by the project.

Section 10(j) of the FPA states that whenever the Commission finds that any fish and wildlife agency recommendation is inconsistent with the purposes and the requirements of the FPA or other applicable law, the Commission and the agency shall attempt to resolve such inconsistency, giving due weight to the recommendations, expertise, and statutory responsibilities of the agency.

In response to our February 9, 2018 notice accepting the application to relicense the project and soliciting motions to intervene, protests, comments, recommendations, preliminary terms and conditions, and preliminary fishway prescriptions, Interior filed one section 10(j) recommendation on April 10, 2018, and Maine DMR filed 14 section 10(j) recommendations on March 27, 2018.

In the draft EA, we determined that Interior's recommendation filed pursuant to section 10(j) was within the scope of section 10(j) and we recommended adopting it. We also determined that 10 of the 14 recommendations filed by Maine DMR were within the scope of section 10(j). Of the ten that were considered to be within the scope of section 10(j), we determined that two recommendations may be partially inconsistent with the purpose and requirements of the FPA or other applicable law. We sent a letter to Maine DMR on November 26, 2018 informing them of the inconsistencies.

On January 16, 2019, Maine DMR responded to our letter, stating that although we did not recommend two of its recommendations, staff's alternative recommendations described in the draft EA were acceptable to them.[279] Also in its January 16, 2019 letter, Maine DMR commented that it continued to disagree with staff's findings regarding Maine DMR's recommended fishway effectiveness testing (measures that staff determined to be outside the scope of section 10(j)). Maine DMR did not request a meeting or teleconference for the purpose of discussing its section 10(j) recommendations. Section 5.2.3 explains staff's rationale for not recommending these out-of-scope recommendations and Appendix A responds to Maine DMR's comments on the draft EA.

[279] In both cases the measures were related to operation and construction schedules for fish protection measures and staff alternatively recommended measures consistent with Commerce's section 18 fishway prescription.

Table 45 lists the recommendations filed pursuant to section 10(j), and indicates whether the recommendations are included under the staff alternative, as well as the basis for our determinations concerning measures that we consider inconsistent with section 10(j). Environmental recommendations that we consider outside the scope of 10(j) have been considered under section 10(a) of the FPA and are addressed in the specific resource sections of this document.

Table 45. Analysis of fish and wildlife agency recommendations for the Ellsworth Project.

Recommendation	Agency	Within scope of section 10(j)?	Levelized Annual Cost	Recommend Adopting?
Release a continuous minimum flow of 250 cfs from May 1 to June 30 and 105 cfs from July 1 to April 30, from Ellsworth and Graham Lake dams to protect and enhance aquatic habitat.	Interior	Yes.	$0	Yes. Staff also recommends a flow of 123 cfs from April 1 to December 31 for downstream fish passage, as prescribed by Interior and Commerce under section 18. The 123-cfs flow release for downstream passage would contribute to the 250-cfs minimum flow release from May 1 to June 30 and *vice versa* for the remainder of the downstream passage season.
Modify the temporarily-installed Alden weir at the Graham Lake Development to: (1) provide at least a 2-foot depth of flow over the full range of lake elevations in any new license; and (2)	Maine DMR	Yes	$14,600	Yes. Consistent with Maine DMR's recommendation to provide a flow of *at least* 2 feet over the weir, staff recommends a minimum flow of 3 feet over the

Recommendation	Agency	Within scope of section 10(j)?	Levelized Annual Cost	Recommend Adopting?
release any minimum flows required in any new license designed in accordance with FWS's Design Criteria Manual and in consultation with resource agencies, and operate and maintain the Alden weir from April 1 through December 31 each year.				Alden weir, as prescribed by Commerce.
Operate the modified Alden weir for downstream passage of diadromous fish species by 2 years after license issuance.		Yes	$0	Yes. Staff also recommends that construction occur outside of the downstream migration season to minimize the effects of construction on migrating fish.
Modify the downstream fish passage facility for diadromous fish at the Ellsworth Development to consist of: (1) a Worthington fish boom	Maine DMR	Yes.	$126,360	Yes.

Recommendation	Agency	Within scope of section 10(j)?	Levelized Annual Cost	Recommend Adopting?
guidance system (or similar design) with 15-foot-deep screens extending from the eastern end of the intakes to the western shore of the reservoir; (2) a downstream fish passage facility entrance capable of providing an attraction flow of 123 cfs; (3) a realigned downstream migrant pipe discharge that prevents fish and conveyance flows from contacting the spillway; and (4) a spillway flume with taller sidewalls to fully contain the conveyance flow and fish during passage to the plunge pool.				
Operate the modified downstream fish passage facility for diadromous fish species from April 1		Yes.	$0	No. Measure is inconsistent with Commerce's FPA section 18 fishway prescription

Recommendation	Agency	Within scope of section 10(j)?	Levelized Annual Cost	Recommend Adopting?
to December 31 each year by three years after license issuance.				that requires construction and operation of the fish passage facility before the third migration season after issuance of a new license, which could occur before Maine DMR's recommended schedule. Staff recommends a construction schedule that is consistent with Commerce's section 18 prescription.
Install full-depth 1-inch trashracks (permanent or seasonal overlay) over the intakes of Units 2, 3, and 4 at the Ellsworth Development from April 1 to December 31 each year to physically exclude Atlantic salmon, alosines and eels from the turbine intake.	Maine DMR	Yes.	$20,390	Yes.

Recommendation	Agency	Within scope of section 10(j)?	Levelized Annual Cost	Recommend Adopting?
Install the recommended trashracks within three years after license issuance.		Yes.	$0	No. Measure is inconsistent with Commerce's FPA section 18 fishway prescription that requires construction and operation of the fish passage facility by May 1 of the third year of the new license, which could occur before Maine DMR's recommended schedule. Staff recommends a construction schedule that is consistent with Commerce's section 18 prescription.
Cease operation of Unit 1 and operate Unit 4 before operating Units 2 and 3 at the Ellsworth Development during critical downstream fish passage seasons determined in consultation with the resource agencies.	Maine DMR	No.[a]	Unknown – recommendation lacks specificity needed to estimate a cost.	No. Maine DMR has not specified the extent of the critical passage season for a Unit 1 shutdown. However, Commission staff does recommend prioritizing operation of Units 1 and 4 over Units 2 and 3 during the entire

Recommendation	Agency	Within scope of section 10(j)?	Levelized Annual Cost	Recommend Adopting?
				downstream passage season and curtailing operation of Unit 1 during the staff-recommended critical passage season for Atlantic salmon smolts, which is defined as the 15-day period in the spring after water temperatures rise above 50° F.
Cease operation at the Ellsworth Development from 8 PM to 4 AM from September 1 to October 31 and for 3 consecutive nights following each large rainstorm in August and operate the existing downstream fish passage facility to provide safe, timely, and effective downstream passage for migrating eels within 2 years of license issuance.	Maine DMR	Yes.	$56,240	Yes. Staff recommends implementing these measures upon license issuance instead of 2 years after license issuance.

Recommendation	Agency	Within scope of section 10(j)?	Levelized Annual Cost	Recommend Adopting?
Modify the eel passage operating schedule during the term of the license based on empirical passage data developed for the project and/or a predictive model for eel movements through the project.	Maine DMR	No.[b]	Unknown – recommendation lacks specificity needed to estimate a cost	No.
Construct upstream eel passage ramps at the Graham Lake Dam and Ellsworth Dam in accordance with FWS's Design Criteria Manual and in consultation with resource agencies, and operate and maintain the ramps from June 1 through October 31 each year.	Maine DMR	Yes.	$42,740	Yes. Staff recommends an upstream eel passage facility consisting of a covered metal or plastic volitional ramp that is lined with a wetted substrate, angled at a maximum slope of 45 degrees, and sized to accommodate a maximum capacity 5,000 eels per day, consistent with the FWS's Design Criteria Manual.

Recommendation	Agency	Within scope of section 10(j)?	Levelized Annual Cost	Recommend Adopting?
Operate the new upstream passageways at the Ellsworth and Graham Lake developments for American eel by 2 years after license issuance.	Maine DMR	Yes	$0	Yes. Staff also recommends that construction occur outside of the upstream migration season to minimize the effects of construction on migrating fish.
Develop an evaluation plan and conduct effectiveness testing and quantitative monitoring of the upstream eel passage facilities in consultation with the resource agencies. The study should evaluate attraction efficiency over three nights by counting the number of migrating eels at the project and comparing this number to number of eels passing upstream via the ramp. Passage effectiveness should be assessed by releasing 100 captive eels at the entrance to the	Maine DMR	Yes	$1,620	

Recommendation	Agency	Within scope of section 10(j)?	Levelized Annual Cost	Recommend Adopting?
upstream eel passage facility and tracking passage upstream over 24 hours to assess with 90 percent of the eels pass the fishway.				
Develop an operation and maintenance plan for the new upstream eel passage facility in consultation with resource agencies.	Maine DMR	Yes	$0 – Costs would be included in the $470 cost of developing and maintaining a comprehensive operation and maintenance plan for all fish and eel passage facilities, as shown below for maintaining fishway operating procedures.	Yes.

Recommendation	Agency	Within scope of section 10(j)?	Levelized Annual Cost	Recommend Adopting?
Test the effectiveness of the modified downstream fish passage facilities at the Ellsworth and Graham Lake developments for passage of adult eels using radio telemetry methods.	Maine DMR	No[c]	Unknown – recommendation lacks specificity needed to estimate a cost.	No.
Test the effectiveness of the downstream fish passage facilities at the Ellsworth and Graham Lake developments to determine if the downstream fish passage facilities meet performance standards for Atlantic salmon developed through the course of consultation under the ESA.	Maine DMR	No[c]	Unknown – recommendation lacks specificity needed to estimate a cost.	No.
If performance standards are not met, implement additional measures including increasing the depth of the Worthington		No[d]	Unknown – recommendation lacks specificity	No.

Recommendation	Agency	Within scope of section 10(j)?	Levelized Annual Cost	Recommend Adopting?
fish guidance system, curtail project operation, spill or nighttime shutdowns; and modifying the ledge/plunge pool and spillway surfaces.			needed to estimate a cost.	
Maintain fishways in proper working order and remove trash, logs, and material that would hinder passage. Perform routine maintenance before a migratory period such that fishways can be tested and inspected, and will be operational during the migratory periods.	Maine DMR	Yes	$0 – Costs would be included in the project's overall annual operation and maintenance cost ($930,804) as shown above in Table 40.	Yes.
Develop an operation and maintenance plan for all downstream fish passage facilities in consultation with resource agencies.	Maine DMR	Yes	$810	Yes.

[a] This is not a specific fish and wildlife measure. The provisions of this measure are generic and uncertain.

[b] This is not a specific fish and wildlife measure. Modifying the operating schedules without specific limits would represent an uncertain future action. There is no reserved authority under section 10(j) for future, uncertain actions.

[c] This is not a specific fish and wildlife measure. The provisions of this recommendation are generic and uncertain. In addition, there is no reserved authority under section 10(j) for future, uncertain actions such as modification of the facilities.

[d] There is no reserved authority under section 10(j) for measure related to uncertain, future actions. Measures instituted at a time conditioned on future events that might never occur, are outside the scope of section 10(j).

5.5 CONSISTENCY WITH COMPREHENSIVE PLANS

Section 10(a)(2) of the FPA, 16 U.S.C., § 803(a)(2)(A), requires the Commission 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 the project. We reviewed the following 19 comprehensive plans that are applicable to the Ellsworth Project. No inconsistencies were found.

Atlantic States Marine Fisheries Commission. 1999. Amendment 1 to the Interstate Fishery Management Plan for shad and river herring. (Report No. 35). April 1999.

Atlantic States Marine Fisheries Commission. 2000. Interstate Fishery Management Plan for American eel (*Anguilla rostrata*). (Report No. 36). April 2000.

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6.0 FINDING OF NO SIGNIFICANT IMPACT

If the Ellsworth Project is issued a new license as proposed with the additional staff-recommended measures, the project would continue to operate while providing enhancements to aquatic and terrestrial resources, protection of threatened and endangered species, improvements to recreation facilities, and protection of cultural and historic resources in the project area.

Based on our independent analysis, we find that the issuance of a license for the Ellsworth Project, with additional staff-recommended environmental measures, would not constitute a major federal action significantly affecting the quality of the human environment.

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APPENDIX A

Staff Responses to Comments on the Draft Environmental Assessment

Commission staff issued its draft environmental assessment (EA) for the relicensing of the Ellsworth Hydroelectric Project (Ellsworth Project) on November 21, 2018. Staff requested comments on the draft EA to be filed within 60 days of the issuance date, on January 20, 2019. Due to the funding lapse at certain federal agencies between December 22, 2018 and January 25, 2019, the Commission extended the comment period to February 23, 2019. The following entities filed comments pertaining to the draft EA.

Commenting Entity	Date Filed
Kenneth Shellenberger III	January 16, 2019
Twyla Bryant	January 16, 2019
Twyla Bryant	January 18, 2019
Frenchman Bay Conservancy	January 18, 2019
Maine Department of Inland Fisheries and Wildlife (Maine DIFW)	January 22, 2019
Maine Department of Marine Resources (Maine DMR)	January 22, 2019
Maine Elver Fisherman Association	January 22, 2019
Downeast Salmon Federation (DSF)	January 22, 2019
Black Bear Hydro Partners LLC (Black Bear Hydro)	January 22, 2019
Edward Damm	January 22, 2019
Brad Perry	January 22, 2019
James Birmingham and Michelle Dawson	January 22, 2019
DSF	January 24, 2019
Janice Buckingham	January 25, 2019
Leslie Hailui[280]	January 25, 2019
Unreadable	January 25, 2019
Michael Good	January 25, 2019
Frank Sloggs	January 25, 2019
Julie Staggs	January 25, 2019
Graham Plether	January 25, 2019
Roger Marks	January 25, 2019

[280] Italics indicate attempts made by Commission staff to determine commenters' names when printed names were not provided and only signatures were included with the filing.

Antonio Blasi	January 25, 2019
Sergei Breus	January 25, 2019
Catherine Fore	January 25, 2019
Gregory Michael	January 25, 2019
Deborah Richards	January 25, 2019
John Alzord	January 25, 2019
Mark Whiting	January 25, 2019
Rosamond Rea	January 25, 2019
Barbara Witham	January 25, 2019
Kent Lewis	January 25, 2019
Terance Yam	January 25, 2019
Alan Kane	January 25, 2019
Brad Perry	January 25, 2019
Edward Merrick	January 25, 2019
Paul Haster	January 28, 2019
Carla Haskell	January 28, 2019
Karla Ramsay	January 28, 2019
Victor Ryolizky	January 28, 2019
Hilly and Joe Crary	January 29, 2019
Martha Dickerson	January 29, 2019
George Leinbaugh	January 29, 2019
Jeffrey and Theresa Smith	January 29, 2019
Carol Gregory	January 29, 2019
Madea Steinman	January 29, 2019
Unreadable	January 31, 2019
Casey Teonson	February 4, 2019
Nathaniel Henson	February 4, 2019
Mark Whiting and Catherine Fox	February 4, 2019
DSF	February 4, 2019
Edward Damm	February 4, 2019
Brad Perry	February 6, 2019
Robert Miller	February 11, 2019
Gene Flower	February 13, 2019
National Marine Fisheries Service (NMFS)	February 15, 2019
Martin and Semena Curlik	February 15, 2019
DSF (Petition with 332 signatures)	February 19, 2019
Barbara Carrion	February 19, 2019
Gabrielle Wellman	February 20, 2019
U.S. Fish and Wildlife Service (FWS)	February 22, 2019
Schoodic Riverkeepers	February 22, 2019
Native Fish Coalition, Maine Chapter	February 22, 2019

Edward Damm	February 25, 2019
Todd and Christa Little-Siebold	February 25, 2019
Daniel Bierman	February 25, 2019
Arthur Smoeleye	February 25, 2019
Burris Jester	February 25, 2019
Friends of Graham Lake (Brad Perry)	February 25, 2019
Vivian Jester	February 25, 2019
DSF	February 26, 2019
Martin and Semena Curlik	February 26, 2019
Thomas Hansen	March 1, 2019
Tammy and Robert Packis	March 8, 2019

Below, we summarize the comments received on the draft EA that pertain to our analysis; respond to those comments; and indicate, where appropriate, how we modified the final EA. The comments are grouped by topic for convenience. We do not summarize and respond to comments that request legal determinations, only express opinions (*e.g.*, either for or against the proposed project or the staff alternative), or simply reiterate a stakeholder's position or recommendation.

<u>Analysis of Alternatives</u>

Comment: FWS states that the draft EA is unconventional with respect to National Environmental Policy Act (NEPA) practice because it does not present a separate analysis of each alternative to the proposed action. FWS requests that we issue a revised draft EA that presents a separate analysis of each alternative considered.

NMFS states that because the draft EA does not analyze the effects of the "staff alternative with mandatory conditions," the draft EA does not provide a clear description of how the licensee will be required to operate and maintain the project under the terms of a new license and does not present a clear analysis of the effects to NMFS's trust resources, including endangered Atlantic salmon.

Response: With respect to NMFS's and FWS's comments on the need for a separate analysis of each alternative, NEPA and the implementing regulations do not require that an EA provide a separate review of each reasonable alternative. This is true even for an environmental impact statement (EIS). The Council on Environmental Quality's (CEQ) regulations state that an EIS "must rigorously explore and objectively evaluate all reasonable alternatives,"[281] and devote "substantial treatment" to each.[282] CEQ explains in its guidance that this does not dictate an amount of information to be provided, but rather prescribes "a level of treatment . . . to enable a reviewer to evaluate and compare alternatives."[283]

Section 5.1 of the EA (Comparison of Alternatives) directly compares the environmental, recreational, and cultural resource measures associated with the alternatives, including Black Bear Hydro's proposal, the staff alternative, the staff alternative with mandatory conditions, and the no-action alternative (see Table 41) The alternatives differ as to the new environmental protection, mitigation, or enhancement measures that could be implemented, with the greatest emphasis on structures and monitoring for fish passage. The EA's combined analysis of the proposed action and action alternatives in section 3.3 (draft EA at 36-281; final EA at 42-298) provides a level of treatment for each of the considered alternatives that enables a reviewer to evaluate and compare these alternatives, including the staff alternative with mandatory conditions. Specifically, the analyses provide detailed information related to the design, construction, operation, maintenance, monitoring, and effectiveness of each of the measures included in the alternatives. A separated analysis of the action alternatives would be needlessly duplicative.

With respect to NMFS's comments that the draft EA does not present a clear analysis of the effects of the alternatives on NMFS's trust resources, including endangered Atlantic salmon, the draft EA at section 3.2 (Scope of Cumulative Effects, pages 41-42), section 3.3.2.2 (Aquatics, Environmental Effects, pages 86-184), section 3.3.2.2 (Cumulative Effects, pages 184-191), and section 3.3.4.2 (Threatened and Endangered Species, Environmental Effects, pages 222-269) provides an evaluation of the potential direct, indirect, and cumulative effects of the proposed action and alternatives on species and critical habitat. For instance, the draft EA at pages 212-216 discusses the effects of the existing and prescribed upstream fishways on Atlantic salmon.

Comment: NMFS and FWS recommend that Commission staff revise the draft EA to compare all of the licensing alternatives with equal weight and to give greater consideration to mandatory conditions, including the section 18 fishway prescriptions. FWS states that the staff alternative selected in section 5 (Conclusions and Recommendations) omits some of the federal agencies' mandatory conditions, and that

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[281] 40 C.F.R. § 1502.14(a) (2019).

[282] 40 C.F.R. § 1502.14(b) (2019).

[283] Forty Most Asked Questions Concerning CEQ's National Environmental Policy Act Regulations, 46 Fed. Reg. 18,026, 18,028 (Mar. 23, 1981).

the alternatives presented in the revised EA should include the mandatory conditions provided by the U.S. Department of the Interior (Interior) and U.S. Department of Commerce (Commerce). NMFS states that excluding Commerce's prescriptive terms and conditions from the preferred alternative is contrary to existing law and will only serve to confuse the public and add little value to the decision-making process.

Response: Pursuant to section 18 of the Federal Power Act (FPA), the Commission must include section 18 fishway prescriptions in any license issued for a project. However, staff develops its preferred alternative pursuant to section 10(a) of the FPA. We are required to consider and independently evaluate measures for fish and wildlife resources, including section 18 fishway prescriptions.[284] Neither section 18 nor section 10(a) of the FPA obligate Commission staff to include fishway prescriptions under the staff alternative. In conducting our analysis, we believe that some of the measures included in the federal agency fishway prescriptions do not provide benefits that justify their costs; therefore, we do not include them in the staff alternative. Nevertheless, as stated in section 2.5, *Staff Alternative with Mandatory Conditions*, we recognize that the Commission is required to include all section 18 fishway prescriptions in any license that is issued. Therefore, the staff alternative with mandatory conditions includes any section 18 fishway prescriptions that were excluded from the staff alternative, and these section 18 fishway prescriptions will be required in any license that is issued for the project.

Comment: NMFS states that, as the federal resource agency for the management of diadromous fish and habitat, its comments, recommendations, and prescriptive terms and conditions should have been given more deference in the Commission's decisions and recommendations affecting aquatic resources.

Response: Commission staff bases its recommendations on the record of information in the proceeding, which includes considering an agency's expertise in a particular resource area, as applicable. While we recognize NMFS's role and expertise in fisheries resource issues and oversight, we have the responsibility to conduct an independent analysis and weigh the benefits of the measures to the resource and the cost to the project under sections 10(a) and 4(e) of the FPA.

Alternatives to Project Licensing and Decommissioning

Comment: The Maine Chapter of the Native Fish Coalition, Edward Damm (January 22, 2019), Gabrielle Wellman, and Michael Good recommend that the license require the dams to be removed, and/or that the river be returned to its natural state. The

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[284] *Steamboaters v. FERC*, 759 F.2d 1382 (9th Cir. 1985).

commenters state that the dams are preventing fish passage, and that severe drawdowns of Graham Lake are stranding fish and mussels, reducing access to spawning habitat, negatively affecting littoral and riparian habitats, and reducing lake access for residents and small business owners.

Response: Under section 2.6, *Alternatives Considered but Eliminated from Detailed Analysis*, we briefly discuss project decommissioning with and without dam removal, and state our reasons why these alternatives do not warrant further analysis. In sections 3.3.2, 3.3.4, and 3.3.5, we provided detailed analyses of project effects on fish passage, aquatic resources, and lake access.

Project Description

Comment: Black Bear Hydro states that the draft EA on page 14 incorrectly states that the generator lead line is 450 feet long. Black Bear Hydro states that the actual length of the line is 320 feet.

Response: Exhibit A, page A-8 of the December 30, 2015 license application indicates that a transmission line of approximately 320 feet connects the project's step-up transformer to an adjacent non-project Emera Maine substation. However, the amended Exhibit A filed on May 12, 2016, indicates that the project transmission facilities include "[a] generator lead of approximately 450 feet that conducts the 2.3-kV generator voltage from the powerhouse to the Project step-up transformer located in the adjacent non-Project substation owned by the local utility." The project description included in the EA reflects the updated information filed on May 12, 2016.

Comment: Black Bear Hydro states that the draft EA on page 17 incorrectly references "powerhouses," and must be revised to make clear that there is only one powerhouse at the project.

Response: We revised the final EA to clarify that the project has only one powerhouse.

Graham Lake Elevation

Comment: Black Bear Hydro disagrees with Commission staff's recommendation to narrow the operating range of Graham Lake from 10.8 feet (93.4-104.2 feet msl) to 4.5 feet (98.5-103.0 feet msl). Black Bear Hydro states that the draft EA analysis does not: (1) demonstrate a correlation between water clarity and project operation; (2) demonstrate a correlation between significant shoreline erosion issues and project operation; or (3) adequately analyze the implications of the staff-recommended operating limits on shoreline owners or wetland and waterfowl habitat.

Black Bear Hydro states that Commission staff's suggested change in the elevation range for Graham Lake is based upon an entirely new scenario that was neither discussed nor considered during the relicensing scoping process, was not studied during the relicensing process, and is not supported by site-specific information. Black Bear Hydro states that the recommended operational restrictions in the draft EA are too costly and there are not substantial demonstrable benefits to the resources that would result from the change.

Response: In the following paragraphs, we address Black Bear's comments concerning the effects of staff's recommended operating range on developmental and non-developmental resources, including the effects on project economics, water clarity, erosion, wetland and waterfowl habitat, recreation, and flood control. As to the procedural issues raised by Black Bear Hydro, Commission staff's April 4, 2013 scoping document stated that the EA would address the effects of impoundment water levels and reservoir drawdowns on fish and wildlife, and on aquatic, riparian, littoral, and wetland habitat. Following Commission staff's February 9, 2018 notice that the project was ready for environmental analysis, several commenters recommended modifications to the existing minimum and maximum water surface elevations, including the specific elevation changes that Commission staff evaluated in the draft EA. Consistent with CEQ's regulations,[285] the EA evaluates the environmental impacts of the proposed action and the impacts of the operating alternatives suggested by stakeholders for reducing the adverse effects of the action on the quality of the human environment.

Regarding Black Bear Hydro's assertion that the staff-recommended operating range is not supported by site-specific data, staff is using the best available information as required by NEPA (including project-specific Secchi depths, impoundment elevations, and impoundment surface area data), to evaluate the effects of the alternative operating ranges on turbidity, aquatic habitat, shoreline erosion, recreation, and aesthetics. In section 5.2.2 (Additional Measures Recommended by Staff), staff balances the cost of lost generation against the environmental benefits associated with the alternative operating ranges, including the benefits of increasing the percentage of permanently wetted littoral area, improving recreational access and aesthetics, and reducing turbidity. Ultimately, we believe that an operating range of 98.5 and 103.0 feet msl would best balance developmental and non-developmental resources at the project, and recommend that any license issued for the project require a change in the current operating range of Graham Lake from between 93.4 and 104.2 feet msl to between 98.5 and 103.0 feet msl.

Comment: Forty-nine stakeholders state that Commission staff's recommended operating range in the draft EA of 4.5 feet for Graham Lake should be reduced to 4 feet. Twyla Bryant requests a 4-foot operating range with an upper water surface elevation no

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[285] 40 C.F.R. § 1502.1 (2019).

higher than 102.0 feet msl. Edward Damm (January 22, 2019) requests an operating range of 98.2 to 102.2 feet msl, and DSF and Gene Flower request a range of 99 to 103 feet msl. Using indicators such as the location of trees, perennial vegetation, and waterline marks on docks to define an average long-term upper impoundment elevation, Mark Whiting and Catherine Fox recommend an operating range of 98.4 to 102.4 feet msl. Stakeholders generally comment that reducing the operating range from the existing 10.8-foot range would improve water quality, reduce erosion and turbidity, improve shoreline aesthetics by eliminating the prevalence of mudflats, and reduce project effects on fish, mussels, and nesting loons. FWS, Maine DIFW, and Burris Jester support the staff-recommended operating range of 98.5 to 103.0 feet msl.

Response: Although none of stakeholders discuss the specific benefits of reducing the operating range from the staff-recommended range of 4.5 feet to 4.0 feet, the range appears to be based on an analysis conducted by DSF. In a November 30, 2017 letter, DSF analyzed the operating ranges of other FERC projects in Maine and non-FERC regulated lakes in the Cobbosseecontee watershed in Maine, and found most of the operating ranges to be less than or equal to 4.5 feet.

Staff analyzes the effects of the 4-foot operating ranges submitted by Bryant, Damm, Whiting and Fox, DSF, and Flower in section 3.3.2.2. Staff assumes these recommendations will be acceptable to other commenters that recommend a 4-foot operating range but did not specify an upper and lower water surface elevation.

Comment: DSF filed a comment and series of petitions that alternately recommend a stable water surface elevation for Graham Lake or a water surface elevation that protects 25 percent of the littoral zone.

Response: Staff analyzed both of these alternatives in section 3.3.2.2. Specifically, Cook *et al*.'s recommendation would provide a stable water surface elevation, and the alternative operating ranges shown in Table 15 would protect at least 25 percent of the littoral zone. Therefore, no additional analysis is required.

Water Clarity

Comment: Black Bear Hydro states that the draft EA erroneously concludes that water clarity (as measured by Secchi depth) is directly correlated with the elevation of Graham Lake. Black Bear Hydro states that it is unclear how Commission staff can conclude that the staff-recommended operating range would improve water clarity, given that Commission staff's own analysis found that the relationship between impoundment elevation and Secchi depth is not statistically significant.

Response: As stated by Black Bear Hydro, the relationship between Secchi depth and water surface elevation shown in Figure 14 of the final EA is not statistically significant. However, staff is not attempting to use water surface elevation to predict Secchi depth; therefore, a statistically significant relationship between water surface elevation and Secchi depth was not necessary for staff's analysis or recommendation. Rather, staff used the data shown in Figure 14 to analyze the frequency of shallow Secchi depths when the elevation of Graham Lake was within each of the alternative operating ranges. In addition to lower frequencies of shallow Secchi depths at operating ranges less than 10.8 feet, staff's analysis indicates that narrower operating ranges would allow existing beds of aquatic vegetation to expand and allow new areas to be colonized by aquatic and shoreline vegetation, all of which would stabilize sediment, reduce resuspension of sediment, and improve water clarity.

Comment: Black Bear Hydro states that reservoir water clarity and turbidity can be impacted by many factors, one of which is higher inflows and increased sediment loading from tributaries or runoff during periods of higher precipitation in the spring and fall. Black Bear Hydro states that the draft EA does not sufficiently consider that turbidity and water clarity can be highly affected by seasonal factors, other than changing impoundment levels. Black Bear Hydro further states that any analysis of water clarity that ignores the impacts of run-off and tributary inflows that carry higher sediment content is flawed.

Response: Commission staff has revised the analysis in section 3.3.2.2 – *Aquatic Resources, Impoundment Levels*, to address the issues raised by Black Bear Hydro. Based on the heavily-forested Union River watershed, the quality of Atlantic salmon spawning habitat in the West Branch Union River, and the clarity of the other lakes and ponds in the watershed, staff has concluded that the effect of seasonal sediment input from tributaries and runoff on water clarity is likely low and not the dominant cause of turbidity in Graham Lake. Rather, the source of the suspended sediment in Graham Lake is likely a combination of: (1) shoreline erosion, (2) resuspension of fine-grained sediment by wave action, (3) resuspension of fine-grained sediments during impoundment drawdown and refill, and (4) erosion of mudflats exposed at lower water surface elevations during precipitation events.

Comment: Black Bear Hydro states that the draft EA describes mudflats that contain highly erodible sediment that becomes suspended in the water when the impoundment elevation changes, but fails to include literature citations or documentation of this effect at Graham Lake or any other lake or reservoir in Maine. Black Bear Hydro states that Commission staff must rely upon scientific or other credible information before concluding that the resuspension of sediments reduces water clarity.

Response: Commission staff revised section 3.3.2.2 to include the appropriate citations.

Comment: Black Bear Hydro states that water color can significantly reduce Secchi depth, and the 2014 water quality study indicates that the water in Graham Lake is strongly colored. Black Bear Hydro states that the draft EA does not discuss the effects of natural sources of water color (such as tannins[286] from the wetlands, bogs, and tributaries surrounding and inundated by Graham Lake), on Secchi depth measurement. Black Bear Hydro further states that the strongly colored water of Graham Lake is a natural feature of water in the project area and is unrelated to turbidity, sediment, project operation, or impoundment elevation. Black Bear Hydro indicates that the high color values of Great Pond, which is at the headwater of the West Branch of the Union River, and Webb Pond, which flows into Graham Lake via Webb Brook, illustrate that other lakes and impoundments in the project vicinity have strongly colored water similar to Graham Lake.

Response: As explained in the revised analysis in section 3.3.2.2 of the EA, the Secchi depths for Graham Lake are shallower than expected at a given true color value when compared to other lakes and impoundments in Maine. This factor, in combination with the low chlorophyll values reported for Graham Lake and the presence of highly-erodible soils around the perimeter of the impoundment (see section 3.3.1.1, *Geology and Soil Resources* and section 3.3.2.1, *Aquatic Resources, Aquatic Habitat*), suggest that Graham Lake's shallow Secchi depth values are likely due to suspended sediment.

<u>Erosion</u>

Comment: Black Bear Hydro states that Commission staff's conclusion in the draft EA that reducing the full pool elevation of Graham Lake from 104.2 to 103.0 feet msl will reduce erosion and turbidity is not supported by the analysis in the draft EA. Black Bear Hydro states that shoreline erosion at Graham Lake is not widespread and is confined to certain areas of the western shoreline of the lake. Black Bear Hydro states that human activities (*i.e.*, shoreline development, tree clearing, mowing, *etc.*) may be a significant factor for erosion, due to the increased overland flow and runoff associated with these activities.

Black Bear Hydro references a shoreline erosion report from 1990 that concluded that shoreline erosion has occurred since the construction of the project, and has decreased over time as the reservoir reaches a new equilibrium with the shoreline. Black

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[286] Tannins are organic substances found in tree bark and other plant tissues. When decaying plant material comes in contact with water, tannins dissolve into the water and impart a brown color, which is similar to what happens while steeping tea. Other plant-based dissolved organic matter, such as fulvic and humic acid, can also color water. The decaying plant matter found in wetlands, bogs, and forested streams provide a source of these types of colored dissolved organic matter.

Bear Hydro states that the licensee reduced the maximum reservoir elevation from 105.2 feet msl to 104.2 feet msl in 1980 to address erosion, and water clarity is now higher than it was 30 years ago. Black Bear Hydro states that Graham Lake is still reaching equilibrium with the shoreline, and it is unclear how another 1-foot reduction in the maximum reservoir elevation would reduce shoreline erosion or improve water clarity. Because much of the shoreline and soils under the impoundment are highly erodible, Black Bear Hydro states that it is possible that lowering the full pond elevation will actually increase turbidity in Graham Lake by moving the water-shoreline interface further into the lake and disrupting the equilibrium that has been developing since 1980.

Response: As stated in section 3.3.2.1, *Aquatic Resources, Water Quality*, the shallow Secchi depths observed in Graham Lake are likely due to suspended sediment rather than phytoplankton abundance or water color (see the response above). Given that over 90 percent of Hancock County is forested and many of the other lakes and impoundments in the Union River watershed have much lower turbidity than Graham Lake, the source of the suspended sediment in Graham Lake is likely a combination of: (1) shoreline erosion, (2) resuspension of fine-grained sediment by wave action, (3) resuspension of fine-grained sediments during impoundment drawdown and refill, and (4) erosion of mudflats exposed at lower water surface elevations during precipitation events. For Graham Lake, Secchi depth represents an index of the effects of these sources of suspended sediment. Based on our analysis of the Lake Stewards Secchi depth data, Secchi depths less than 2 meters occur more frequently between elevations of 103.0 and 104.2 feet msl than at other elevations (see Table 12). This suggests that the effects of shoreline erosion and sediment resuspension are most prevalent between 103.0 and 104.2 feet msl, and lowering the water surface elevation to 103.0 feet msl would help reduce these effects and improve water clarity. In addition, reducing the upper water surface elevation to 103.0 feet msl would reduce the length of shoreline exposed to erosion by 2.2 percent (see Table 14) and provide a slight reduction in sediment input from erosion.

Black Bear Hydro states that shoreline development, tree clearing, mowing, and other human activities may be significant causes of erosion. However, as stated in section 3.3.3.1, *Terrestrial Resources*, only approximately 35 acres of land are non-project maintained lawn, open field, or non-project electrical transmission corridor/shrubland meadow out of the 2,144 acres of land within the project boundary. Given that Graham Lake has a surface area of 10,042 acres and a perimeter of approximately 93 miles, the effects of non-project human activities on shoreline erosion in Graham Lake are likely minor.

Black Bear Hydro states that water clarity is now higher than it was 30 years ago due to lowering the maximum water surface elevation from 105.2 to 104.2 feet msl. However, visual inspection of Figure 1 in Black Bear Hydro's comments on the draft EA and a t-test[287] of the Lake Stewards' Secchi depth data (Maine DEP, 2018a) collected before and after 1980 indicate that there is no significant difference between the mean Secchi depth before and after Black Bear Hydro lowered the upper water surface elevation to 104.2 feet msl ($p = 0.34$).[288] However, as shown in Table 12, 64.2 percent of Secchi depth observations recorded at water surface elevations greater than 103.0 feet msl were less than 2 meters, which is a higher percentage than observed for all other water surface elevations except for 98.0 to 99.0 feet msl. This difference in shallow Secchi depth frequency suggests that processes contributing to sediment suspension have a greater effect at water surface elevations greater than 103.0 feet msl, and that lowering the upper water surface elevation to 103.0 feet msl would reduce these effects.

With regard to Black Bear Hydro's statement about the development of a new equilibrium after lowering the upper water surface elevation from 105.2 to 104.2 feet msl, it is unclear how a new equilibrium can be established given the variability in how much of the operating range Black Bear Hydro has used each year. Aquatic vegetation cannot become established between approximately 98.2 feet msl and 103.5 feet msl, which is the long-term operating range based on daily averages between 1999 and 2014 (see Figure 5), because that portion of the operating range can be dewatered for much of the year. Similarly, upland terrestrial vegetation cannot become established below 104.2 feet msl when that part of the operating range is routinely saturated. Based on the water surface elevation data shown in Figure 5 of the EA and the data provided by Black Bear Hydro since 2014, there are also several years when the water surface elevation of Graham Lake did not reach 104.2 feet msl, which also inhibits the development of an equilibrium at 104.2 feet msl. Therefore, reducing the operating range to the water surface elevations most commonly used over the past several years, and using that range consistently each year would increase the likelihood of establishing an ecological equilibrium in the near future. The establishment of aquatic vegetation below the lower end of the operating range and terrestrial vegetation above the upper end would, in turn, further reduce shoreline erosion and resuspension of fine-grained sediments and improve water clarity.

Wetland and Waterfowl Habitat

[287] A t-test compares the means (*i.e.*, average) of two groups of data to see how different the mean of one group is from the mean of the other. In this case, the Secchi depth data before 1980 is one group and the data after 1980 is the second group.

[288] The data shown between 1982 and 1995 on Figure 1 of Black Bear Hydro's comments are not in the Lake Stewards' database. In addition, staff excluded the two observations that were over 4 meters because those observations were 2 to 3 meters greater than the other Secchi depth observations recorded at that station and the other stations on those days, which indicates the observations over 4 meters were likely data entry errors.

Comment: Black Bear Hydro states that Commission staff's proposed elevation changes will result in changes to wetland types, diversity, size, and interspersion. Black Bear Hydro states that emergent, shrub, and forested wetland areas may be significantly affected by the altered impoundment levels. Black Bear Hydro asserts that a lowered maximum impoundment level could result in decreased wetland acreage at the project, and existing vegetated wetlands could be inundated by the higher minimum elevation, resulting in loss of emergent marsh wetlands to open water.

Black Bear Hydro states that the draft EA does not adequately evaluate the effects of staff's recommended water levels on waterfowl and wading bird habitat areas in Graham Lake.

Response: Section 3.3.3, *Terrestrial Resources- Wetlands*, and section 3.3.2, *Aquatic Resources- Protection of Littoral Habitat*, of the draft EA discuss the effects of the staff-recommended impoundment levels on wetlands and littoral habitat at Graham Lake. We believe that reducing the maximum impoundment elevation could eventually result in vegetation at higher elevations transitioning from wetland vegetation to upland vegetation. Reducing the Graham Lake operating range could also provide a larger and more stable littoral zone (*i.e.*, 30 to 88.7 percent more littoral zone remaining wetted on a year-round basis), which would allow for the expansion of existing beds of wetland vegetation and for new areas to be colonized by wetland vegetation over time. However, the effects of the operational changes on wetland communities would occur throughout the term of any new license, and cannot be quantified with precision based on the influences of project-specific environmental variables on wetland communities (*e.g.*, annual precipitation and streamflow).

As to waterfowl and wading bird habitat, the marsh-nesting bird habitat that was surveyed in 2014 did not identify the presence of any state-listed marsh-nesting birds. Generally speaking, reducing impoundment drawdowns and increasing the stability of the littoral zone of the impoundment should improve habitat for marsh nesting birds by providing more stable nesting conditions.

Altogether, the environmental impacts to wetlands and waterfowl habitat are adequately discussed and no additional analysis of the environmental effects of the operational alternatives is necessary.

Comment: In response to Black Bear Hydro's comment letter, Mark Whiting states that to protect wildlife (*i.e.*, nesting birds), the elevation of Graham Lake should be stabilized within its "natural bounds." Mr. Whiting asserts that maintaining water levels between a maximum elevation of 102.4 feet msl (which he identifies as the "natural water level") and a minimum water level of 98.4 feet msl would provide a variety of benefits to nesting birds, including protecting nests from both flooding and mainland predators, reducing the exposure of mudflats, and improving habitat for invertebrates.

Response: As noted above, reducing impoundment drawdowns and increasing the stability of the littoral zone of the impoundment could improve habitat for nesting birds by providing more stable nesting conditions. See section 3.3.3, *Terrestrial Resources- Wetlands*, and section 3.3.2, *Aquatic Resources- Protection of Littoral Habitat*, of the EA for a discussion of the effects of the staff-recommended impoundment levels on wetlands and littoral habitat at Graham Lake.

Comment: Black Bear Hydro states that, contrary to the presumption in the draft EA that the Maine Department of Environmental Protection (Maine DEP) "requires" 75 percent of the littoral zone to remain wetted to protect aquatic habitat, the Maine DEP only has a policy guideline for maintaining 75 percent of the littoral zone in a wetted condition. Black Bear Hydro states that the EA should be clear that the water quality standard for Graham Lake is that "waters must be of sufficient quality to support all species of fish indigenous to the receiving waters and maintain the structure and function of the resident biological community."

Response: We have revised the final EA to clarify that Maine DEP recommends, but does not necessarily require, 75 percent of the littoral zone to remain wetted to meet state water quality standards.

<u>Recreation Access</u>

Comment: Black Bear Hydro states that the draft EA does not discuss the effects of reducing the full pond level by 1.2 feet (from 104.2 to 103.0 feet msl) on shoreline landowners, and that the final EA should address to what degree docks would need to be replaced or extended if the maximum impoundment level is permanently lowered during the summer season.

Response: Based on the average daily elevation of Graham Lake between 1999 and 2014 (Figure 5), the elevation of Graham Lake has increased most years above 103 feet msl between the end of April and the beginning of June. The lake elevation has then decreased gradually from June through September, with average daily lake levels decreasing below 103 feet msl by mid-June. By Labor Day, the average lake elevation has been around 100 feet msl. Provided that the elevation of Graham Lake is typically lower than 103 feet msl for the majority of the summer season, docks on Graham Lake should already be constructed to provide access to the lake at elevations below 103 feet msl. Therefore, the change in maximum elevation recommended by Commission staff in the draft EA is unlikely to have an adverse effect on water access for property owners around the lake. The final EA does not need to be modified.

Flood Control

Comment: Black Bear Hydro states that the draft EA does not discuss the ancillary flood control benefits provided by the current seasonal drawdown regime of Graham Lake and the effect that changes in impoundment elevation limits may have on flood storage potential. Black Bear Hydro states that reducing the allowable operating range of the reservoir from 10.8 feet to 4.5 feet, as recommended by Commission staff, would result in the loss of 2.42 billion cubic feet of useable storage, which is equivalent to 55 percent of the useable storage of the project. Black Bear Hydro states that the loss of this operating capacity would be a critical loss to the management of snowmelt and spring runoff, and may result in increased spillage during significant runoff periods (estimated to be approximately 2.8 billion cubic feet, or 65 percent more spillage than under the existing conditions). Black Bear Hydro states that increasing spillage during spring runoff could increase flooding downstream of the Graham Lake Dam.

Response: We revised section 3.3.2.2 of the EA, *Aquatic Resources – Environmental Effects*, to include an analysis of the effect that changes in impoundment elevation limits may have on the spring runoff and snowmelt storage potential of Graham Lake.

Developmental Analysis

Comment: Black Bear Hydro disagrees with Commission staff's estimated annual cost of $12,290 in lost generation revenue resulting from the staff-recommended changes to the operating range of Graham Lake. Black Bear Hydro states that reducing the current operating range from 10.8 feet to 4.5 feet would potentially reduce generation revenues by as much as $91,000 annually. Black Bear states that staff's recommended operating range is too costly and that there are not substantial demonstrable benefits to environmental resources that would result from reducing the current operating range from 10.8 feet to 4.5 feet.

Response: Black Bear Hydro has historically operated the project in a manner that is generally consistent with staff's recommendation to operate Graham Lake between a minimum elevation of 98.5 feet msl and a maximum elevation 103.5 feet msl, as shown in Figure 5. Staff does, however, recognize that operating Graham Lake within the 4.5-foot operating range would eliminate Black Bear Hydro's ability to freely utilize the full storage capacity associated with the 10.8-foot operating range. Therefore, based on Black Bear Hydro's comments, staff revised the cost of each of the alternative operating ranges in sections 4 and 5 of the EA to reflect the cost of lost generation associated with spillage. As noted in the EA, staff estimates that reducing the operating range from 10.8 feet to 4.5 feet, as recommended by staff, would result in an annual cost of $86,180. This estimate is based on Black Bear Hydro's estimate of 1,500 MWh of lost hydropower generation. Based on the environmental benefits discussed in section 5.2.2, *Additional*

Measures Recommended by Staff, staff maintains its 4.5-foot operating range recommendation from the draft EA.

Aquatic Resources

Comment: Black Bear Hydro states that the draft EA on page 37 incorrectly states that the Union River has a drainage area of approximately 547 square miles. Black Bear Hydro states that this description should be revised to state that the Union River has a drainage area of approximately 547 square miles at the Ellsworth Dam.

Response: We have revised the final EA to state that "The Union River from its headwaters to the Ellsworth Dam has a drainage area of approximately 547 square miles."

Comment: Black Bear Hydro states that the draft EA on page 37 incorrectly describes the tributaries to the project. Black Bear Hydro states that the description should be revised to state that "the source of the West Branch of the Union River is Great Pond, the source of the Middle Branch is Upper Middle Branch Pond (Alligator Lake), and the East Branch is Rocky Pond."

Response: We have revised the final EA to state that "the source of the West Branch of the Union River is Great Pond, the source of the Middle Branch is Upper Middle Branch Pond (Alligator Lake), and the source of the East Branch is Rocky Pond."

Comment: Black Bear Hydro states that the Maine water quality standards described on page 46 of the draft EA should be revised to exclude dissolved iron and manganese, as these are not part of the Maine Class B standard.

Response: We have removed the reference to dissolved iron and manganese in the final EA.

Comment: Black Bear Hydro states that the draft EA on page 48 incorrectly states that thermal stratification occurred two to five times at each monitoring station in Graham Lake during a 2013 water quality study. Black Bear Hydro states that the language should be revised to state that thermal stratification occurred one to five times.

Response: Of the three stations surveyed during the 2013 water quality study, station 1 exhibited stratification the fewest times during the study season (late-April through October). Staff evaluated the temperature profiles and data provided in Attachment 2-2 of the initial study report, filed September 4, 2014, and used a 1°C change in temperature per meter of depth as a guideline to identify thermal stratification. For station 1, which exhibited the fewest instances of stratification, this guideline was met on June 27, 2013. However, on July 18, 2013, the temperature decreased by only

0.8°C between 7 and 8 meters depth at station 1, while the dissolved oxygen (DO) concentration declined from 6.4 to 5.2 milligrams per liter (mg/L) and the DO saturation declined by 15.2 percent. In addition, the DO concentration at the bottom of the water column (12 meters) was 3.3 mg/L and 37.2 percent saturated. While the change in temperature did not fully meet the guideline used by staff, the change in DO concentration and saturation between 7 and 8 meters depth and the low DO concentration and saturation at the bottom suggest that the water column had been thermally stratified or was becoming stratified. Furthermore, the water column at stations 2 and 3 were both stratified on that day. Therefore, staff considered that station 1 was effectively stratified on June 27, 2013 and July 18, 2013. Accordingly, no changes are needed to the description of the occurrences of thermal stratification in Graham Lake.

Comment: Black Bear Hydro states that Figure 6 on page 49 of the draft EA needs to be corrected to move the location of water quality monitoring station 1 further south in Graham Lake.

Response: We revised Figure 6 using the station coordinates provided in Black Bear Hydro's initial study report filed September 4, 2014.

Comment: Black Bear Hydro states that the draft EA on page 56 incorrectly states that Graham Lake has a maximum width of approximately 2 miles. Black Bear Hydro states that the description should be revised to indicate that Graham Lake has a maximum width of about 3 miles.

Response: We revised the final EA to indicate that Graham Lake has a maximum width of approximately 3 miles.

Comment: Black Bear Hydro states that the draft EA on page 89 incorrectly states that the Graham littoral zone reaches an elevation of 96.2 feet msl under the current operating range from Graham Lake. Black Bear Hydro states that the description should be revised to state that the littoral zone reaches an elevation of 92.6 feet msl.

Response: We revised the final EA to state that the littoral zone reaches an elevation of 92.6 feet msl under the current operating range.

Comment: Black Bear Hydro states that the draft EA on page 252 incorrectly states that the project boundary includes land and water up to a contour elevation of 66.7 feet msl on the Union River between the Graham Lake Dam and Lake Leonard. Black Bear Hydro states that this description should be revised to state that the project boundary includes "land and water within the Union River bank on an approximately 3.1-mile-long riverine reach of the Union River between Graham Lake Dam and Lake Leonard."

Response: We have revised the final EA to state that the current boundary consists of "land and water up to a contour elevation of 66.7 feet msl on Lake Leonard, and land and water within the Union River bank on the approximately 3.1-mile-long riverine reach of the Union River between Graham Lake Dam and Lake Leonard."

Fish Passage

Comment: Martin and Semena Curlik commented on February 15, 2019 that the license should require permanent natural fish bypasses for all fish species, and that the project should be operated to maintain water levels to sustain safe fish passage that does not harm fish.

Response: The comment does not specify whether the concern is for upstream or downstream passage, or both. The comment also does not specify what is meant by "natural" fish bypasses. The term "natural fish bypasses" could be interpreted as "volitional" passage (as compared to the existing trap and haul facility) or a specific type of fishway that resembles a natural stream channel (referred to as a "rock ramp" fishway or "natural" fishway). Besides the no-action alternative, each alternative evaluated in the EA includes upstream and downstream fish passage measures, including the facilities and water necessary to provide fish passage for alosines, American eel, and Atlantic salmon. These analyses can be found in sections 3.3.2 (*Proposed Action and Action Alternatives-Aquatic Resources*) and 3.3.4 (*Proposed Action and Action Alternatives- Threatened and Endangered Species*).

Downstream Fish Passage

Comment: Black Bear Hydro states that Commission staff's recommendation for nighttime generation shutdowns for downstream eel passage appears to be intended for the term of the license, including the recommendation for shutting down the turbines from 8 p.m. until 4 a.m. during September and October, and also shutting down the turbines for 3 days following any rain event in August in which 1 inch or more is recorded in a 24-hour period. Black Bear Hydro states that nighttime generation shutdowns would not be necessary after Black Bear Hydro implements its proposed measures, including: (1) installing full-depth 1-inch trashracks at three of the four turbine intakes; (2) shutting down the fourth turbine at night during the downstream eel passage season; (3) modifying the downstream fish bypass system; and (4) reinstating nightly shutdowns if downstream passage for eels is not shown to be safe and effective, as determined during the downstream eel passage effectiveness study required by Interior's section 18 prescription. Black Bear requests that any final license requirements reflect the clarification that nighttime shutdowns are only required until the effectiveness of the physical measures is demonstrated.

Response: Staff's analysis and rationale for recommending shutdowns after rain events in August and nightly in September and October throughout the term of the license is in section 3.3.2 and 5.2.2 of the EA. Staff concludes that because the risk of eel entrainment and impingement at the project is high, and the estimated turbine survival rate for eels at the project is low, shutting down generation for nighttime periods and following rain events during the adult eel outmigration season is necessary to protect migrating eels. Although Black Bear Hydro proposes to install 1-inch trashracks at Units 2-4, a 1-inch clear spacing size would not exclude all adult eels from entrainment in the turbines. Previous studies in New England have documented the width of adult eels as ranging from 0.9 to 1.1 inches wide. We also note that our recommendation is consistent with Interior's section 18 prescription, which does not contain any language indicating that the prescribed turbine shutdowns are an interim measure.

Comment: Black Bear Hydro states that minimum flows are currently passed downstream at Graham Lake Dam either through the Alden weir (which provides surface-oriented fish passage) or through the Tainter gates at the dam. Black Bear Hydro states that Commission staff's recommendation to pass minimum flows downstream through Graham Lake Dam via the Alden weir from April 1 through December 31, or ice-in, is not consistent with Interior's prescription. Black Bear Hydro states that Interior's prescription only requires the minimum flow to be passed through the Alden weir for 3 months (from August through October), and not 9 months (from April through December).

Black Bear Hydro states that Commission staff's recommendation that all minimum flows be passed through the Alden weir would require that the weir be redesigned to pass all seasonal minimum flows, including the required 250-cfs flow in May and June, rather than only the 123-cfs minimum flows required from August through October. Black Bear Hydro requests that the draft EA be revised to be consistent with Interior's prescription to pass minimum flows through the weir only from August through October.

In addition, Black Bear Hydro states that the weir would likely have to be completely replaced to be able to operate at the entire staff-recommended 4.5-foot elevation range for Graham Lake. Black Bear Hydro explains that this is because of the combination of Commerce's section 18 prescription requirement that the weir pass a minimum of 3 feet of water and staff's recommendation that the higher flows of 250 cfs be passed through the weir. Black Bear Hydro contends that the staff-recommended 4.5-foot limitation on the elevation of the lake surface would not allow this flow and depth combination through the existing Alden weir. Separately, Black Bear Hydro states that Commission staff's recommendation to pass all minimum flows through the Alden weir could be interpreted as a requirement to pass minimum flows through the Alden weir for the entire year, and not just the 3 months prescribed by Interior.

Response: To clarify, Interior recommends a year-round minimum flow under section 10(j), not under its section 18 prescription. In addition, Commission staff recommends that minimum flows be passed through the weir from April through December (or ice in), not for the entire year. Interior's section 18 prescription, as Black Bear Hydro correctly points out, requires that minimum flows be passed via the weir from August through October. However, there is no inconsistency between the staff recommendation and Interior's prescription because Interior does not specify that the minimum flows should be provided "only" from August through October.

According to Black Bear Hydro, approximately 130 to 158 cfs passes through the weir when the water is 5.9-6.5 feet deep. According to this flow-depth relationship, Black Bear Hydro is correct that the Alden weir will need to be redesigned or replaced in order to provide the higher staff-recommended minimum flow of 250 cfs in May and June and the staff-recommended 4.5-foot operating range. The analysis and rationale for providing the higher flows is in section 3.2.2 and 5.2.2 of the EA, including additional new text in section 5.2.2 emphasizing the specific benefit of reducing migration delay for endangered Atlantic salmon smolts. Commission staff concludes that providing the minimum flows via the weir would provide a stronger attraction flow for surface oriented Atlantic salmon and alosines, which collectively migrate from April 1 through the end of the year or until the impoundment freezes over. Endangered Atlantic salmon smolts migrate in May and June, the months when the higher minimum flow would be required. To minimize possible smolt migration delay, passing the minimum flow through the Alden weir, rather than making the smolts sound to the depth of the gates for passage, is worth the cost of redesigning or replacing the weir.

Comment: Black Bear Hydro states that the interim measures it has proposed for reducing turbine-induced mortality of downstream migrating alosines (*i.e.*, monitoring the tailrace for injured/dead fish and shutting down generation following mortality events) are sufficient for protecting alosines, and that the additional staff-recommended monitoring and generation shutdown procedures are not necessary.

Black Bear Hydro states that the mortality of juvenile river herring does not directly correlate to a similar reduction in adult returns. According to Black Bear Hydro, the reported mortalities of hundreds or even thousands of out-migrating juveniles would not be expected to have any measurable effect on the population size of alosines considering the substantial numbers of out-migrating juveniles (which Black Bear Hydro estimates could be as high as 20 to 30 million), and thus would not justify the recommendation in the draft EA for generation shutdowns following significant rain events and observations of out-migrating alosines.

Response: As explained in sections 3.2.2 and 5.2.2, Black Bear Hydro's proposed method for reducing entrainment-related fish kills has not been effective. The time period between when dead or injured fish are observed in the tailrace and the time that generation is shut down has been too long to prevent several substantial fish kills. Furthermore, there is strong evidence that juvenile alosines move downstream after significant rain events. Therefore, the staff-recommended shutdowns following rain events and observations of schools of outmigrating alosines in the forebay have a sound basis and are expected to significantly reduce entrainment-related fish kills. Until permanent modifications are made to improve the safety of downstream passage for juvenile alosines, staff's recommended interim measures would help reduce mortality caused by entrainment-related fish kills.

Comment: Black Bear Hydro has concerns with the practicality and effectiveness of Commission staff's recommendation to monitor the forebay of Graham Lake Dam and the tailrace of the Ellsworth Development for out-migrating alosines following significant storm events. Black Bear Hydro states that the "forebay" of Graham Lake Dam is a 10,000-acre lake with relatively low water clarity, especially after significant rainfall and runoff events. In addition, Black Bear Hydro states that employees would not be able to safely monitor either the lake or tailrace at night, and that the staff recommendation should only apply to monitoring during daylight hours. If the Commission maintains that Black Bear should conduct interim monitoring, then Black Bear seeks clarification or refinement regarding the monitoring methodology.

Response: Black Bear Hydro's assumption that staff's recommendation only applies during daylight hours is correct, as stated in sections 3.3.2 and 5.2.2. Schools of outmigrating juvenile alosines are surface-oriented and usually observable during the day by the dimpling effect they create on the water surface. Visual monitoring should be conducted from the top of Graham Lake Dam during daylight hours and passage of juvenile alosines can be confirmed by observing them going through the Alden weir. Black Bear Hydro has not stated why monitoring the surface of the forebay (*i.e.*, the area immediately upstream of the dam) and observing the presence of juvenile alosines passing through the Alden Weir would be impractical, unsafe, or overly burdensome, especially because monitoring would only be required for a relatively brief period until the permanent downstream fish passage measures are implemented. We have clarified the text of staff's recommendation in section 5.2.2 of the EA.

Comment: Black Bear Hydro states that Commission staff's recommendation to shut down generation for 24 hours when a school of alewives is observed in Graham Lake is not clear because it does not specify the size of the school of fish that would trigger a shutdown. Black Bear seeks clarification on the definition of a "school."

In addition, Black Bear Hydro states that a school of alewives may pass downstream within minutes and not require 24 hours to pass through the project. If monitoring indicates that the school has dissipated or passed downstream sooner than 24 hours after fish passage, Black Bear Hydro requests flexibility to reinitiate generation prior to the end of the 24-hour period recommended by staff.

Response: Staff does not recommend shutting down generation at the project every time juvenile alosines are observed in the Graham Lake forebay. However, estimating the size of a school would be difficult without employing hydroacoustics, which would add considerable costs to the staff-recommended measure. One relatively easy and inexpensive way to qualitatively assess school size would be to measure the time that juvenile alosines are observed continuously moving through the Alden weir. For example, a school that takes 5 minutes to move through the Alden weir is likely to be smaller than a school that takes an hour to move through the weir. Therefore, staff recommends that Black Bear Hydro consult with Maine DMR, FWS, and NMFS to determine a methodology for establishing a reasonable school size to trigger a shutdown.

With regard to the duration of the shutdown, and Black Bear Hydro's request for flexibility, the rate of movement of the fish between the two project dams is the important rate to consider, not the rate of the fish moving through the Graham Lake forebay. At the Ellsworth Project, this distance is 4.1 miles. Movement rates of juvenile alosines at the Vernon Project on the Connecticut River averaged 1.25 miles per hour (Normandeau Associates, 2017). At this rate, juvenile alosines would take an average of 3.28 hours to move through the 4.1-mile stretch of the Union River. Therefore, it is likely that most schools of outmigrating juvenile alosines could pass downstream of the Ellsworth Dam in less than 24 hours following observations of their passage at the Graham Lake Dam. Staff revised the duration of the recommended shutdowns to 4 hours based on the average travel time calculated.

Comment: Black Bear Hydro references staff's recommendation in the draft EA to protect Atlantic salmon, alosines, and American eel by prioritizing operation of generating Units 1 and 4 over Units 2 and 3 from April 1 to December 31, and states that the Commission should not specify the time period for when the licensee must prioritize operation of generating units. Black Bear Hydro proposes to establish these dates in consultation with resource agencies post-licensing.

Response: Staff's analysis and rationale for specifying the unit prioritization dates and for recommending unit prioritization during the entire downstream passage season for diadromous fish is explained in section 5.2 (Comprehensive Development and Recommended Alternative, pages 336 and 337) of the draft EA. Black Bear Hydro presents no reason or additional information for staff to change its recommendation. As explained in section 5.2 (Comprehensive Development and Recommended Alternative, pages 359-360) of the final EA, this measure would not require Black Bear Hydro to curtail generation or otherwise result in additional costs to Black Bear Hydro.

Comment: Black Bear Hydro states that staff's recommendation to limit construction of downstream fish passage facilities to time periods outside of the downstream migration season and to construct the passage facilities prior to the third migration season after license issuances is impractical and unnecessarily constrains the construction schedule. Black Bear Hydro states that staff's recommendation would require construction to be completed in the winter months (January through March), which is expensive, unsafe, and unnecessary from a biological perspective. Black Bear states that FERC should require Black Bear to consult with appropriate agencies on the methodology and seasonal timing of construction.

Response: Staff's recommendation in section 5.2.2 of the EA explains that performing construction activities during the fish passage season could negatively affect migrating fish by creating passage delays or by forcing migrating fish to utilize unsafe means of downstream passage, such as turbine passage or inadequate spill that could injure and kill migrating fish. While we acknowledge that winter construction could pose difficulties beyond those encountered during other times of the year, Black Bear Hydro has not explained why the difficulties would make winter construction prior to the third migration season impossible, rather than merely difficult. As explained in section 5.2.2 of the EA, constructing the downstream fish passage facilities within three passage seasons of license issuance (as opposed to within 2 years of license issuance, as prescribed by Interior), would provide additional time to complete construction outside of the downstream passage season.

Comment: Black Bear Hydro states that, contrary to what is stated on page 150 of the draft EA, alosines have been able to successfully locate the entrances to the downstream fish passage facility at the Ellsworth Dam.

Response: As the analysis in section 3.3.2 explains, the entrances to the downstream fish passage facility are positioned close to the turbine intakes and the attraction flows are relatively small compared to the maximum hydraulic capacities of the turbines. Therefore, any alosines that do not locate the entrances are attracted to the intakes and susceptible to potential entrainment-related injury or mortality. The existing situation is the reason that the proposed, prescribed, and staff-recommended measures include an increase in attraction flow and a fish guidance boom.

Comment: The Maine Elver Fisherman Association states that turbine shutdowns should be required around the new moons from August to November, and after any major rain events to facilitate downstream eel passage.

Response: The staff-recommended alternative, which incorporates Interior's nighttime shutdown prescription, is similar to this recommendation, but does not specify moon phases and would require the shutdowns at night from September 1 through October 31, as well as for 3 nights following each 1-inch or greater rain event in August. The Maine Elver Fisherman Association has not provided an explanation for why additional protection is needed, nor has it provided any additional data or information for staff to evaluate. Accordingly, staff has not revised the analysis or changed its recommendation.

Comment: DSF's January 22, 2019 letter states that the draft EA provides contradictory evidence on whether there is a plunge pool at the Ellsworth Dam spillway that is safe enough to prevent injury to fish passed over the dam spillway. DSF states that the fish kill that occurred in 2017 demonstrates that spillway passage is not safe and needs to be made safe before any fish are allowed to pass over the top of the spillway.

Response: Section 5.2.2 of the draft EA, *Additional Measures Recommended by Staff*, includes staff's recommendation to operate the plunge pool during the downstream fish passage season and to modify the plunge pool by removing the rocky outcrops (i.e., "ledges") to protect downstream migrants from being injured or killed by the outcrops. In section 3.3.2 and 3.3.4 of the draft EA, staff concludes that modifying the spillway flume exit to eliminate the rock ledge, as required in Interior's section 18 fishway prescription, would protect alosines and salmon from being injured or killed from impacting the rock ledge during passage.

Comment: Black Bear Hydro states that Commission staff's recommendation in the draft EA to install a diversionary guidance boom using specific criteria is inconsistent with Black Bear Hydro's proposal in the Species Protection Plan, including that Black Bear Hydro has not proposed a specific boom placement, spacing, or the use of high-strength netting. Black Bear Hydro recommends that FERC not include the exact design parameters of the guidance boom in the final EA. Rather, Black Bear Hydro states that the Commission should adhere to "normal practice" and let Black Bear Hydro work out the details of those parameters with the agencies during the design consultation phase.

NMFS requests that the license require Black Bear Hydro to install a diversionary guidance boom at Ellsworth Dam constructed of rigid panels instead of the high-strength netting recommended in the draft EA. NMFS states that, based on its experience, panels composed of netting will tear, and may become less effective at higher flow velocities.

Response: Commission staff is required to consider and independently evaluate measures for fish and wildlife resources. Staff's analysis of the diversionary guidance boom and its rationale for recommending the design specifications are located in sections 3.3.2.2 and 5.2.2 of the EA.

Black Bear Hydro and NMFS question the vulnerability of high-strength netting to damage from debris. As the analysis in the EA describes, both rigid panels and high-strength netting have been successfully used at other Commission-licensed projects. In addition to Commerce requiring approval of the design of the boom via its section 18 prescription (which it says could be designed like the one at the Lockwood Project, which is a combination of punch plate and netting), the Commission will also require final approval of the design to ensure its effectiveness and safety. We have clarified in section 5.2.2 that staff is recommending lightweight yet rigid panels.

Comment: The draft EA states on page 120 that Black Bear Hydro does not specify why trashrack raking would be an issue at Unit 1, or whether the impediment could be resolved by installing a trashrack overlay that could be removed and cleaned seasonally. Black Bear Hydro clarifies that Unit 1 is not designed for a trash rake to operate at the unit. Black Bear Hydro states that there is no deck or rake rails and the gate house limits the ability to rake either by machine or by hand.

Response: Staff revised the text to include Black Bear Hydro's explanation of why trashrack raking at Unit 1 would be an issue.

Comment: Black Bear Hydro states that the draft EA on page 20 should clearly state that the listed fish passage improvements, such as the fish guidance boom, are specific to Ellsworth Dam, not Graham Lake Dam.

Response: Staff corrected the description in section 2.2.2, *Proposed Operation and Environmental Measures*, to state that these measures are associated with Ellsworth Dam.

Comment: Black Bear Hydro states that the draft EA should be revised on page 27 to recognize that Commerce's section 18 fishway prescription would require Black Bear Hydro to provide downstream fish passage from April 1 to December 31 each year, "as river conditions allow."

Response: Commerce's section 18 prescription does not include the phrase "as river conditions allow." Nonetheless, the staff-recommended alternative includes Black Bear Hydro's proposal to temporarily modify the proposed minimum flow releases and elevation limits at the Ellsworth and Graham Lake developments during: (1) approved maintenance activities; (2) extreme hydrologic conditions; (3) emergency electrical system conditions; or (4) agreement between the Licensee, the Maine DEP, and appropriate state and/or federal fisheries management agencies.

Upstream Fish Passage

Comment: A total of 49 stakeholders comment that the 15-year timeline for the implementation of upstream fish passage at the project, as prescribed by Commerce, should be reduced to 5 years from license issuance. Stakeholders referenced a variety of reasons for providing upstream fish passage within 5 years, including that the existing trap and haul fishway facility at the Ellsworth Dam is inadequate for Atlantic salmon. DSF's January 22, 2019 letter states that Commerce has not provided supporting facts showing that it will take 15 years after license issuance to install upstream fish passage facilities for Atlantic salmon, or that downstream passage measures will take 10 years or more to successfully implement before new upstream passage facilities can be constructed. DSF states that if the downstream passage measures for Atlantic salmon work as intended upon installation, then there is no need for any delay in installing swim-through upstream passage at Ellsworth and Graham Lake dams. DSF and the Schoodic Riverkeepers state that volitional upstream passage facilities should be constructed within 2 years of the downstream passage performance goal achievement.

On February 25, 2019, Edward Damm commented that volitional fish passage is needed immediately and that any delay in safe fish passage construction is not defensible.

Response: There is nothing in the record to suggest that the existing trap and haul facility is ineffective at passing Atlantic salmon upstream of the project. As discussed in section 5.2.3 of the draft EA, *Measures Not Recommended*, Black Bear Hydro is currently using the trap and haul facility to successfully pass thousands of river herring each year. Staff is recommending effectiveness studies for upstream Atlantic salmon passage to evaluate the effectiveness of the trap and haul facility at attracting and passing adult salmon upstream of the project.

As stated in section 5.2.3, the extent of potential adverse effects associated with the existing upstream fish passage facilities cannot be reconciled until sufficient salmon returns are available to use the upstream facilities. The timeliest and most certain method for evaluating the effectiveness of the existing facilities is to implement a deliberate system of stocking smolts upstream of the project, testing the downstream passage improvements, waiting for those fish to mature and return from the ocean, and then testing the attraction of Atlantic salmon to the existing upstream fish passageway entrance. The 15-year time period prescribed by Commerce provides a reasonable amount of time for carrying out this process and ensuring efficient upstream passage for Atlantic salmon. The analysis contained in this EA and the supplemental rationale provided by Commerce in its April 23, 2019 modified section 18 fishway prescription clearly explain the timeline necessary for downstream passage improvements and effectiveness studies. None of the commenters have provided compelling information for revising staff's analysis or recommendation.

Comment: Black Bear Hydro comments that Commission staff's estimate of a capital cost of $283,000 to design and install the new upstream Atlantic salmon passage measures at the Ellsworth Dam and Graham Lake Dam is an order of magnitude too low and must be corrected. Black Bear Hydro estimates the capital costs of constructing the new upstream fishways at Ellsworth Dam and Graham Lake Dam to range from $3.0 to $6.0 million.

Response: Staff revised the EA in section 5.2.3 to clarify that the capital cost for the design and installation of a new upstream Atlantic salmon passage facility is estimated to be $3.45 million. However, as noted in the EA, the cost is discounted to account for the 15 year implementation schedule, which is approximately halfway through an assumed 30 year license term.

Comment: NMFS comments that staff misinterpreted its section 18 prescription on page 214 of the draft EA by stating that new upstream swim-through fish passage facilities would not be needed if the proposed effectiveness studies demonstrate that the existing trap and truck facility is effective at attracting and passing adult salmon at the project, or that modifications could be made to the existing trap and truck facility to render it effective at attracting and passing adult salmon. NMFS clarifies that it will require swim-through fishways at the project within 15 years of license issuance. If the existing entrance to the trap and truck facility is proven to be highly effective, NMFS states that the facility could be used as an entrance to the new swim-through fishway.

Response: Staff modified the EA in section 3.3.4 and section 5.2.3 to correct the description of Commerce's section 18 prescription.

Comment: Black Bear Hydro states that the draft EA on page 22 states that Black Bear Hydro will design and install new upstream Atlantic salmon passage measures at Ellsworth and Graham Lake dams 15 years after issuance of any new license, and operate the new facilities from May 1 to October 31 of each year. However, Black Bear Hydro states that it is also proposing to consult with the resource agencies to determine whether changes in management and/or restoration priorities would warrant a delay in construction of new fish passage measures.

Response: We have added the qualifying language that Black Bear Hydro cites. Due to the status of the Atlantic salmon under the endangered species act (ESA) and the fact that Commerce's section 18 fishway prescription requires specific upstream fish passage measures and consultation on these measures, it is understood that consultation between Black Bear Hydro and the resource agencies (particularly Commerce) on the management and restoration priorities will be an important aspect of any license issued for the project.

Comment: Black Bear Hydro states that the draft EA on page 27 incorrectly describes Commerce's preliminary section 18 fishway prescription as requiring Black Bear Hydro to construct, operate, and maintain a swim-through fishway for upstream Atlantic salmon passage at the Ellsworth and Graham Lake dams in years 13 and 15 of any new license, respectively. Black Bear Hydro states that the draft EA has the order of new upstream fishway construction reversed, and that Commerce's prescription requires the construction of a new fishway at Graham Lake Dam two years prior to the construction of the new fishway at Ellsworth Dam to allow time for an effectiveness study.

Response: We have corrected the text of section 2.3 to reflect Commerce's final fishway prescription, filed on April 23, 2019, which now requires the new upstream fishways to be built concurrently no later than year 15 of any new license.

Comment: Black Bear Hydro states that the draft EA on page 32 incorrectly states that the staff alternative does not include Interior's fishway prescription to modify the upstream eel passage facility if 90 percent of eels do not pass over the upstream fishway during the effectiveness test. Black Bear Hydro notes that the draft EA states on page 31 that Interior's preliminary prescription is part of the staff alternative.

Response: Staff is indeed recommending this measure. We have eliminated this bullet from the list of Interior's prescriptions not recommended in section 2.4.

Comment: Black Bear Hydro takes issue with Commission staff's recommended construction schedule for the proposed upstream eel passage facilities (*i.e.*, outside of the upstream migration season of June 1 to October 31, and within 2 years of license issuance). Black Bear Hydro states that construction at Maine hydropower facilities is contingent on weather and flow conditions, which can constrain when eel ramps are constructed and installed. In addition, Black Bear Hydro states that the draft EA incorrectly assumes that there are no other construction or operational measures to reduce the effects of construction on migrating species (*i.e.*, reducing construction activities during the late summer, installing cofferdams, *etc.*).

Black Bear Hydro also states that construction of an eelway at Graham Lake can occur regardless of the upstream anadromous fish migration season because upstream migrating fish will continue to be trucked from Ellsworth Dam to upstream reaches above Graham Lake Dam until the installation of upstream anadromous fish passage facilities at Ellsworth Dam.

Black Bear Hydro recommends that FERC adhere to "normal practice" and require Black Bear Hydro to consult with the appropriate resource agencies on the methods or seasonal timing of specific construction projects as part of the design phase.

Response: As discussed above in response to a similar comment by Black Bear Hydro, performing construction activities during the fish passage season could negatively affect migrating fish by creating passage delays. While we acknowledge that construction between November 1 and May 31 could pose some difficulties and other measures could potentially be used to reduce project effects, we are not convinced that the construction schedule is impractical, especially for eel ramps that can be largely fabricated off site and installed relatively quickly. Accordingly, we have not changed the staff-recommended eel ramp construction schedule.

Black Bear Hydro's comment about the construction timing of the Graham Lake eel ramp misses the point that eels are already passing upstream of Ellsworth Dam under existing conditions. Therefore, the Graham Lake eel ramp should also be constructed outside the upstream eel passage season in order to not cause upstream passage delay.

Comment: FWS states that the draft EA includes incorrect operating dates for Interior's upstream American eel ramp prescription. FWS contends that the operating dates of June 1 to October 31 described in the draft EA are not correct, and that Interior's prescription requires upstream American eel passage facilities to operate from June through August.

Response: We have clarified the staff-recommended eel ramp operational dates to say they are consistent with the dates included in Maine DMR's section 10(j) recommendation, and inclusive of Interior's prescription measures. Page 8 of Maine DMR's March 27, 2018 letter includes the section 10(j) recommendation to operate the eel ramps from June 1 through October 31. Our analysis of the upstream eel passage season is located in section 3.3.2 of the EA, and section 5.2.2 provides a basis for staff's recommended June 1 to October 31 passage season.

Effectiveness Testing

Comment: FWS states that three of Interior's prescriptions pertaining to fish passage facility effectiveness testing were excluded from the staff analysis in the draft EA, and that the three prescriptive measures should be included in the environmental analysis. Maine DMR comments that the lack of support in the draft EA for effectiveness testing for all new or modified fish passage testing contradicts the Commission's study[289] that evaluated the effectiveness of upstream and downstream fish passage facilities, and included recommendations to assess the effectiveness of mitigation, monitor fish passage facilities, and gather more information on the effectiveness of fish passage facilities. Maine DMR and FWS disagree with staff's conclusions that fish passage facilities that are designed and operated in accordance with the FWS Design Criteria Manual will necessarily meet performance standards for migratory species and ensure safe, timely, and effective passage. Maine DMR and FWS state that because so many variables can affect fish passage, it is imperative that each facility be tested to determine whether it is mitigating for adverse environmental impacts on diadromous species.

Response: Sections 3.3.2 and 3.3.4 of the draft EA include detailed analyses of the effectiveness testing measures recommended and prescribed by the resource agencies, and sections 5.2.2 and 5.2.3 of the draft EA explain the rationale for staff's

[289] FERC Division of Hydropower Administration and Compliance. 2004. Evaluation of Mitigation Effectiveness at Hydropower Projects: Fish Passage. 63 pages.

recommendations on effectiveness testing. In addition, any effectiveness testing that is required under section 18 of the FPA would be required as part of any new license issued for the project.

Comment: DSF requests that Black Bear Hydro be required to perform entrance attraction testing for voluntary upstream passage immediately upon license issuance.

Response: Adult Atlantic salmon have not been arriving at the existing upstream trap and truck facility for several years. Additionally, alosines are successfully using the entrance to the trap and truck facility, which demonstrates that the location and operation of the fishway are adequate for current conditions. As this EA explains, and as Commerce emphasizes in its modified section 18 fishway prescription, the data sought by DSF for a volitional passage facility cannot be obtained until several prior steps are undertaken, including downstream passage improvements, effectiveness testing of those improvements, stocking of marked smolts, and the return of those marked smolts as adults seeking to move upstream of the Ellsworth Dam.

Comment: Black Bear Hydro takes issue with Commission staff's description of Black Bear Hydro's proposed fishway effectiveness testing for Atlantic salmon smolt downstream passage on pages 168 and 169 of the draft EA, particularly with regard to staff opining on the method that could be used to mark smolts during the study. Black Bear Hydro states that Commission staff should not specify study methods that have not been proposed, and that the most appropriate method of marking smolts during the study will be determined in consultation with relevant resource agencies.

Response: We have not recommended the use of a specific smolt marking method during effectiveness testing. Rather, in the absence of a specific methodology identified in Black Bear Hydro's draft biological assessment and Species Protection Plan, staff discussed a standard smolt marking methodology in the context of the analysis of Black Bear Hydro's proposed effectiveness studies. Commission staff understand that the proposed effectiveness studies are at the conceptual stage of planning and, as staff stated in section 3.3.4 of the draft EA, additional study details are needed, including detailed methodology on marking, tagging, and tracking smolts, as well as the appropriate timing for stocking the marked and tagged smolts. Therefore, staff recommends in section 5.2.2 that an effectiveness testing study plan be developed in consultation with Commerce and Maine DMR.

Comment: NMFS and Black Bear Hydro state that the draft EA is not clear that the Atlantic salmon smolt performance standard of 90 percent is intended to be a whole project survival standard (inclusive of Ellsworth Dam and the Graham Lake Dam). NMFS expects that 90 percent of out-migrating smolts that approach Graham Lake Dam from upriver will successfully survive passage through both dams. This equates to approximately 95 percent survival through each dam.

Similarly, NMFS and Black Bear Hydro state that the 90 percent performance standard for upstream salmon passage incorporates both dams. NMFS states that the fishway entrance at the Ellsworth Dam would need to achieve a capture efficiency of at least 95 percent for there to be a reasonable expectation that the whole project efficiency will equal 90 percent once both upstream fishways have been completed.

NMFS states that the adaptive management measures for improving downstream fish passage effectiveness apply to the Ellsworth Dam and not the Graham Lake Dam (as stated on page 20 of the draft EA, under the second bullet).

Response: Staff understand that 90 percent survival is intended to be the performance standard as measured by survival of smolts after passing downstream through both developments (*i.e.*, an average of 95 percent survival per development). Staff also understands that upstream passage effectiveness would be calculated similarly, as a combined efficiency of upstream migrating salmon passing both dams, and that a 95 percent or higher capture efficiency would be necessary at the Ellsworth Dam for NMFS to expect that the 90 percent overall project efficiency could be achieved. We have revised the text in section 2.2 in order to clarify these standards. We also changed the text in section 2.2 of this final EA to indicate that the specific adaptive management measures for improving downstream fish passage effectiveness apply to the Ellsworth dam and not the Graham Lake Dam.

Comment: Black Bear Hydro states that the draft EA on page 22 should be clarified to state that Black Bear Hydro's proposal to test the effectiveness of the existing fishway trap and truck facility is dependent on marked salmon smolts returning to the project in adequate number as adults (*i.e.*, at least 40 individuals returning annually). Black Bear Hydro also clarifies that it is proposing that performance standards be demonstrated to be achieved after two test years.

Response: Staff are aware of these proposed details and the reason for the timing of the effectiveness testing, and described them accurately in section 3.3.2 of the draft EA.

<u>Fish Stocking</u>

Comment: Until upstream and downstream fishways are installed at the project for American eel, the Maine Elver Fisherman Association state that the licensee should be required to stock glass eels (juvenile American eels) in Lake Leonard and Graham Lake during spring migration. The Maine Elver Fisherman Association state that a sustainable escapement target for the stocking numbers should be calculated by FWS and that, until these numbers are calculated, Lake Leonard should be stocked with at least 100 pounds of juvenile eels, and Graham Lake should be stocked with at least 400 pounds of juvenile eels.

Response: The Maine Elver Fisherman Association's recommendations are not accompanied by any explanation of how their recommended stocking densities were calculated and therefore, we have no basis for conducting an analysis of the measure. Further, as Interior describes in section 12.2.1 of its prescription, the design capacity of upstream and downstream eel passage facilities is difficult to calculate because the number of juvenile eels depends on numerous factors, including the glass eel fishery downstream of the project.

Juvenile eels are currently able to move past both dams, at least in some numbers, as evidenced by the populations of adult eel upstream of both dams. To protect and enhance American eel populations in the Union River, staff recommend installing upstream eel ramps at both dams within two years of license issuance and we recommend adopting Interior's section 18 prescription for generation shutdowns during peak adult eel outmigration times. These measures complement other interim and permanent downstream passage measures that would benefit all diadromous fish species, including Atlantic salmon, alosines, and American eel.

Based on the lack of specific information on stocking densities, the ability for juvenile eels to pass upstream under current conditions, and the recommended measures for reducing project effects on eels within two years of license issuance, we do not recommend stocking glass eels at the project.

Endangered Species

Comment: Black Bear Hydro states that the draft license article requiring Black Bear Hydro to revise the Species Protection Plan within 90 days of license issuance does not provide sufficient time to develop study plans and consult with resource agencies. Black Bear Hydro requests that Commission staff allow 180 days to submit a revised Species Protection Plan.

Response: Considering the importance of the measures contained in the Species Protection Plan, and their role in protecting endangered species under the ESA, we have revised the draft article to provide 180 days to revise the Species Protection Plan, as Black Bear Hydro requests.

Comment: NMFS does not concur with Commission staff's determination in the draft EA that the issuance of a new license for the Ellsworth Project is not likely to adversely affect shortnose sturgeon, Atlantic sturgeon, or the designated critical habitat for the GOM DPS for Atlantic salmon. Regarding Atlantic salmon, NMFS states that regulation of flow in the Union River and the maintenance of two impoundments affect the critical habitat essential features regarding safe, timely, and effective swim-through passage (PCE 8 and PCE 11). NMFS states that Section 7 consultation remains incomplete.

Response: As stated in section 3.3.4.2, *Atlantic Salmon Critical Habitat,* the tributaries of Graham Lake would remain accessible to adult salmon at water surface elevations greater than 97 feet msl. Staff's recommended minimum impoundment elevation of 98.5 feet msl would ensure that these tributaries remain accessible for adult and juvenile salmon throughout the year. Similarly, staff's recommended minimum flows of 250 cfs from May 1 to June 30,123 cfs from July 1 to December 31, 105 cfs from January 1 to March 31, and 123 cfs from April 1 to April 30 would ensure that an adequate zone of passage exists in the mainstem of the Union River between Lake Leonard and Graham Lake for both adult and juvenile salmon. In addition, meeting 90 percent effectiveness for upstream and downstream passage after developing volitional upstream passage facilities and modifying existing downstream passage facilities would ensure that the safe, timely, and effective passage requirements of PCE 8 and PCE 11 would be met. NMFS did not provide any information about how the maintenance of the project impoundments would adversely affect salmon migration. Therefore, staff has not changed the conclusion that staff's alternative with mandatory conditions is not likely to adversely affect Atlantic salmon critical habitat. However, based on NMFS's statement that it does not concur with staff's determination that the project is not likely to adversely affect critical habitat, we will request formal consultation with NMFS for Atlantic salmon critical habitat (see section 1.3.3*, Endangered Species Act*).

Regarding Commission staff's determination that relicensing the project is not likely to adversely affect sturgeon (and NMFS's non-concurrence with that determination), please see the response to the next comment. We will request to begin formal consultation regarding shortnose sturgeon and Atlantic sturgeon.

Comment: NMFS comments that the draft EA and Black Bear Hydro's proposed Species Protection Plan incorrectly state that NOAA staff will handle any trapped sturgeon at the project. NMFS states that Black Bear Hydro will be responsible for the safe removal and release of any sturgeon that are captured in the fish trap at the project. NMFS further states that effects to sturgeon need to be fully addressed in the final EA and through section 7 consultation.

Response: We have edited the text on page 267 of section 3.3.4 to clarify that Black Bear Hydro will be responsible for the removal and release of any sturgeon that are captured in the fish trap at the project.

With regards to project effects on sturgeon being fully addressed in the final EA, we assume NMFS is referring to its December 21, 2018 letter, in which it states that capture, collection, and handling of sturgeon (as described in the sturgeon handling plan) is a "take" as defined in section 9 of the ESA. We make this assumption because Commission staff has not identified any other possible effects on sturgeon and neither has NMFS. Staff has revised the text in section 3.3.4 to address the effects of implementing the sturgeon handling plan and the "take" that implementation of the plan could potentially represent. Accordingly, we have also revised our determination to state that relicensing the project is likely to adversely affect sturgeon.

Comment: NMFS states that the draft EA discounts the effect that impoundments have on anadromous fish, and that large project impoundments like the one created by Graham Lake Dam have a negative effect on outmigrating juvenile salmon smolts. NMFS states that impounding water significantly modifies riverine habitats by converting them into lake habitats, which creates ideal spawning conditions for fish predators (*e.g*., bass, pike, pickerel). Based on the Atlantic salmon smolt downstream passage studies that Black Bear Hydro conducted in 2016 and 2017, NMFS states that smolts move much slower through Graham Lake than through the free flowing reaches of the lower Union River, and that smolts experience excessive mortality as they migrate downstream through Graham Lake.[290] NMFS states that predators may cause high levels of smolt mortality and that project operation directly affects water elevations, which contributes to bass spawning success and predation in the impoundment. Therefore, NMFS states that Commission staff should consider the mortality that occurs in Graham Lake to be a project effect.[291]

NMFS states that if the adverse conditions in the project impoundment are allowed to persist, it is unlikely that critically endangered Atlantic salmon will be able to be restored to the Union River. NMFS requests that the Commission require Black Bear Hydro to compare mortality of smolts in the impoundment with the mortality of smolts through an unimpounded reference reach of sufficient length within the same river. To make this comparison, NMFS recommends that Black Bear Hydro conduct a post-license study to evaluate smolt mortality through a reference reach in the West Branch of the Union River. NMFS also recommends that Black Bear Hydro evaluate smolt mortality that occurs in the lowermost region of Graham Lake, as proposed in Black Bear Hydro's Species Protection Plan. NMFS indicates that the information derived from a post-license smolt mortality study is necessary to accurately characterize the extent and cause

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290 NMFS states that its proposed downstream fish passage performance standard is 95 percent survival at each project development. Given this proposed standard, staff interprets NMFS' comment to mean that a mortality rate greater than 5 percent for smolts migrating through Graham Lake is excessive.

291 NMFS February 15, 2019 comment at page 5, citing *Am. Rivers v. FERC*, 895 F.3d 32, 46 (D.C. Cir. 2018) of the dam-related mortality in the area immediately upstream of Graham Lake Dam, as well as to adaptively minimize and/or mitigate those effects.

Response: During the 2016 and 2017 downstream smolt passage studies, Black Bear Hydro quantified mortality experienced by smolts in the following locations: (1) the West Branch of the Union River approximately 3.4 miles upstream of Graham Lake (2016 only), (2) Graham Lake, (3) passing downstream through Graham Lake Dam, (4) the unimpounded reach of the Union River between Graham Lake and Lake Leonard, (5) Lake Leonard, (6) passing downstream through Ellsworth Dam, and (7) the unimpounded reach of the Union River downstream of Ellsworth Dam. In addition, Black Bear Hydro estimated background mortality (*i.e.*, mortality not due to dam passage) for tagged smolts released into the unimpounded reach of the Union River downstream of Graham Lake during the 2017 study, and similar information can be derived from the 2016 study.

The data provided by the studies show that per-mile mortality rates vary by year and location in reaches where dam passage was not required (see Table 31). Per-mile mortality rates were consistently lower in 2016 than 2017. The highest mortality rate occurred in the lower reach of Graham Lake in 2017 (17.4 percent per mile). The second highest rate occurred in 2016 for smolts migrating from the release site in the West Branch of the Union River to the first radio telemetry receiver in Graham Lake, which is the closest analog to the West Branch Union River reference reach that NMFS recommends studying post-licensing. Smolts migrating from the West Branch to Graham Lake experienced a mortality rate of 6.9 percent per mile. This mortality rate was higher than the mortality rates observed in Graham Lake that year. Furthermore, except for the mortality rate observed in lower Graham Lake in 2017, the per-mile mortality rates observed in the free-flowing reaches of the Union River between Graham Lake Dam and Lake Leonard were similar to, or slightly higher than those observed in Graham Lake in 2016 (see Table 31). Given the mortality information that Black Bear Hydro collected during the two study years, including smolt mortality from the West Branch of the Union River and other unimpounded reaches of the Union River, it is unclear what new information a post-license smolt mortality study would provide.

NMFS indicates that Graham Lake causes an additional 0.2 to 0.8 percent mortality per mile over background rates. However, as mentioned above, smolt predation in Graham Lake does not appear to be consistently higher than smolt predation in the unimpounded reaches upstream and downstream of Graham Lake Dam. In addition, the per-mile mortality rates observed in Graham Lake and the Union River in 2016 and 2017 are similar, in terms of variability, to mortality rates observed over multiple years in several reaches in the Penobscot River (Stich *et al*., 2015c). Given the amount of available mortality information and the observed mortality patterns, we do not recommend that Black Bear Hydro conduct a post-license smolt mortality study.

Recreation and Aesthetic Resources

Comment: Victor Ryolizky recommends that Black Bear Hydro be required to develop and implement a river corridor plan for the Union River Basin and the current project boundary that would provide an overall strategy for conservation and development.

Response: Black Bear Hydro has control over the land and water within the project boundary. The entire Union River Basin is much larger than the project boundary, and therefore the Commission does not have the ability to require measures covering its entirety. The EA considers all the various resource areas affected by the project, and any license issued for the project would be best adapted to a comprehensive plan for improving or developing the waterway for all beneficial public uses, pursuant to section 10(a) of the FPA.

Comment: Victor Ryolizky recommends that Black Bear Hydro be required to develop an 800-foot-long recreation trail downstream of the Ellsworth Dam to increase recreational opportunities from the City of Ellsworth, including opportunities for people to walk from the downtown area and view the dam and Union River.

Response: The recreation trail recommended by Victor Ryolizky would be located on the eastern bank of the Union River, which is not suitable for a recreational trail because there is no public access on the eastern shore across from the powerhouse, and there is no public access through private property that is adjacent to this area on the eastern shore. The western shore of the Union River below the Ellsworth Dam provides public access along the project boundary with a view of the downstream side of the dam, which extends approximately 400 feet along the river from the fence around the powerhouse. There is a small public parking area below the Ellsworth Dam. While there is no formal trail on the western shore, the shoreline can be easily traversed.

Comment: Victor Ryolizky requests that drawdowns be limited to 2 to 3 feet at the Shore Road boat launch on Lake Leonard, in order to provide a consistently higher water level for smaller boat access, including canoes, kayaks, and rowboats.

Mr. Ryolizky requests the installation of an additional, “softer” launch area for smaller boats at the Shore Road boat launch because he states that the existing concrete boat ramp can damage smaller boats by chipping the bottom of the boats.

Mr. Ryolizky states that a maintenance plan should be developed for the Shore Road boat launch to include trash removal during the peak summer season.

Mr. Ryolizky requests that Black Bear Hydro keep the bottom of the ramp at the Shore Road boat launch clear of aquatic vegetation to provide easier access for smaller boats.

Response: In the EA, Commission staff recommends that Lake Leonard continue to be operated within a 1-foot bandwidth, between an elevation of 65.7 and 66.7 feet msl, which is below Victor Ryolizky's recommendation of a maximum drawdown of 2 to 3 feet.[292]

The Shore Road boat ramp on Lake Leonard includes an approximately 6-foot wide concrete boat ramp. Only approximately 4 feet of the concrete's width is exposed, while the other 2 feet are covered by vegetation. On the side of the concrete is an area of small stones, gravel, and dirt that can serve as a soft launch. There is aquatic vegetation growing up on the other side of this soft area, but currently this soft section is approximately 3-feet-wide. This soft-bottomed section can be used to launch a hand-carried boat approximately 3-feet wide, with the concrete ramp providing solid footing immediately next to it. The project also provides launches with bottoms of small stones, gravel, and dirt at nearby Graham Lake at the current canoe portage trail takeout and on the sides of the concrete boat ramp. A gravel and mud launch would continue to be available at Graham Lake at Black Bear Hydro's proposed new canoe portage trail. There are also public, non-project boat launches at Graham Lake, including the Fletcher's Landing and Mariaville boat launches that have concrete launches as well as areas of small stones, gravel, and dirt that can be used as soft launches. The soft boat launches at Graham Lake are free of aquatic vegetation due to the variation in lake elevation at Graham Lake. Additionally, Commission staff is recommending higher minimum lake elevations at Graham Lake to, in part, improve access for boats at Graham Lake. Based on the availability of a non-concrete launch area at the Shore Road boat ramp and the existing small boat access sites at Graham Lake (three of which are located within 5 miles of the Shore Road ramp at Lake Leonard), staff is not recommending the removal of aquatic vegetation or the installation of a soft-surface boat launch at the Shore Road site.

With regard to the need for a maintenance plan for the Shore Road boat launch, Commission staff recommends Black Bear Hydro's proposed Recreation Facilities Management Plan that provides for periodic mowing, litter clean-up, removal of fallen trees that hinder facility use, trimming overgrowth along the canoe portage trail, and checking that portage trail signage is in-place and readable. According to the Recreation Facilities Management Plan, Black Bear would also conduct other improvements or repairs on an observed, as-needed basis. Additionally, the Commission's standard terms and conditions for a hydropower license require the licensee to operate and maintain

[292] See final EA at 345.

recreational facilities, including improvements such as access roads, wharves, launching ramps, beaches, picnic and camping areas, sanitary facilities, and utilities. Accordingly, any new license would include the requirement to maintain launching ramps, and a separate maintenance plan for the Shore Road boat launch would not be necessary.

Comment: Black Bear Hydro states that the draft EA variously refers to the length of the Graham Lake canoe portage trail as being 300 feet or 360 feet in length. Black Bear Hydro states that the draft EA should be revised to consistently reflect a portage trail length of 360 feet.

Response: We have revised section 3.3.5 of the final EA to state the canoe portage trail is approximately 360 feet long.

Comment: Black Bear Hydro states that the draft EA on page 253 incorrectly states that the non-project recreation sites include a city-owned access site located on the east bank of the Union River on Infant Street, upstream of Lake Leonard. According to Black Bear Hydro, the draft EA should be revised to state that the non-project recreation sites include "a city-owned access (informal footpaths to the shorelines) to the east and west banks of the Union River upstream of Lake Leonard and an access and parking area on the eastern bank on Infant Street."

Response: We have revised section 3.3.5 of the final EA to state that the non-project recreation sites include "a city-owned access site at Infant Street on both sides of the Union River that includes informal trails to the shoreline on the east and west banks of the Union River upstream of Lake Leonard, and an access and parking area on the eastern bank of the Union River on Infant Street."

Comment: Black Bear Hydro states that the draft EA on pages 308-309 incorrectly states that there is no cost associated with operating and maintaining the existing project recreation facilities. Black Bear Hydro states that the draft EA should be modified to include an annual cost of $26,000 (2015 dollars) to operate and maintain the project recreation facilities, and an annual cost of $20,000 (2015 dollars) for safety signage.

Response: Because Black Bear Hydro states that the operation and maintenance on the existing project recreation facilities is *continuing*, we have inferred that Black Bear Hydro already performs operation and maintenance at these facilities every year. Therefore, we have already included it as part of the overall operation and maintenance cost for the project as provided in Table 40 and do not need to modify Table 42. The installation and maintenance costs for the Part 8 and directional safety signage are included in Table 40 in the levelized annual cost of implementing the Recreation Facilities Management Plan.

Comment: Black Bear Hydro states that the draft license articles on pages 411 and 412 of the draft EA would give Black Bear Hydro less than a full construction season to complete recreation facility improvements. Black Bear Hydro states that the license should require completion of the improvements within one year after the Commission approves the Recreation Facilities Management Plan.

Response: We have revised the draft license article in the final EA to require completion of the improvements within one year of approval of the Recreation Facilities Management Plan.

Comment: Ed Damm states that the Commission should require a "shoreland management plan" for Graham Lake because there does not seem to be any planning or management for the creation of a defensible vegetative edge to reduce erosion.

Response: Commission staff recommends reducing the operating range and maximum shoreline elevation of Graham Lake to reduce erosion and turbidity in the impoundment, as discussed in section 5.2.2 of the EA, *Additional Measures Recommended by Staff*. To the extent that Mr. Damm desires the installation of erosion control structures on the shoreline of his property, Article 409 of the existing license provides the licensee with authority to grant permission for certain types of use and occupancy of project lands and water without prior Commission approval, including the installation of erosion control structures to protect the existing shoreline. Commission staff recommends that any new license include a standard land use article, which is referred to as a "Use and Occupancy" article in Appendix B of the EA. Together, these measures would provide the necessary means for addressing shoreline erosion at Graham Lake, and no modification of the EA is necessary.

Cultural Resources

Comment: Black Bear Hydro states that the description of the project history on page 277 of the draft EA needs to be supplemented to account for the addition of a fourth turbine and powerhouse modifications in 1923.

Response: We have revised section 3.3.6 of the final EA to state that "A fourth unit was added in 1923 when the powerhouse was enlarged."

Comment: Black Bear Hydro states that the draft EA on page 277 incorrectly states that the Ellsworth Powerhouse and Dam and the Graham Lake Dam and Bridge are eligible for the National Register under criteria A and C. Black Bear Hydro states that the language should be revised to state that they are either listed or eligible for listing for the National Register under criteria A and C.

Response: We have revised section 3.3.6 of the final EA to state that "The Ellsworth Powerhouse and Dam is listed on, and the Graham Lake Dam and Bridge is eligible for listing on, the National Register under criteria A and C."

Comment: Black Bear Hydro states that the draft EA on page 279 should be revised to recognize that the Maine Central Railroad Bridge is eligible for the National Register under criteria A and C, not just criterion C.

Response: We have revised section 3.3.6 of the final EA to state that Maine Central Railroad Bridge is eligible for listing in the National Register under criteria A and C.

Comment: Black Bear Hydro states that the draft EA on page 326 incorrectly states that the licensee must implement the draft HPMP filed on December 30, 2015 to provide for management of historic resources throughout the term of any new license. Black Bear Hydro states that this language should be revised to require Black Bear Hydro to "[f]inalize and implement the draft HPMP filed on December 30, 2015 to provide for management of historic resources throughout the term of any new license."

Response: Black Bear Hydro has not indicated how it intends to finalize the draft HPMP. Black Bear Hydro has not filed any amendments to the draft HPMP, and the draft HPMP has been included in the Programmatic Agreement that was signed by the Maine SHPO on June 6, 2019. Therefore, no revisions appear to be needed to finalize the HPMP.

APPENDIX B

LICENSE CONDITIONS RECOMMENDED BY STAFF

In this section, we present draft license articles for staff-recommended measures:

Draft Article 201. *Administrative Annual Charges*. The licensee must pay the United States annual charges, effective the first day of the month in which this license is issued, and as determined in accordance with the provisions of the Commission's regulations in effect from time to time, to reimburse the United States for the cost of administration of Part 1 of the Federal Power Act. The authorized installed capacity for that purpose is 8.9 megawatts.

Draft Article 202. *Exhibit Drawings.* Within 45 days of the date of issuance of the license, he licensee must file two sets of the approved exhibit drawings and geographic information system (GIS) data in electronic file format on compact disks with the Secretary of the Commission, ATTN: OEP/DHAC.

(a) Digital images of the approved exhibit drawings must be prepared in electronic format. Prior to preparing each digital image, the FERC Project-Drawing Number (*i.e.*, P-2727-1001 through P-2727-10XX) must be shown in the margin below the title block of the approved drawing. Exhibit F drawings must be segregated from other project exhibits, and identified as **Critical Energy/Electric Infrastructure Information as stated in 18 C.F.R. (2019)**. Each drawing must be a separate electronic file, and the file name must include: FERC Project-Drawing Number, FERC Exhibit, Drawing Title, date of this License, and file extension in the following format [P-2727-1001, G-1, Project Boundary, MM-DD-YYYY.TIF]. All digital images of the exhibit drawings must meet the following format specification:

IMAGERY – black & white raster file
FILE TYPE – Tagged Image File Format, (TIFF) CCITT Group 4 (also known as T.6 coding scheme)
RESOLUTION – 300 dots per inch (dpi) desired, (200 dpi minimum)
DRAWING SIZE FORMAT – 22” x 34” (minimum), 24” x 36” (maximum)
FILE SIZE – less than 1 megabyte desired

Each Exhibit G drawing that includes the project boundary must contain a minimum of three known reference points (*i.e.*, latitude and longitude coordinates, or state plane coordinates). The points must be arranged in a triangular format for GIS georeferencing the project boundary drawing to the polygon data, and must be based on a standard map coordinate system. The spatial reference for the drawing (*i.e.*, map projection, map datum, and units of measurement) must be identified on the drawing and each reference point must be labeled. In addition, each project boundary drawing must be stamped by a registered land surveyor.

(b) The project boundary GIS data must be in a georeferenced electronic file format (such as ArcView shape files, GeoMedia files, MapInfo files, or a similar GIS format). The filing must include both polygon data and all reference points shown on the individual project boundary drawings. An electronic boundary polygon data file(s) is required for each project development. Depending on the electronic file format, the polygon and point data can be included in single files with multiple layers. The georeferenced electronic boundary data file must be positionally accurate to ±40 feet in order to comply with National Map Accuracy Standards for maps at a 1:24,000 scale. The file name(s) must include: FERC Project Number, data description, date of this License, and file extension in the following format [P-2727, boundary polygon/or point data, MM-DD-YYYY.SHP]. The data must be accompanied by a separate text file describing the spatial reference for the georeferenced data: map projection used (*i.e.*, Universal Transverse Mercator, State Plane, Decimal Degrees, *etc*.), the map datum (*i.e.*, North American 27, North American 83, *etc*.), and the units of measurement (*i.e.*, feet, meters, miles, *etc*.). The text file name must include: FERC Project Number, data description, date of this License, and file extension in the following format [P-2727, project boundary metadata, MM-DD-YYYY.TXT].

<u>Draft Article 203</u>. *Amortization Reserve*. Pursuant to section 10(d) of the Federal Power Act, a specified reasonable rate of return upon the net investment in the project must be used for determining surplus earnings of the project for the establishment and maintenance of amortization reserves. The licensee must set aside in a project amortization reserve account at the end of each fiscal year one half of the project surplus earnings, if any, in excess of the specified rate of return per annum on the net investment. To the extent that there is a deficiency of project earnings below the specified rate of return per annum for any fiscal year, the licensee must deduct the amount of that deficiency from the amount of any surplus earnings subsequently accumulated, until absorbed. The licensee must set aside one-half of the remaining surplus earnings, if any, cumulatively computed, in the project amortization reserve account. The licensee must maintain the amounts established in the project amortization reserve account until further order of the Commission.

The specified reasonable rate of return used in computing amortization reserves must be calculated annually based on current capital ratios developed from an average of 13 monthly balances of amounts properly included in the licensee's long-term debt and proprietary capital accounts as listed in the Commission's Uniform System of Accounts. The cost rate for such ratios must be the weighted average cost of long-term debt and preferred stock for the year, and the cost of common equity must be the interest rate on 10-year government bonds (reported as the Treasury Department's 10-year constant maturity series) computed on the monthly average for the year in question plus four percentage points (400 basis points).

Draft Article 204. *Headwater Benefits.* If the licensee's project was directly benefited by the construction work of another licensee, a permittee, or the United States on a storage reservoir or other headwater improvement during the term of the prior license (including extensions of that term by annual licenses), and if those headwater benefits were not previously assessed and reimbursed to the owner of the headwater improvement, the licensee must reimburse the owner of the headwater improvement for those benefits, at such time as they are assessed, in the same manner as for benefits received during the term of this new license. The benefits will be assessed in accordance with Part 11, Subpart B, of the Commission's regulations.

Draft Article 301. Contract Plans and Specifications. At least 60 days prior to the start of any construction, the licensee must submit one copy of its plans and specifications and supporting design document to the Commission's Division of Dam Safety and Inspections (D2SI)-New York Regional Engineer, and two copies to the Commission (one of these shall be a courtesy copy to the Director, D2SI). The submittal to the D2SI-New York Regional Engineer must also include as part of preconstruction requirements: a Quality Control and Inspection Program, Temporary Construction Emergency Action Plan, and Soil Erosion and Sediment Control Plan. The licensee may not begin construction until the D2SI-New York Regional Engineer has reviewed and commented on the plans and specifications, determined that all preconstruction requirements have been satisfied, and authorized start of construction.

Draft Article 302. Cofferdam and Deep Excavation Construction Drawings. Should construction require cofferdams or deep excavations, the licensee must: (1) have a Professional Engineer who is independent from the construction contractor, review and approve the design of contractor-designed cofferdams and deep excavations prior to the start of construction; and (2) ensure that construction of cofferdams and deep excavations is consistent with the approved design. At least 30 days before starting construction of any cofferdams or deep excavations, the licensee must submit one copy to the Commission's Division of Dam Safety and Inspections (D2SI)-New York Regional Engineer and two copies to the Commission (one of these copies shall be a courtesy copy to the Commission's Director, D2SI), of the approved cofferdam and deep excavation construction drawings and specifications, and the letters of approval.

Draft Article 303. Project Modification Resulting from Environmental Requirements. If environmental requirements under this license require modification that may affect the project works or operations, the licensee must consult with the Commission's Division of Dam Safety and Inspections (D2SI)–New York Regional Engineer. Consultation must allow sufficient review time for the Commission to ensure that the proposed work does not adversely affect the project works, dam safety, or project operation.

Draft Article 4XX. *Commission Approval, Filing Reports, Notification, and Filing of Amendments*.

(a) Resource Plan Requirements

Conditions found in Appendix X of this license require the licensee to prepare: (1) upstream and downstream eel passage design plans (U.S. Department of the Interior [Interior] Conditions 12.3 and 12.4); (2) a fishway operation and maintenance plan (Interior Condition 12.5.2); and (3) upstream and downstream fish passage effectiveness monitoring plans (Interior Conditions 12.6.1 and 12.6.2) in consultation with the U.S. Fish and Wildlife Service and resource agencies. The conditions do not provide for Commission approval or do not specifically require the requisite design plans for the fish passage facilities. Therefore, the due date for filing each plan with the Commission is as specified below:

Interior Fishway Prescription Condition No.	**Plan Name**	**Due Date for Filing the Plan(s) with the Commission**
12.3	Upstream American eel fishway design plan	Within 6 months of license issuance
12.4	Downstream American eel fishway design plan	Within 6 months of license issuance
12.5.2	Fishway operation and maintenance plan for upstream and downstream passage	Within 12 months of license issuance
12.6.1	Upstream eel effectiveness monitoring plan	Within 6 months of license issuance
12.6.2	Downstream eel effectiveness monitoring plan	Within 6 months of license issuance

The licensee must include with each plan filed with the Commission documentation that the licensee developed the plan in consultation with the U.S. Department of Commerce (Commerce), Interior, and Maine Department of Marine Resources (Maine DMR), and received approval from Interior. Each such plan also must include a provision to file any resulting reports with the Commission, as well as the appropriate agency or agencies. In addition, each report must include any recommended additional operational and structural modifications and/or habitat enhancement measures to provide eel passage, if other proposed passage measures for eel are ineffective. The Commission reserves the right to make changes to any plan submitted. Upon Commission approval, the plan becomes a requirement of the license, and the licensee must implement the plan or changes in the project operation or facilities, including any changes required by the Commission.

(b) Requirement to Notify Commission of Planned and Unplanned Deviations from License Requirements, and Fulfilling License Requirements

Interior fishway prescription condition 12.6.2 in Appendix X would allow the licensee to modify the timing of seasonal American eel downstream fishway operations based on effectiveness monitoring data. The Commission must be notified as soon as possible in writing, but no later than 10 days after each such modification. Any modification(s) in the seasonal timing of fishway operation must be based on consultation with Interior, Commerce, and Maine DMR. The Commission reserves the right to further modify the timing of fishway operations for any reason, including to address any project or public safety concerns.

(c) Requirement to File Amendment Applications

Certain conditions of the Commerce's fishway prescription in Appendix X and Interior's fishway prescription in Appendix X contemplate unspecified long-term changes to project operation or facilities for the purposes of complying with the agencies' fishway prescriptions or mitigating environmental impacts (*e.g.*, Condition 7.3.5 of Commerce's fishway prescription and Condition 12.6.2 of Interior's fishway prescription require fishway effectiveness monitoring and potential additional protective measures or alternative actions to ensure that the design passage criteria are met). Such changes may not be implemented without prior Commission authorization granted after the filing of an application to amend the license.

<u>Draft Article 4XX</u>. *Graham Lake and Lake Leonard Operating Range*. The licensee shall operate the project so that water levels in Lake Leonard are maintained between the elevations of 65.7 feet mean sea level (msl) and 66.7 feet msl (flashboard crest), and water levels in Graham Lake are maintained between the elevations of 98.5 and 103.0 feet msl during normal operation.

These requirements may be temporarily modified if required by operating emergencies beyond the control of the licensee, and for short periods upon agreement among the licensee, the Maine Department of Environmental Protection (Maine DEP), Maine DMR, the National Marine Fisheries Service (NMFS), and the U.S. Fish and Wildlife Service (FWS). If water surface elevations are so modified, the licensee must notify the Commission, Maine DEP, Maine DMR, NMFS, and FWS no later than 10 days after each such incident, and file an incident report with the Commission, Maine DEP, Maine DMR, NMFS, and FWS no later than 30 days after each such incident.

<u>Draft Article 4XX</u>. *Minimum Flow Requirements*. To protect the water quality and aquatic resources in the Union River, and to provide downstream fish passage, the licensee must discharge from the Ellsworth Project into the Union River the following continuous minimum flows according to the schedule below:

Period	Flow
January 1 to March 31	105 cfs
April 1 to April 30	123 cfs
May 1 to June 30	250 cfs
July 1 to December 31, or ice in	123 cfs

These flow requirements may be temporarily modified if required by operating emergencies beyond the control of the licensee, or for short periods, upon agreement among the licensee, Maine DEP, Maine DMR, NMFS, and FWS. If minimum flows are so modified, the licensee must notify the Commission and Maine DEP, Maine DMR, NMFS, and FWS no later than 10 days after each such incident, and file an incident report with the Commission and Maine DEP, Maine DMR, NMFS, and FWS no later than 30 days after each such incident.

Draft Article 4XX. *Operation Compliance Monitoring Plan*. Within 6 months of license issuance, the licensee must file with the Commission, for approval, a revised "Operations Monitoring Plan" that includes, but is not necessarily limited to:

(1) a detailed description of how the project facilities will operate the project to comply with the requirements specified in Draft Article 4XX (*Graham Lake and Lake Leonard Operating Range*) and Draft Article 4XX (*Minimum Flow Requirements*) during normal operation, and in the event of an emergency;

(2) a detailed description of how the licensee will monitor compliance with the operational requirements specified in Draft Article 4XX (*Graham Lake and Lake Leonard Operating Range*) and Draft Article 4XX (*Minimum Flow Requirements*), including descriptions of the mechanisms and instrumentation or gages (*i.e.*, type and exact locations of all flow and impoundment elevation monitoring equipment) used, and procedures for maintaining and calibrating monitoring equipment;

(3) the methods and frequency for reporting monitoring data to the Commission, Maine DEP, Maine DMR, Maine Department of Inland Fisheries and Wildlife, (Maine DIFW), NMFS, and FWS; and

(5) an implementation schedule.

The licensee must include with the plan, documentation of consultation with Maine DEP, Maine DMR, Maine DIFW, NMFS, and FWS; copies of comments and recommendations on the completed plan after it has been prepared and provided to the agencies; and specific descriptions of how the agencies' comments are accommodated by the plan. The licensee must allow a minimum of 30 days for the agencies to comment and to make recommendations before filing the plan with the Commission. If the licensee does not adopt a recommendation, the filing must include the licensee's reasons based on project-specific information.

For any temporary modifications of project operations, the licensee must include, as part of its emergency notification to the Commission, an incident report. The report must, to the extent possible, identify the cause, severity, and duration of the incident, and any observed or reported adverse environmental impacts resulting from the incident. The report also must include: (1) operational data necessary to determine compliance with the article; (2) a description of any corrective measures implemented at the time of the occurrence and the measures implemented or proposed to ensure that similar incidents do not recur; and (3) comments or correspondence, if any, received from Maine DEP, Maine DMR, Maine DIFW, NMFS, and FWS regarding the incident. Based on the report and the Commission's evaluation of the incident, the Commission reserves the right to require modifications to the project facilities and operations to ensure future compliance.

The Commission reserves the right to require changes to the monitoring plan. The licensee must not begin implementing the plan until the Commission approves the plan. Upon Commission approval, the licensee must implement the plan, including any changes the Commission required.

Draft Article 4XX. *Fish Passage Facilities*. The licensee must operate and maintain upstream and downstream fishways at Graham Lake and Ellsworth dams, including:

(1) the existing upstream trap and truck facility for passage of alosines and Atlantic salmon, subject to potential modification following the effectiveness testing described in the Species Protection Plan required by Article 4XX;

(2) new upstream eel passage facilities at the Ellsworth and Graham Lake dam that must be: (a) constructed outside of the upstream migration season (June 1 to October 31) and operational within 2 years of license issuance; (b) constructed at the Ellsworth Dam at the bedrock outcrop adjacent to the eastern end of the dam; (c) constructed at the Graham Lake Dam at a location that is to be determined through consultation between the licensee and fisheries management agencies, as described in Condition 12.3 of Interior's fishway prescription in Appendix X; and (d) designed in accordance with FWS's Fish Passage Engineering Design Criteria Manual, including that the facilities must: (i) consist of a covered metal or plastic volitional ramp that is lined with a wetted substrate and angled at a maximum slope of 45 degrees, with 1-inch-deep resting pools that are sized to the width of the ramp and spaced every 10 feet along the length of the ramp; and (ii) accommodate a maximum capacity of 5,000 eels/day;

(3) the existing downstream fish passage facility at Graham Lake Dam for passage of Atlantic salmon, alosines, and American eel, to be modified in accordance with Commerce's Fishway Prescription Condition No. 7.33 (Appendix X) and Interior's

Fishway Prescription Condition No. 2.4.1 (Appendix X), with all construction activities occurring outside of the upstream migration season (May 1 to November 15) and modifications completed within 2 years of license issuance; and

(4) the existing downstream fish passage facility at Ellsworth Dam for passage of Atlantic salmon, alosines, and American eel, to be modified in accordance with Commerce's Fishway Prescription Condition No. 7.33 (Appendix X) and Interior's Fishway Prescription Condition No. 2.4.2 (Appendix X), with all modifications completed prior to the third migration season after license issuance.

Draft Article 4XX. *Fish Passage Operation and Maintenance Plan*. Within 12 months of license issuance, the licensee must file, with the Commission for approval, a revised Fish Passage Operations and Maintenance Plan that is based on, and includes the provisions of the Fish Passage Operations and Maintenance Plan, filed on September 28, 2018, with the following modifications:

(1) update the plan to include the operation and maintenance of the new and modified passage facilities described in Article 4XX, *Fish Passage Facilities* and the conditions included in Interior's fishway prescription in Appendix X and Commerce's fishway prescription in Appendix X;

(2) include a schedule of fishway operating times and minimum conveyance flows;

(3) perform routine maintenance before the migration season, such that the existing fishways would be fully operational during the migratory period;

(4) clear debris from fish passage facilities prior to the migration season, and determine the frequency of debris clearing during the migration season with final approval from the Commission;

(5) include provisions for updating the plan on an annual basis to reflect any changes in fishway operation and maintenance for the following year;

(6) develop and include procedures for operation and maintenance of the existing fishways during emergencies and project outages; and

(7) develop and include safety rules and procedures.

All revisions to the Fish Passage Operations and Maintenance Plan must be developed after consultation with NMFS, FWS, and Maine DMR. The licensee must include with the plan documentation of consultation, copies of recommendations on the completed plan after it has been prepared and provided to the agencies above, and specific descriptions of how the agencies' comments are accommodated by the plan. The licensee must allow a minimum of 30 days for the agencies to comment and to make recommendations before filing the plan with the Commission for approval. If the licensee does not adopt a recommendation, the filing must include the licensee's reasons, based on project specific information.

The Commission reserves the right to require changes to the Fish Passage Operations and Maintenance Plan. Implementation of the plan must not begin until the licensee is notified by the Commission that the plan is approved. Upon Commission approval, the licensee must implement the plan, including any changes required by the Commission.

Draft Article 4XX. *Shakedown Period*. Operate each new and modified fish passage facility for a one-season "shakedown" period following the completion of construction and modification activities, and make adjustments to the facilities if they are not operating as designed. Any adjustments that are made to the facilities should be completed before the next fish passage season that follows the "shakedown" period.

Draft Article 4XX. *Generator Shutdown for Downstream Fish Passage.* Beginning on April 1 [in the year of the third downstream migration season following license issuance], the licensee must cease operation of the Unit 1 generator on an annual basis for a period of 15 consecutive days after the water temperature in the Union River reaches 50 °F in spring, to protect outmigrating Atlantic salmon smolts from entrainment.

Draft Article 4XX. *Unit Prioritization for Downstream Fish Passage.* Upon license issuance, the licensee must prioritize operation of generating Units 1 and 4 over Units 2 and 3 from April 1 to December 31 to protect Atlantic salmon, alosines, and American eel.

Draft Article 4XX. *Interim Downstream Fish Passage*. Upon license issuance, the licensee must implement the following measures to reduce entrainment of downstream migrating fish during the interim period between license issuance and implementation of the modifications to project facilities described in Article 4XX (*Fish Passage Facilities*), Article 4XX (*Seasonal Trashrack Installation*), Interior's fishway prescription (Appendix X), and Commerce's fishway prescription (Appendix X):

(1) continue to provide downstream passage between April 1 and December 31 (or ice-in) for out-migrating Atlantic salmon and river herring at Graham Lake Dam through the existing surface weir and Tainter gate;

(2) continue to provide downstream passage between April 1 and December 31 (or ice-in) for out-migrating Atlantic salmon and river herring at the Ellsworth Dam through the three existing surface weirs;

(3) monitor the forebay of Graham Lake Dam on an hourly basis during the 4-day period following a storm event that exceeds 17 percent of the total average monthly rainfall and monitor the tailrace of Ellsworth Dam on an hourly basis throughout the alosine downstream passage season (June 1 – November 30), subject to consultation with NMFS and Maine DMR;

(4) implement the following generation shutdown procedures at the Ellsworth Development when a school of out-migrating alosines is observed passing through the Alden weir at Graham Lake or dead or injured alosines are observed in the tailrace of Ellsworth Dam:

a. immediately reduce generator output at the Ellsworth Development to the minimum hydraulic capacity needed to pass minimum flows at the project, and adjust the Tainter gate settings at the Graham Lake Dam to release 700 cfs; and

b. Once the increased flow from Graham Lake reaches Lake Leonard and begins to spill over the Ellsworth Dam flashboards, cease generation completely for a 4-hour period.

Prior to implementing the generation shutdown procedures, the licensee must consult with Maine DMR, the U.S. Fish and Wildlife Service, and the National Marine Fisheries Service to determine the criteria for the school size at Graham Lake that would result in a cessation of generation.

The interim passage measures must remain in place until all modifications to the downstream fish passage facility at the Ellsworth Development are complete, following the one season "shakedown" period described in Article 4XX, *Shakedown Period*.

<u>Draft Article 4XX</u>. *Species Protection Plan*. Within 180 days of license issuance, the licensee must file, with the Commission for approval, a revised Species Protection Plan for the protection of Atlantic salmon, Atlantic sturgeon, and shortnose sturgeon. The plan must be based on, and include the provisions of, the Species Protection Plan filed on September 28, 2018 as Attachment A to the Draft Biological Opinion, with the following modifications:

(1) Include a provision to cease operation of Unit 1 for 15 days when Union River water temperature reaches 50 °F in spring to protect outmigrating salmon smolts;

(2) Include marking/tagging/tracking technique in the upstream and downstream passage effectiveness study methodology and the appropriate timing for stocking marked/tagged smolts;

(3) File a plan for the proposed passage effectiveness studies as attachments to the Species Protection Plan;

(4) Determine the need for an additional 1 or 2 years of effectiveness studies, with final approval from the Commission, if the upstream fishway meets the 90 percent performance standard after the first year;

(5) Determine the need for an additional 1 or 2 years of effectiveness studies, with final approval from the Commission, if the downstream fishways meet the 90 percent performance standard after the first year;

(6) Determine the need for future effectiveness studies, and/or fishway modifications, and/or new volitional fishways with final approval from the Commission, if after 3 years of upstream passage effectiveness studies, the upstream fishway does not meet the 90 percent effectiveness performance standard;

(7) Determine the need for future effectiveness studies, and/or fishway modifications, with final approval from the Commission, if after 3 years downstream passage effectiveness studies, the upstream fishway does not meet the 90 percent effectiveness performance standard;

(8) Remove the provision to conduct a study to evaluate smolt mortality in Graham Lake;

(9) Add a provision to file an application to amend the license and get Commission approval, prior to implementing any future, and currently unspecified operational, structural, and/or habitat enhancement measures that may be used to improve passage and/or address performance criteria for upstream and downstream migrating Atlantic salmon.

All revisions to the Species Protection Plan must be developed after consultation with NMFS, FWS, and Maine DMR. The licensee must include with the plan, documentation of consultation, copies of recommendations on the completed plan after it has been prepared and provided to the agencies above, and specific descriptions of how the agencies' comments are accommodated by the plan. The licensee must allow a minimum of 30 days for the agencies to comment and to make recommendations before filing the plan with the Commission. If the licensee does not adopt a recommendation, the filing must include the licensee's reasons, based on project specific information.

The Commission reserves the right to require changes to the plan. Implementation of the plan must not begin until the licensee is notified by the Commission that the plan is approved. Upon Commission approval, the licensee must implement the plan, including any changes required by the Commission.

Draft Article 4XX. *Reservation of Authority to Prescribe Fishways*. Authority is reserved to the Commission to require the licensee to construct, operate, and maintain, or provide for the construction, operation, and maintenance of such fishways as may be prescribed by the Secretaries of the Interior or Commerce pursuant to section 18 of the Federal Power Act.

Draft Article 4XX. *Northern Long-Eared Bat Protection Measures*. The licensee must implement the following measures to protect northern long-eared bat habitat: (1) avoid cutting trees equal to or greater than 3 inches in diameter within the project boundary from June 1 through July 31, unless they pose an immediate threat to human life or property; and (2) where trees need to be removed, only remove trees between August 1 and May 31.

Draft Article 4XX. *Recreation Facilities Management Plan.* Within six months of the effective date of this license, the licensee must file a Recreation Facilities Management Plan for Commission approval. The plan must include provisions for operating and maintaining the following recreation facilities for the term of the license: (1) the existing Graham Lake Dam boat ramp; (2) a new canoe portage trail on the west side of the Union River around Graham Lake Dam; (3) a new angler access trail on the eastern shore of Graham Lake Dam, in the same location as the existing canoe portage trail; and (4) the existing Shore Road carry-in boat launch on Lake Leonard. The plan must include a requirement for publicly noticing limitations to recreation site access, and a schedule for resolving any access issues to project water and recreation facilities.

The plan must describe the following recreation improvements, to be conducted within one year of the Commission's approval of the Recreation Facilities Management Plan:

(1) Construct a new portage trail on the west side of the Union River around Graham Lake Dam. The trail must include: (1) a new canoe take-out facility located near the current Graham Lake Dam boat launch; (2) a new trail that that extends along the flood control structure on the downstream side of Graham Lake Dam; and (3) a new canoe put-in facility located downstream of Graham Lake Dam;

(2) Convert the downstream side of the old canoe portage trail on the eastern shore of Graham Lake Dam into an angler access trail and improve the trail to remove any existing impediments to access of the Union River downstream of the Graham Lake Dam; and

(3) Improve the Graham Lake Dam boat launch by grading and compacting the gravel section of the boat launch to correct the drainage issue at the top of the boat ramp that is causing erosion.

The licensee must prepare the Recreation Facilities Maintenance Plan after consultation with FWS and Maine DIFW. The licensee must include with the plan documentation of consultation, copies of comments and recommendations to the completed plan after it has been prepared and provided to the agencies, and specific descriptions of how the agencies' comments are accommodated by the plan. The licensee must allow a minimum of 30 days for the agencies to comment and to make recommendations before the plan with the Commission. If the licensee does not adopt a recommendation, the filing must include the licensee's reasons based on project-specific information.

The Commission reserves the right to require changes to the plan. Implementation of the plan must not begin until the licensee is notified by the Commission that the plan is approved. Upon Commission approval, the licensee must implement the plan, including any changes required by the Commission.

Draft Article 4XX. *Programmatic Agreement and Historic Properties Management Plan*. The licensee must implement the "Programmatic Agreement between the Federal Energy Regulatory Commission and the Maine Historic Preservation Commission (Maine SHPO) for Managing Historic Properties that may be affected by Issuing a License to Black Bear Hydro Partners, LLC for the Operation of the Ellsworth Hydroelectric Project in Hancock County, Maine," executed on ________ by the Maine SHPO, and including but not limited to the Historic Properties Management Plan (HPMP) for the project. Pursuant to the requirements of this Programmatic Agreement, the licensee must file, for Commission approval, a final HPMP within one year of issuance of this order. When filing the HPMP for Commission approval, the licensee must include documentation of consultation with the Maine SHPO, the Passamaquoddy Tribe at Pleasant Point and Indian Township, and the Penobscot Nation during the development of the HPMP.

The Commission reserves the authority to require changes to the HPMP at any time during the term of the license. If the Programmatic Agreement is terminated prior to Commission approval of the HPMP, the licensee must obtain approval from the Commission, the Maine SHPO, and the Penobscot Indian Nation THPO before engaging in any ground-disturbing activities or taking any other action that may affect any historic properties within the project's area of potential effects.

Draft Article 4XX. *Use and Occupancy.* (a) In accordance with the provisions of this article, the licensee has the authority to grant permission for certain types of use and occupancy of project lands and waters and to convey certain interests in project lands and waters for certain types of use and occupancy, without prior Commission approval. The licensee may exercise the authority only if the proposed use and occupancy is consistent with the purposes of protecting and enhancing the scenic, recreational, and other environmental values of the project. For those purposes, the licensee has the continuing responsibility to supervise and control the use and occupancies for which it grants permission, and to monitor the use of, and ensure compliance with the covenants of the instrument of conveyance for, any interests that it has conveyed, under this article. If a permitted use and occupancy violates any condition of this article or any other condition imposed by the licensee for protection and enhancement of the project's scenic, recreational, or other environmental values, or if a covenant of a conveyance made under the authority of this article is violated, the licensee must take any lawful action necessary to correct the violation. For a permitted use or occupancy, that action includes, if necessary, canceling the permission to use and occupy the project lands and waters and requiring the removal of any non-complying structures and facilities.

(b) The types of use and occupancy of project lands and waters for which the licensee may grant permission without prior Commission approval are: (1) landscape plantings; (2) non-commercial piers, landings, boat docks, or similar structures and facilities that can accommodate no more than 10 water craft at a time and where said facility is intended to serve single-family type dwellings; (3) embankments, bulkheads, retaining walls, or similar structures for erosion control to protect the existing shoreline; and (4) food plots and other wildlife enhancement. To the extent feasible and desirable to protect and enhance the project's scenic, recreational, and other environmental values, the licensee shall require multiple use and occupancy of facilities for access to project lands or waters. The licensee must also ensure, to the satisfaction of the Commission's authorized representative, that the use and occupancies for which it grants permission are maintained in good repair and comply with applicable state and local health and safety requirements. Before granting permission for construction of bulkheads or retaining walls, the licensee must: (1) inspect the site of the proposed construction, (2) consider whether the planting of vegetation or the use of riprap would be adequate to control erosion at the site, and (3) determine that the proposed construction is needed and would not change the basic contour of the impoundment shoreline. To implement this paragraph (b), the licensee may, among other things, establish a program for issuing permits for the specified types of use and occupancy of project lands and waters, which may be subject to the payment of a reasonable fee to cover the licensee's costs of administering the permit program. The Commission reserves the right to require the licensee to file a description of its standards, guidelines, and procedures for implementing this paragraph (b) and to require modification of those standards, guidelines, or procedures.

(c) The licensee may convey easements or rights-of-way across, or leases of project lands for: (1) replacement, expansion, realignment, or maintenance of bridges or roads where all necessary state and federal approvals have been obtained; (2) storm drains and water mains; (3) sewers that do not discharge into project waters; (4) minor access roads; (5) telephone, gas, and electric utility distribution lines; (6) non-project overhead electric transmission lines that do not require erection of support structures within the project boundary; (7) submarine, overhead, or underground major telephone distribution cables or major electric distribution lines (69-kV or less); and (8) water intake or pumping facilities that do not extract more than one million gallons per day from a project impoundment. No later than January 31 of each year, the licensee must file with the Commission a report briefly describing for each conveyance made under this paragraph (c) during the prior calendar year, the type of interest conveyed, the location of the lands subject to the conveyance, and the nature of the use for which the interest was conveyed. No report filing is required if no conveyances were made under paragraph (c) during the previous calendar year.

(d) The licensee may convey fee title to, easements or rights-of-way across, or leases of project lands for: (1) construction of new bridges or roads for which all necessary state and federal approvals have been obtained; (2) sewer or effluent lines that discharge into project waters, for which all necessary federal and state water quality certification or permits have been obtained; (3) other pipelines that cross project lands or waters but do not discharge into project waters; (4) non-project overhead electric transmission lines that require erection of support structures within the project boundary, for which all necessary federal and state approvals have been obtained; (5) private or public marinas that can accommodate no more than 10 water craft at a time and are located at least one-half mile (measured over project waters) from any other private or public marina; (6) recreational development consistent with an approved report on recreational resources of an Exhibit E; and (7) other uses, if: (i) the amount of land conveyed for a particular use is five acres or less; (ii) all of the land conveyed is located at least 75 feet, measured horizontally, from project waters at normal surface elevation; and (iii) no more than 50 total acres of project lands for each project development are conveyed under this clause (d)(7) in any calendar year. At least 60 days before conveying any interest in project lands under this paragraph (d), the licensee must file a letter with the Commission, stating its intent to convey the interest and briefly describing the type of interest and location of the lands to be conveyed (a marked Exhibit G map may be used), the nature of the proposed use, the identity of any federal or state agency official consulted, and any federal or state approvals required for the proposed use. Unless the Commission's authorized representative, within 45 days from the filing date, requires the licensee to file an application for prior approval, the licensee may convey the intended interest at the end of that period.

(e) The following additional conditions apply to any intended conveyance under paragraph (c) or (d) of this article:

(1) Before conveying the interest, the licensee must consult with federal and state fish and wildlife or recreation agencies, as appropriate, and the State Historic Preservation Officer.

(2) Before conveying the interest, the licensee must determine that the proposed use of the lands to be conveyed is not inconsistent with any approved report on recreational resources of an Exhibit E; or, if the project does not have an approved report on recreational resources, that the lands to be conveyed do not have recreational value.

(3) The instrument of conveyance must include the following covenants running with the land: (i) the use of the lands conveyed must not endanger health, create a nuisance, or otherwise be incompatible with overall project recreational use; (ii) the grantee must take all reasonable precautions to ensure that the construction, operation, and maintenance of structures or facilities on the conveyed lands will occur in a manner that will protect the scenic, recreational, and environmental values of the project; and (iii) the grantee must not unduly restrict public access to project lands or waters.

(4) The Commission reserves the right to require the licensee to take reasonable remedial action to correct any violation of the terms and conditions of this article, for the protection and enhancement of the project's scenic, recreational, and other environmental values.

(f) The conveyance of an interest in project lands under this article does not in itself change the project boundaries. The project boundaries may be changed to exclude land conveyed under this article only upon approval of revised Exhibit G drawings (project boundary maps) reflecting exclusion of that land. Lands conveyed under this article will be excluded from the project only upon a determination that the lands are not necessary for project purposes, such as operation and maintenance, flowage, recreation, public access, protection of environmental resources, and shoreline control, including shoreline aesthetic values. Absent extraordinary circumstances, proposals to exclude lands conveyed under this article from the project shall be consolidated for consideration when revised Exhibit G drawings would be filed for approval for other purposes.

(g) The authority granted to the licensee under this article shall not apply to any part of the public lands and reservations of the United States included within the project boundary.

APPENDIX C

U.S. DEPARTMENT OF COMMERCE'S SECTION 18 FISHWAY PRESCRIPTIONS

7.3 SECTION 18 FISHWAY PRESCRIPTION

We hereby submit the following fishway prescriptions pursuant to Section 18 of the FPA, 16 USC §811. Section 18 of the FPA states in relevant part that, "the Commission must require the construction, maintenance, and operation by a Licensee of...such fishways as may be prescribed by the Secretary of Commerce or the Secretary of the Interior." Congress provided guidance on the term "fishway" in 1992 when it stated as follows:

"The items which may constitute a 'fishway' under Section 18 for the safe and timely upstream and downstream passage of fish must be limited to physical structures, facilities, or devices necessary to maintain all life stages of such fish, and Project operations and measures related to such structures, facilities, or devices which are necessary to ensure the effectiveness of such structures, facilities, or devices for such fish." Pub.L. 102-486, Title XVII, § 1701(b), Oct. 24, 1992.

The following mandatory fishway prescriptions are based on the best biological and engineering information available at this time, as described in the explanatory statements that accompany each prescription. This prescription has been developed over a period of several years by our biological and engineering staff, in close consultation with the Licensee, the U.S. FWS and other entities that participated in this relicensing proceeding. Each prescription is supported by substantial evidence contained in the record of pre-filing consultation, and subsequent updates, compiled and submitted in accordance with the Commission's procedural regulations. The explanatory statements included with each prescription are intended to summarize the supporting information and analysis upon which these prescriptions are based. Our Administrative Record was previously submitted under separate cover (Accession # 20180411-4008).

7.3.1 Upstream Fish Passage – Alosine

The licensee shall operate and maintain upstream fish passage facilities that pass alosine species in a safe, timely and effective manner. The state of Maine currently limits the number of alewife and blueback herring stocked into the watershed, and trap counts demonstrate that the facility is effective for meeting stocking goals. However, if the state of Maine increases the number of alewife and blueback herring stocked into the watershed to the point that the existing facility is no longer sufficient, than the licensee will need to build and operate fishways at the Ellsworth and Graham Lake dams that meet the performance standards identified in Section 7.3.5. Likewise, management objectives for American shad may change during the term of the new license. If a management program for American shad is initiated for the Union River during the license term, then the licensee will need to demonstrate the trap or passage facility available at that time is safe, timely and effective for those fish. If the standards identified in 7.3.5 are not met, than the licensee will need to improve the existing structure to meet the performance standard or build and operate fishways at Graham Lake and Ellsworth that meet those performance standards. Timing of construction of any new fishway shall be consistent with requirements for upstream Atlantic salmon measures (Section 7.3.2). Therefore, we do not require any changes to the existing fish trap and truck facility at this time, although we reserve our authority to prescribe additional upstream fishways consistent herewith in the future.

The Licensee shall keep the fishways in proper order and shall keep fishway areas clear of trash, logs, and material that would hinder passage. Anticipated maintenance shall be performed in sufficient time before a migratory period such that fishways can be tested and inspected and will properly operate prior to the migratory periods.

Rationale

Restoration of anadromous fish is a long-standing resource goal for the Union River watershed. The original order issuing a license for the Ellsworth Project in 1987 contemplated fishways. The requirement for dedicated fish passage facilities that can achieve agency management goals is necessary to support our broader restoration goal for the watershed. The continued use of the existing trap facility will support our agency's mission goals for sustainable fisheries and coastal communities, as well as the state's current management goals.

We further support this position on the factual background herein and the following facts:

a. Anadromous fish historical habitat has been identified in the Union River (Smith 1898).

b. Alewife and blueback herring have unimpeded access to the Ellsworth Dam at the head of tide.

c. The state of Maine has stocked alewife in lake habitat above Graham Dam since the 1970s (URFCC 2000, BREG 2015).

d. The existing stocking process at the Ellsworth Project supports current stocking goals and results in nominal mortality of stocked fish (BBHP 2014, URFCC 2018).

7.3.2 Upstream Fish Passage – Atlantic salmon

The Licensee shall operate and maintain upstream fish passage facilities that pass Atlantic salmon safely, timely and effectively during the term of this license. The present Ellsworth trap and truck facility is insufficient at passing salmon and will need to be replaced with a state of the art swim-through fishway, such as a vertical slot fishway, a Denil, an Ice Harbor fishway, or a fishlift (or their equivalent). We require installation and operation of effective upstream swimthrough passage structures for Atlantic salmon at the Graham Lake Dam and Ellsworth Dam no later than year 15 of the new license. The Licensee shall meet with the resource agencies annually to discuss fishway operation, study results, and the siting, design, and construction of the new fishways. The Licensee may consult with the resource agencies prior to the specified dates to determine whether changes in management and restoration priorities would warrant a delay of fishway construction. Any changes to our prescribed fishways or delays in construction will require agreement with NMFS. We anticipate that our ESA consultation on the proposed relicensing will consider installation and operation no later than year 15 of the new license; any change to the schedule will likely require reinitiation of that consultation, including an evaluation of any conclusion we made as to whether the proposed action is likely to jeopardize the continued existence of the Gulf of Maine DPS of Atlantic salmon or result in the destruction or adverse modification of designated critical habitat. Until the new fishways are operational, the licensee must continue to operate the existing Ellsworth fishway. The Licensee shall keep the existing fishway – as well as any fishway constructed in the future - in proper order and clear of trash, logs, and material that would hinder passage. Anticipated maintenance shall be performed in sufficient time before a migratory period such that fishways can be tested and inspected and will properly operate prior to the migratory periods.

Additional protective measures or alternative actions may be necessary for Atlantic salmon pending analysis of the Commission's proposed action under section 7 of the ESA and conclusions of our anticipated Biological Opinion.

Rationale

Restoration of Atlantic salmon is a long-standing resource goal for the Union River watershed. Smolt stocking occurred in the river until 1991. At that point, smolt stocking was reduced and then later terminated because few of the stocked smolts returned as adults (Baum 1997). The poor returns have been attributed to inadequate upstream and downstream passage at the Ellsworth Dam (ASRSC 1982). Salmon fry have continued to be stocked in the River through 2017. Based on the number of adults anticipated from fry stocking (between 0.1 and 2.2 per 10,000 fry stocked (USASAC 2017)) we would expect as many as five salmon a year returning to the Union River. In addition to returns from stocking, we expect that salmon occur in the Union River as a result of straying. With a straying rate of 3 percent (Baum 1997) from the runs on the nearby Narraguagus and Penobscot Rivers, we expect dozens of returning adults to be straying to nearby rivers. The 10-year (2007-2016) average number of returning salmon to the Penobscot

River is approximately 1,200 adults (USASAC 2017). A 3 percent straying rate would mean that up to 36 adults could be straying to nearby rivers, including the Union River.

Despite the returns expected to the Union River from stocking and straying, very few adult salmon have been observed in the river. A failure to detect adult salmon may explain the difference between what we expect and what we observe. The adult salmon numbers for the Union River are based solely on the number of adult salmon that are caught in the Ellsworth Dam fish trap. However, the Ellsworth Dam fish trap data may underestimate the number of adult salmon in the river for at least two reasons. First, the trap may only capture 50 percent of salmon that approach Ellsworth Dam (USASAC 1991). We note that the 50 percent capture efficacy is based on older information, but this is the only information we have on capture efficacy and there is no data showing that conditions have changed for the better. Second, if salmon do enter the fishway it is possible that they are not detected due to overcrowding of the hopper (see section 6.4.2.1).

The requirement for dedicated fish passage facilities issued during this licensing proceeding is necessary to support our broader restoration goal for the Downeast Coastal SHRU for federally endangered Atlantic salmon. Time is needed, however, for: (1) implementation and evaluation of improvements to downstream passage protection measures, and (2) the evaluation of the existing trap entrance, and (3) the design and construction of swim through fishways. We know that downstream passage survival at this project is extremely low (BBHP 2016, 2017), which is a significant component of the failed productivity. Passing adult salmon upstream prior to fixing the problems with downstream passage will lead to unacceptable levels of mortality of those fish and their progeny as they migrate back to the marine environment (Nieland et al. 2013, Nieland et al. 2015). Therefore, waiting to achieve the downstream performance standard before improving upstream passage is prudent. Additionally, prior to upstream fishway construction, studies will be required at the Ellsworth dam to determine whether the existing fishway entrance is located such that it will effectively attract a high proportion of motivated adult salmon. If the best available information indicates that the existing entrance cannot attract a high proportion of adults, then the new fishway should be sited based on the results of the studies and be constructed as required.

Although our objective is to restore safe, timely, and effective passage into the Union River as soon as possible, we acknowledge that a certain amount of delay in construction of upstream fishways is appropriate given the concerns with downstream survival and the time needed to address those concerns; as well as the need to identify the appropriate location for the upstream fishway at the Ellsworth Dam. Black Bear has agreed to construct upstream fishways no later than fifteen years after license issuance. This timeline will be evaluated under section 7(a)(2) of the US Endangered Species Act to determine whether or not it is adequate to avoid jeopardy of the species and/or adverse modification of the critical habitat.

We anticipate that the downstream performance standard will be achieved at the project within six years of the downstream measures being implemented (Table 3). This is a reasonable estimate given our experience on the neighboring Penobscot River, where standards are close to being achieved at four mainstem dams after five years of adaptive management (BBHP 2019). Once downstream passage has been improved, the focus will shift to providing safe, timely, and effective upstream passage for Atlantic salmon. Although there are other potential methods, the preferred approach for identifying the appropriate location for the new fishway entrance would be to stock a sufficient number of salmon smolts to produce motivated adult salmon that will return to the river two years later, where they can be used to conduct a telemetry study. However, we acknowledge that hatchery resources are limited, and there is uncertainty regarding when salmon smolts will be available to provide a source of motivated prespawn adult salmon for the study. Decisions regarding the allocation of these resources will be made by the appropriate government agencies outside of this relicensing process. Therefore, if it does not appear that smolts will be allocated for this purpose within a reasonable amount of time, the best available methods (*e.g.*, modelling, telemetry studies with a surrogate species) will be used to site the fishway. We believe that four years will provide adequate time for these studies to occur. If a telemetry study with adult salmon is possible, we would expect stocking to occur the two years following the achievement of the downstream performance standard. The adult telemetry studies would then occur during the two years following adult stocking. If this study is not possible due to a lack of availability of smolts and/or returning adults, then the best available alternative methods will be used to ensure that the best available information is being used to site the fishway. Once the fishway site is determined, we anticipate that fishway design and construction will be completed in two years.

Table 3. Approximate schedule for the design, construction, and evaluation of downstream and upstream fishways at the Ellsworth Project.

Phase	**Year of license**	**Activity**
Phase 1 (Downstream Passage)	Year 1	License issued
	Year 3	Downstream fishways become operational
	Year 4-9	Evaluate and adaptively manage downstream passage
Phase 2 (Upstream Passage)	Year 10-13	Conduct upstream fishway siting study at Ellsworth Dam
	Year 14-15	Design and construct upstream fishways
Phase 3	Year 16 to exp	Operate safe timely and effective swimthrough passage

We further support the need for a swimthrough fishway on the factual background herein and the following facts:

a. Anadromous fish such as salmon historical habitat has been identified in the Union River (Smith 1898).

b. Atlantic salmon have unimpeded access to the Ellsworth Dam at the head of tide, and strays from other rivers within the GOM DPS are expected (see section 6.4.2.1.)

c. Dams such as the Ellsworth and Graham dams are an impediment to upstream migration of anadromous fish (74 FR 29300, June 19, 2009; 74 FR 29344, June 19, 2009; 78 FR 48944, August 12, 2013).

d. Properly designed and located fishways, with suitable near-field and far-field attraction are capable of passing Atlantic salmon and other species upstream of dams (Larinier 2002a, b, Larinier and Marmulla 2004, Bunt et al. 2012, NMFS 2012, USFWS 2017).

7.3.3 Downstream Fish Passage – Anadromous Species

The Licensee shall construct, operate and maintain downstream fish passage facilities for anadromous fish species that provide safe, timely and effective downstream passage consistent with the performance standards developed in the ESA consultation for Atlantic salmon and described in Section 7.3.5 for alosine. Modifications to the downstream passage facilities shall be operational by May 1 of the third year of the new license.

The downstream passage facility at the Ellsworth dam shall be modified to incorporate the following improvements:

- Installation of a fish guidance system leading to a bypass surface entrance. The guidance system shall be comprised of a rigid hanging curtain or boom (of similar construction as the fish booms that are being used on the Kennebec river at Lockwood, Hydro Kennebec, and Shawmut power stations) leading to a modified surface entrance(s) for discharge through a bypass facility.

- Installation of 1-inch clear space trashracks or overlays at existing trashracks for Units 2, 3, and 4, such that no more than 1-inch clear spaced trashracks are present throughout the full depth of the intake opening.

- Prioritize operation of Unit 4 over Units 2 and 3 and curtail operation of Unit 1 during critical downstream fish passage seasons. The critical downstream fish passage seasons will be determined in consultation with the resource agencies.
- Modification of the existing spillway downstream fish passage weir entrance to increase the depth to a minimum of 3 feet, install tapered walls similar to an Alden

weir, and increase the spillway downstream fish passage weir capacity to pass up to 5 percent of station hydraulic capacity (approximately 120 cfs).

- Modification of the fish transport pipe to improve the discharge angle onto flume.

- Increase the height of the sides along the flume on the spillway to handle increased flow and to reduce spillover.

- If the defined performance standards (section 7.3.5) cannot be met with the above improvements, additional measures will be implemented to further reduce fish injury and mortality. Such measures may include increasing the depth of the guidance system, turbine curtailment or shutdowns, or modification of the spillway and/or the ledge at the base of the dam.

The downstream passage facility at the Graham Lake dam shall be modified to incorporate the following improvements:

- The Alden weir at Graham Lake Dam shall be modified in order to allow at least three feet of water over the weir under all headpond conditions. This can be accomplished by modifying the weir to be moveable in the vertical direction on floats or by mechanical means.

The Licensee shall keep the downstream passage facilities in proper order and clear of trash, logs, and material that would hinder passage. Anticipated maintenance shall be performed in sufficient time before a migratory period such that fishways can be tested and inspected and will operate effectively prior to the migratory periods. Additional measures specific to Atlantic salmon may also be required depending on outcome of the ESA section 7 consultation and requirements of any Incidental Take Statement issued as part of the anticipated Biological Opinion.

The proposed action in the FLA is inadequate for protecting downstream migrating anadromous fish. Anadromous fish are present; the impacts on those fish have been observed for alosine or quantified for Atlantic salmon (BBHP 2016, 2017). Therefore, our prescribed modifications will need to be implemented with the stated three-year time frame.

Rationale

Dedicated fish passage facilities are necessary to protect anadromous species migrating downstream past the Project. We base this position on the factual background herein and the following:

- Downstream migrating anadromous species are exposed to project related impacts (Franke et al. 1997, BBHP 2016, 2017).

- Mortality events have been observed during multiple seasons (see FERC docket # 20161017-5030, 20170810-5111).
- Downstream passage survival is a critical component to achieving recovery goals (Nieland et al. 2013).
- Downstream migrating adults and juvenile Atlantic salmon and alosines require protection from project operations that result in injury and mortality (Taylor and Kynard 1985, Franke et al. 1997, Larinier 2000, FERC 2004, Hecker et al. 2007) (74 FR 29344, June 19, 2009, 78 FR 48944, August 12, 2013).

7.3.4 Seasonal Migration Windows

Fishways shall be operational during the migration windows for each life stage of Atlantic salmon (adults, kelts and smolts), and adults and juveniles of American shad, blueback herring, and alewife. The migratory seasons for anadromous fish are well known in the major rivers of the Northeast (Loesch 1987, ASMFC 2000). Based on state-wide and Union River watershed specific data, approved fish passage protective measures shall be operational during the follow migration windows:

a. Upstream alosine: May 1 to July 31

b. Upstream Atlantic salmon: May 1 – November 15

c. Downstream alosine: June 1 – November 30

d. Downstream kelt: April 1 to June 15 and October 17 – December 31 (or ice-in)

e. Downstream smolt: April 1 to June 15.

Rationale

a. Adult alosine in Maine commonly migrate upstream between May and June, and as late as August and outmigrate soon after spawning from June to early August (BWPH 2015a).

b. Juvenile alosine typically outmigrate in September and October but may migrate as early as August and as late as December (Mullen et al. 1986, Weiss-Glanz et al. 1986).

c. Trap operations at the Ellsworth Dam typically captured adult salmon from June to October (Baum 1997) because the trap was not operated for salmon until June in most years because of the alewife run, and because personnel were not available to operate the lift in November (ASRSC 1982). Salmon have been documented returning to the Cherryfield Dam in the nearby Narraguagus River, as well as the former Bangor and Veazie dams on the Penobscot River, between the months of May and November (Baum 1997).

d. Following spawning in the fall, Atlantic salmon kelts may immediately return to the sea, or over-winter in freshwater habitat and migrate in the spring, typically April or May (Baum 1997).

e. Based on smolt trapping studies in the Narraguagus, Sheepscot, Piscataquis, and East Machias Rivers in 2011 - 2015, smolts migrate between late April and early June with a peak in early May (USASAC 2016).

7.3.5 Monitoring And Passage Performance Standards

Licensee must monitor upstream and downstream fishways at the Ellsworth and Graham Lake dams. Monitoring will ensure fish passage protection measures are constructed, operated and functioning as intended for the safe, timely and effective passage of migrating fish. We will evaluate the results of the monitoring against performance standards developed for each species. Those performance standards are presently in development for alosine and Atlantic salmon. Based on the best available information from dam impact assessment on the Penobscot and Connecticut Rivers, this performance standard will likely include a total project (*i.e.*, Ellsworth Dam and Graham Lake Dam combined) survival of approximately 90 percent. Lastly, the following requirements are to ensure data collected reflect conditions at the Project.

a) Licensee will develop study design plans in consultation with NMFS and state and federal resource agencies. The licensee must obtain approval from the resource agencies prior to filing with the Commission for final approval.

b) Licensee must conduct all monitoring according to scientifically accepted practices.

c) Licensee shall begin monitoring at the start of the first migratory season after each fishway facility (Atlantic salmon and alosines) is operational and shall continue for up to three years or as otherwise required through further consultation.

d) Licensee shall conduct studies to evaluate the effectiveness of fishways for juvenile and adult life stages of alosines and Atlantic salmon.

e) Licensee shall be provide monitoring study reports to the resource agencies for a minimum 30-day review and consultation prior to submittal to the Commission for final approval.

f) The Licensee shall include resource agencies' comments in the annual reports submitted to the Commission for final review.

7.3.6 Fishway Design Review

The Licensee shall submit design plans to the resource agencies for review and consultation during the conceptual, 30, 60 and 90 percent design stages. Following resource agency approval, the Licensee shall submit final design plans to the Commission for final approval prior to the commencement of fishway construction activities; this filing must include all unaddressed resource agency comments. Once the fishway is constructed, final as-built drawings that accurately reflect the project as constructed should be filed with the U.S. FWS and us.

7.4 RESERVATION OF AUTHORITY

This modified prescription was developed in response to the proposals being considered by the Commission in this proceeding, our current policies and mandates, and our understanding of current environmental conditions at the Project. If any of these factors change over the term of the license, then we may need to alter or add to the measures prescribed in this licensing process. Therefore, we hereby reserve authority under Section 18 of the FPA to prescribe such additional or modified fishways at those locations and at such times as we may subsequently determine are necessary to provide for effective upstream and downstream passage of anadromous fish through the Project facilities, including without limitation, our authority to amend the following fishway prescriptions upon approval by us of such plans, designs, and completion schedules pertaining to fishway construction, operation, maintenance, and monitoring as may be submitted by the Licensee in accordance with the terms of the license articles containing such fishway prescriptions. We propose to reserve authority by requesting that the Commission include the following condition in any license it may issue for the Project:

Pursuant to Section 18 of the Federal Power Act, the licensee shall build the fishways described in the National Marine Fisheries Service' Prescription for Fishways at the Ellsworth Project (FERC No.2727). The Secretary of Commerce reserves his authority to prescribe additional or amended fishways as he may decide are required in the future.

APPENDIX D

U.S. DEPARTMENT OF THE INTERIOR'S SECTION 18 FISHWAY PRESCRIPTIONS[293]

11 Reservation of Authority to Prescribe Fishways

In order to allow for the timely implementation of fishways, including effectiveness measures, the Department reserves its authority through the Commission's inclusion of the following condition in any license(s) it may issue for the Project:

> Pursuant to Section 18 of the Federal Power Act, the Secretary of the Interior herein exercises his authority under said Act by reserving that authority to prescribe fishways during the term of this license and by prescribing the fishways described in the Department of Interior's Prescription for Fishways at the Ellsworth Hydroelectric Project.

12 Prescription for Fishways

Pursuant to Section 18 of the Federal Power Act, as amended, the Secretary of the Department of Interior, as delegated to the Service, hereby exercises his authority to prescribe the construction, operation and maintenance of such fishways as deemed necessary.

Fishways shall be constructed, operated, and maintained to provide safe, timely and effective passage for American eels at the expense of BBHP. To ensure the immediate and timely contribution to the restoration and enhancement of American eel in the Union River upstream of the Ellsworth Project, the following are included and shall be incorporated by BBHP to ensure the effectiveness of the fishways pursuant to section 1701(b) of the 1992 National Energy Policy Act (P.L. 102-486, Title XVII, 106 Stat. 3008).

12.1 TIMING OF PASSAGE IMPLEMENTATION

American eel are currently present in the Union River watershed and at the Ellsworth Project and would benefit from immediate implementation of safe, timely, and effective upstream and downstream passage. The Commission will need to include appropriate license articles requiring preparation of detailed design plans, installation schedules and

[293] On April 22, 2019, the FWS filed a letter indicating that no entity requested a hearing, and no comments were filed, on its preliminary fishway prescription filed April 10, 2018. Thus, FWS states that the April 10, 2018 preliminary fishway prescription should be incorporated, unchanged and unmodified, as the final prescription for fishways under any new license.

studies to evaluate effectiveness of all upstream and downstream measures to be developed in consultation with the Service and other resource agencies. In order to allow for proper consultation with resource agencies and approval by the Commission of all design plans, permanent American eel upstream and downstream passage must be operational no later than 2 years after the date of issuance of a new license.

12.2 DESIGN CRITERIA

12.2.1 Design Population

BBHP will design upstream and downstream fish passage for American eels that is sufficient to pass all available upstream and downstream migrating eels that arrive at the Project.

The total number of upstream migrating American eels reaching the Project dams depends on a number of factors, including the overall efficiency and cumulative losses of eels attempting to migrate upstream. There is also a large commercial glass eel fishery in downstream tidal waters of the Union River, which reduces the abundance of juvenile eels approaching the Ellsworth Dam. The Service does not have a precise estimate of the number of eels that would be expected to use eel passage at the Project. The abundance of silver eels migrating downstream is also uncertain. Mortalities of silver eels passing the Ellsworth Station have been documented in recent years, which indicates that large numbers of eels may be migrating downstream. Passage facilities will increase rates of survival and provide paths for migration for the American eel population of the western Atlantic Ocean and adjacent continental waters and assist towards achieving state and regional management goals.

12.2.2 American Eel Passage Efficiency

BBHP shall operate the Project to minimize the impact of the Project on upstream migration for juvenile American eel that approach the Project tailwater and spillway. Numerical criteria for upstream American eel passage attraction efficiency may be developed by the Service in the future when additional information about eel abundance and movement in the vicinity of the Project becomes available. Once eels have entered the upstream eel ramp, BBHP must conduct testing to ensure that 90 percent move upstream and exit within 24 hours, based upon standard eel ramp evaluation methods developed by the Service and MDMR for eel ramp fishways at Maine hydroelectric projects (FERC No’s. 2555, 2556, 2364, 2365, 2611, 2574, 2322, 2325, 5073, 2942, 2984, 2931, 2941, and 2932). Downstream eel passage must be safe, timely and effective.

12.3 UPSTREAM EEL PASSAGE

Within two years of License issuance, BBHP shall design and construct eel upstream passage ramps at both the Graham and the Ellsworth dam. The exact location of the eel fishways and other design criteria to be determined by the Service following consultation with BBHP and Maine Department of Marine Resources. The design shall be consistent with Service eel passage design criteria contained in the *2017 Fish Passage Engineering Design Criteria Manual* (USFWS 2017).

12.4 DOWNSTREAM EEL PASSAGE

12.4.1 Graham Dam

BBHP shall improve the Graham Reservoir downstream passage surface weir located in the former log sluice bay to provide safe, timely and effective passage for American eel, as well as anadromous fish species. Within two years of license issuance, BBHP shall modify the Alden weir that was tested for salmon passage, or build a comparable uniform acceleration surface bypass weir. The weir shall accommodate at least a 2-foot depth of flow over the full range of lake elevation allowed in the new license. The weir shall remain in place throughout the months of August through October and shall pass the minimum flow required in the new license. The modifications shall be designed subject to final approval by the Service, and the 30 percent, 60 percent, and 90 percent drawings shall be submitted to the Service for review and approval. BBHP may not begin construction without review and approval from the Service. The facility shall be consistent with the Service's 2017 Fish Passage Engineering Design Criteria Manual.

12.4.2 Ellsworth Dam

BBHP shall improve the Ellsworth Station downstream passage facilities to provide safe, timely and effective passage for American eel, as well as anadromous fish species. Following license issuance, BBHP shall shut down all generation nightly (8 PM to 4 AM) from September 1 through October 31 annually to provide out-migrating American eels safe and timely downstream passage. In addition, BBHP shall shutdown all generation nightly (8 PM to 4 AM) in August for three nights following each rain storm exceeding one inch of rain in 24 hours.
Within two years of license issuance, BBHP shall make the following structural modifications for downstream passage of American eel:

1. Install full depth one inch trashracks at the common intakes of units 2, 3 and 4, as either permanent structures or seasonal overlays, during the months of August through October.

2. Modify the existing downstream fish passage entrance to increase total combined flow through the three weirs to 5 percent of maximum station hydraulic capacity (approximately 123 cfs).
3. Realign the end of the downstream migrant fish passage pipe so water discharges downward to the spillway flume and fish do not impact the spillway when exiting the pipe.
4. Modify the spillway flume to eliminate leakage at the sidewalls of the flume and eliminate discharge to ledges at the toe of the dam.

These structural modifications shall be designed in consultation with the resource agencies and are subject to final Service approval.

12.5 FISHWAY OPERATION AND MAINTENANCE

12.5.1 Operating Dates

BBHP shall operate the upstream eel fishway during the months of June through August. BBHP shall operate the downstream bypass weirs during the months of August through October.

12.5.2 Fishway Operation and Maintenance Plan

Within 12 months of license issuance, BBHP will develop a Fishway Operation and Maintenance Plan (FOMP) covering all operations and maintenance of the upstream and downstream fish passage facilities for the Project, including those provided for American eel. The FOMP shall be submitted to the Service for review and approval. Thereafter, BBHP will keep the FOMP updated on an annual basis, to reflect any changes in fishway operation and maintenance planned for the year. If the Service requests a modification of the FOMP, BBHP shall amend the FOMP within 30 days of the request and send a copy of the revised FOMP to the Service. Any modifications to the FOMP by BBHP will require approval by the Service prior to implementation.
BBHP shall provide information on fish passage operations, and Project generating operations that may affect fish passage, upon written request from the Service. Such information shall be provided within 10 days of the request, or upon a mutually agreed upon schedule.

12.6 FISH PASSAGE EFFECTIVENESS MONITORING PLAN

Efficiency testing of both upstream and downstream American eel passage is critical to evaluating the success of the passage structures and operations, diagnosing problems, determining when fish passage modifications are needed, and what modifications are likely to be effective. It is essential to ensuring the effectiveness of fishways over the term of the license, particularly in cases where the changing size of fish populations may also change fish passage efficiency or limit effectiveness.

12.6.1 Upstream American Eel Effectiveness Monitoring

BBHP will develop a Fishway Effectiveness Monitoring Plan (Upstream Plan) in consultation and with the approval of the Service and submit the Upstream Plan to the FERC for approval within six months of license issuance. The Upstream Plan shall include an upstream efficiency study on juvenile American eel at the new upstream eel fishway to determine the upstream passage efficiency of the fishway throughout the upstream migration season.

The Upstream Plan shall include the standard methods required by the Service and MDMR for eel ramp fishways at Maine hydroelectric projects on the Kennebec and Presumspcot Rivers (FERC No's. 2555, 2556, 2364, 2365, 2611, 2574, 2322, 2325, 5073, 2942, 2984, 2931, 2941, and 2932), and other projects. These standard study methods consist of two components; (1) evaluating attraction efficiency to the facility, and (2) evaluating effectiveness passing eels that have entered the upstream eel passage structure. Attraction efficiency shall be assessed with nighttime observations of migrating eels at the Project in comparison to the number of eels passed. Attraction shall be assessed on a minimum of three nights during the first year of operation. Passage effectiveness shall be assessed with captive eels placed in a holding tank at the fishway entrance. A minimum of 100 eels shall be used in the study and 90 percent must pass the fishway within 24 hours. If the 90 percent criterion is not met, then BBHP shall modify the fishway, in consultation with the Service, by changing the substrate, reducing the slope, increasing the attraction water, or modifying the transport flow.

12.6.2 Downstream American Eel Effectiveness Monitoring

BBHP will develop a Downstream Passage Effectiveness Monitoring Plan (Downstream Plan) in consultation and with the approval of the Service and submit the Downstream Plan to the FERC for approval within six months of license issuance. The Downstream Plan shall demonstrate that downstream passage survival is safe, timely and effective. If this passage rate is not met, then BBHP and the Service will assess passage enhancements including, but not limited to, an extended passage season and/or time of day restrictions, 0.75 inch trashrack spacing, a deep bypass gate, or new downstream eel passage facilities based upon angled trash racks. BBHP will implement the solution selected by the Service.

The Service requires that silver eel passage effectiveness monitoring at the two dams be conducted with radio telemetry methods in order to determine migratory delay, route of downstream passage (i.e. via the three surface bypasses, turbines, or spillage), immediate survival, and latent survival.

12.7 FISHWAY INSPECTIONS

BBHP will provide Service personnel and other Service-designated representatives, timely access to the fish passage facilities at the Project and to pertinent Project operational records for the purpose of inspecting the fishways to determine compliance with the Fishway Prescription.