

**FINAL ENVIRONMENTAL ASSESSMENT
FOR
HYDROPOWER LICENSE**

Mattaceunk Hydroelectric Project
FERC Project No. 2520-076
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

APE	area of potential effect
ASF	Atlantic Salmon Federation
B.P.	Before Present
°C	Celsius
CFR	Code of Federal Regulations
cfs	cubic feet per second
Commerce	U.S. Department of Commerce
Commission	Federal Energy Regulatory Commission
CWA	Clean Water Act
CZMA	Coastal Zone Management Act
D2SI	FERC Division of Dam Safety and Inspections
DO	dissolved oxygen
dpi	dots per inch
EA	environmental assessment
EFH	essential fish habitat
ESA	Endangered Species Act
°F	degree Fahrenheit
FERC	Federal Energy Regulatory Commission
FPA	Federal Power Act
FPOMP	Fish Passage Operations and Maintenance Plan
fps	feet per second
fph	feet per hour
FWS	U.S. Fish and Wildlife Service
GIS	geographic information system
GLHA	Great Lakes Hydro America, LLC
HPMP	Historic Properties Management Plan
IAC	Independent Archaeological Consulting, LLC
ILP	Integrated Licensing Process
Interior	U.S. Department of the Interior
Maine DEP	Maine Department of Environmental Protection
Maine DIFW	Maine Department of Inland Fisheries and Wildlife
Maine DMR	Maine Department of Marine Resources
Maine LUPC	Maine Land Use Planning Commission
Maine SHPO	Maine State Historic Preservation Commission Officer
mg/L	milligrams per liter
MW	megawatt
MWh	megawatt-hours
National Register	National Register of Historic Places
NERC	North American Electric Reliability Corporation
NHPA	National Historic Preservation Act
NMFS	National Marine Fisheries Service

NPCC	Northeast Power Coordinating Council, Inc.
NRI	Nationwide Rivers Inventory
PAD	Pre-Application Document
RM	river mile
SCORP	Statewide Outdoor Recreation Plan
SD1	Scoping Document 1
SPP	Species Protection Plan
THPO	Tribal Historic Preservation Officer
TRC	TRC Environmental Solutions
USGS	U.S. Geological Survey

EXECUTIVE SUMMARY

Proposed Action

On August 31, 2016, Great Lakes Hydro America, LLC (GLHA), filed an application for a new license with the Federal Energy Regulatory Commission (Commission or FERC) to continue to operate the Mattaceunk Hydroelectric Project (Mattaceunk Project). The 19.2-megawatt (MW) project is located on the Penobscot River in Aroostook and Penobscot Counties, Maine, within the towns of Medway, Woodville, Mattawamkeag, and the unorganized township of Molunkus. The project sits about 67 miles upstream of Bangor, Maine. The project does not occupy federal land.

Project Description and Operation

The Mattaceunk Project consists of: (1) a 1,060-foot-long, 45-foot-high dam (Weldon Dam) with a variable crest elevation; (2) a 1,664-acre impoundment with a total storage capacity of 20,981 acre-feet at a normal pool elevation of 240.0 feet USGS datum;¹ (3) an overflow spillway with a permanent crest elevation of 236.0 feet and a flashboard crest elevation of 240.0 feet when equipped with 4-foot-high wooden flashboards; (4) an upstream pool and weir fishway; (5) an intake with trash racks that have 1-inch clear bar spacing covering the top 16 feet (at normal pool) and 2.63-inch bar spacing at depths greater than 16 feet; (6) a downstream surface bypass fishway; (7) a 142-foot-long, 99-foot-wide powerhouse (Weldon Station) integral to the dam containing two Kaplan and two fixed blade propeller turbine/generating units with a combined capacity of 19.2 megawatts; (8) a substation adjacent to the powerhouse; (9) a 9-mile-long, 34.5-kilovolt (kV) transmission line; and (10) appurtenant facilities.

Project recreation facilities include a canoe portage on the west side of the dam and a fishing access area located downstream of the dam on the east bank of the river that includes a small picnic shelter, stairs to access the tailrace for fishing, and parking.

The Mattaceunk Project is operated in a run-of-river mode with year-round use of 4-foot-high flashboards.² GLHA maintains the impoundment surface elevation within

¹ All elevation data are referenced to USGS datum, unless noted otherwise.

² GLHA refers to project operation as run-of-river with pondage. Rather than use the term “pondage” in this final environmental assessment (EA), we specifically describe GLHA’s use of the flashboards.

Pondage refers to the ability of the project to raise the impoundment above the crest of the dam by using flashboards. Although a prior order indicates that the project would be able to operate under a peaking mode, Great Northern Nekoosa Corporation, 55

1.0 foot of the flashboard crest elevation of 240.0 feet when the 4-foot-high flashboards are in place. In contrast, the existing license requires GLHA to maintain an impoundment surface elevation no lower than 2.0 feet below the top of flashboard elevation of 240.0 feet when the flashboards are in place to allow an adequate margin for debris loads, ice loads, or sudden pool increases that might cause flashboard failure. The existing license also requires GLHA to maintain an impoundment surface elevation no lower than 1.0 foot below the dam crest elevation of 236.0 feet when the flashboards are down (for flashboard repairs).

The existing license also requires a year-round, continuous, minimum flow to the tailrace of 1,674 cubic feet per second (cfs) or inflow, whichever is less. Depending on the season, the existing license requires a daily average minimum flow of 2,392 cfs or inflow, if less, from July 1 through September 30 and of 2,000 cfs or inflow, if less, from October 1 through June 30. The project generates about 123,332 megawatt-hours (MWh) annually. No changes to the project's current mode of operation are proposed.

GLHA operates the upstream pool and weir fishway annually from May 1 to November 10 for Atlantic salmon adults, by providing flows through the fishway that consist of a 6- to 8-cfs transport flow with an additional attraction flow of 7 cfs at the entrance to the fishway. At turbine intakes 3 and 4, GLHA operates the downstream surface bypass fishway at its maximum flow capability (140 cfs) to provide downstream passage for Atlantic salmon smolts (outmigrating juveniles) and kelts (outmigrating, post-spawning adults) from April 1 to June 15 and only kelts from October 17 to December 1. Turbines 3 and 4 are the first units on and the last units off whenever the downstream bypass is operational to reduce entrainment of smolts and kelts through turbine intakes 1 and 2, where there is no surface bypass.

Proposed Environmental Measures

GLHA proposes the following measures to protect or enhance environmental resources:

- Install and maintain, on a seasonal basis, an upstream American eel (eel) ladder within 2 years of the effective date of the new license;
- Monitor the upstream eel ladder for use and effectiveness for one passage season;

FERC ¶ 61,472 (1991), the project has never been operated in a peaking mode, nor has there ever been a proposal to operate in a peaking mode.

- Provide downstream passage for eel by implementing annual nighttime turbine shutdowns (8:00 pm to 4:00 am), for a 6-week period between August 15 and October 31,³ in combination with opening the project’s roller gate and installing full-depth trash racks with 1-inch clear bar spacing (see measures included in the Species Protection Plan for Atlantic salmon), beginning the first passage season following license issuance;
- Monitor, for two passage seasons, the effectiveness of the downstream eel passage measures;⁴
- Install an upstream fishway for American shad, blueback herring, and alewife (alosines,⁵ collectively) in year 15 of a new license, expected to be operational in year 16 of a new license;
- Monitor the use and effectiveness of the upstream fishway for alosines for 2 years, following its completion;
- Provide downstream passage for alosines after the upstream fishway for alosines is operational (expected in year 16), by: (1) extending the operation of the existing downstream fish bypass such that it operates continuously from April 1 to December 1; and (2) by opening the log sluice (and releasing between 3 percent [225 cfs] and 9 percent [690 cfs] of the station’s hydraulic capacity) from June 1 to December 1, as needed for alosines, based on monitoring results;
- Monitor, for 2 years, the use of existing downstream passage structures by alosines (including the surface bypass and log sluice), once the new upstream fishway for alosines is operational;
- Implement additional operational and structural modifications and/or habitat enhancement measures to provide eel and alosine passage, if the proposed passage measures for eel and alosines are ineffective;

³ GLHA would develop the annual schedule in consultation with the resource agencies, and based on a predictive model for eel movement through the project.

⁴ We assume GLHA’s proposal to monitor the downstream eel passage measures for 2 years constitutes the monitoring effort that would be undertaken to support development of a predictive model for establishing the turbine shutdown period.

⁵ Throughout this final EA, the term “alosines” is used to collectively refer to American shad, blueback herring, and alewife.

- Continue to implement the Fish Passage Operations and Maintenance Plan (FPOMP), which defines the: (1) operational period for the existing upstream and downstream fishways; (2) annual start-up and shut-down procedures; (3) opening methods; (4) debris management; and (5) safety rules and procedures;
- Continue to operate and maintain the upstream fishway annually from May 1 to November 10 for adult Atlantic salmon, including the 7-cfs attraction flow at the fishway entrance;
- Monitor the upstream fishway and count the number of adult Atlantic salmon passing upstream of the project, using a methodology developed in consultation with resource agencies, to provide an estimate of the number of returning spawners;
- Continue to maintain and operate the downstream surface bypass to provide downstream passage for Atlantic salmon smolts and kelts from April 1 to June 15, and only kelts from October 17 to December 1;
- Implement a Species Protection Plan (SPP) for the federally endangered Atlantic salmon to meet a performance standard of 95 percent effectiveness for upstream passage of adults and 96 percent survival for downstream passage of smolts and kelts, including measures to:
 - (1) coordinate with resource agencies to stock uniquely marked smolts upstream of Weldon Dam in the first 3 years after relicensing to serve as a source of upper-Penobscot-imprinted adult salmon used for studying upstream passage of adults and downstream passage of kelts;
 - (2) conduct up to 3 years of upstream fishway effectiveness monitoring for adults and up to 3 years of downstream passage monitoring for kelts, using the returning, imprinted adult salmon;
 - (3) use trash racks that would have 1-inch clear bar spacing to the full depth of the turbine intakes, and within 2 years after relicensing, be installed seasonally during the downstream migration of eel, alosines, and Atlantic salmon;
 - (4) open the project's log sluice (between 3 percent [225 cfs] and 9 percent [690 cfs] of the station's hydraulic capacity) starting the first passage season following relicensing to provide additional downstream passage for smolts for a 3-week period during the spring that would be determined in consultation with the resource agencies;
 - (5) conduct a minimum of 3 years of monitoring to evaluate the effectiveness of existing passage operations and additional measures (installation of the full-depth trash rack with 1-inch clear bar spacing

and operation of the log sluice), in passing smolts downstream past the dam;

- (6) conduct a study to evaluate the smolt mortality in the project impoundment;
- (7) implement adaptive management that would include additional operational, structural, and/or habitat enhancement measures, if necessary, to improve passage and/or address performance criteria for upstream and downstream migrating Atlantic salmon;

- Continue to operate and maintain the project recreation facilities including: (1) a canoe portage trail; and (2) a downstream angler access area with a parking area, stairs leading to the tailrace area, and a covered picnic area;
- Implement recreation facility improvements at the existing downstream angler access area including: (1) a pulley system to help visitors move their boats between the parking area and river; and (2) a wheelchair ramp to provide access to the picnic facilities; and
- Develop a Historic Properties Management Plan (HPMP) to protect archaeological and historic architectural resources eligible for listing on the National Register of Historic Places (National Register), including the project's dam and powerhouse.

Public Involvement and Areas of Concern

Before filing its license application with the Commission, GLHA conducted pre-filing consultation in accordance with the Commission's Integrated Licensing Process. The intent of the Commission's pre-filing process is to involve the public early in the project planning process and to encourage citizens, governmental entities, tribes, and other interested parties to identify and resolve issues prior to an application being formally filed with the Commission. As part of the pre-filing process, staff conducted scoping to identify issues and alternatives. Staff distributed a scoping document to stakeholders and other interested entities on May 1, 2013. Scoping meetings were held in Medway, Maine, on June 5, 2013. A revised scoping document was issued on August 9, 2013.

GLHA filed its license application on August 31, 2016. On March 24, 2017, the Commission issued a public notice accepting the application and soliciting motions to intervene and protests, stating that the application was ready for environmental analysis, and requesting comments, terms and conditions, recommendations, and prescriptions.

The primary issues associated with relicensing the project are upstream and downstream fish passage (for Atlantic salmon, eel, and alosines) and cultural resources.

Alternatives Considered

This final EA considers the following alternatives: (1) GLHA's proposal, as outlined above; (2) GLHA's proposal with staff modifications (staff alternative); (3) the staff alternative with mandatory conditions; and (4) no action, meaning continued operation of the project with no changes.

Staff Alternative

Under the staff alternative, the project would be operated and maintained as proposed by GLHA, except that the following 11 measures proposed by GLHA are not included under the staff alternative: (1) monitoring downstream eel passage measures for two passage seasons; (2) installation of an upstream fishway for alosines in year 15; (3) monitoring the upstream fishway for alosines; (4) providing downstream passage for alosines; (5) monitoring the downstream passage structures for alosines; (6) implementing additional operational and structural modifications and/or habitat enhancement measures, without final Commission approval, to provide eel and alosine passage; (7) counting the number of adult Atlantic salmon passing upstream of the project; (8) using full-depth trash racks with 1-inch clear bar spacing during the downstream passage season for Atlantic salmon; (9) reevaluating upstream and downstream passage effectiveness for Atlantic salmon every 10 years; (10) conducting a study to evaluate smolt mortality in the project impoundment; and (11) implementing additional operational, structural, and/or habitat enhancement measures, without final Commission approval, to improve passage for upstream and downstream migrating Atlantic salmon. The staff alternative includes the remaining measures proposed by GLHA with some modifications, and additional staff-recommended measures, some of which are fishway prescriptions filed by Interior and NMFS.

The additional and modified measures included in the staff alternative are summarized below.

- Develop an operation compliance monitoring plan to document compliance with the proposed operations described above (i.e., run-of-river operation, limited impoundment fluctuations, and minimum flows) for the protection of aquatic resources in the impoundment and downstream of the dam;
- Monitor the effectiveness of the downstream eel passage measures for three passage seasons from August 1 through October 31;
- Develop individual monitoring plans for upstream and downstream eel passage, as required by Interior's fishway prescription, that include:
 - (1) the goals and objectives of the monitoring;
 - (2) performance criteria for determining the success of the eel passage measures;

- (3) the methodology used to monitor the effectiveness and efficiency of the upstream and downstream passage measures to pass eel;
- (4) provisions for reporting the results of the monitoring (i.e., development of a report) and consulting with the agencies regarding the results (including an annual meeting); and
- (5) a provision to identify and implement (upon Commission approval)
 - (a) additional monitoring studies; or (b) operational and structural modifications and/or habitat enhancement measures to provide eel passage, if, after 1 year of upstream monitoring and 3 years of downstream monitoring, the proposed passage measures for eel are ineffective at achieving the upstream and downstream effectiveness and survival performance criteria.
- Modify the FPOMP to include additional provisions for:
 - (1) performing routine maintenance before the migration season, such that the existing fishways would be fully operational during the migratory period;
 - (2) clearing debris from the trash racks of all turbine intakes prior to the migration season, and identify, with final Commission approval, the frequency of debris clearing during the migration season;
 - (3) monitoring flows in the downstream bypass pipe to detect debris blockages using a method approved by the Commission;
 - (4) clearing debris from the downstream bypass pipe when blockages are detected;
 - (5) procedures for filing with the Commission for informational purposes, an annual report on the operation of the existing fishways and on project generation;
 - (6) developing shutdown procedures for the existing fishways; and
 - (7) developing procedures for operation and maintenance of the existing fishways during emergencies and project outages;
- Operate the proposed upstream eel ladder for a “shakedown” period subsequent to installation, and prior to the passage season and pertinent effectiveness studies to ensure it is operating as designed, and to make minor adjustments to facilities and operations, as needed;
- Modify the SPP for the federally endangered Atlantic salmon to include the following additional provisions:
 - (1) remove the provision to seasonally install trash racks with 1-inch clear bar spacing to the full depth of the turbine intakes for the purpose of protecting smolts and kelts;
 - (2) revise, with final approval from the Commission, the upstream passage effectiveness study methodology to include the type of telemetry tag to be

- used on upstream migrating adults and the appropriate timing for stocking tagged smolts, and refile the SPP with the revised study plan;
- (3) include the proposed passage effectiveness study plans as attachments to the SPP;
 - (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 95 percent performance standard after the first year;
 - (5) determine the need for future effectiveness studies or measures, with final approval from the Commission, if after 3 years of upstream passage effectiveness studies, the upstream fishway does not meet the 95 percent effectiveness performance standard;
 - (6) revise the number of downstream passage effectiveness studies for smolts to indicate that a minimum of 3 years of study would be conducted;
 - (7) revise the criteria for achieving the downstream performance standard for smolts to state that the standard would be considered achieved if a total of 3 years of effectiveness studies for smolts demonstrate that the downstream passage structures meet a 96 percent survival performance standard;
 - (8) determine, with final approval from the Commission, when to begin implementation of phased spill measures for downstream passage of smolts, with the restriction that phased spill measures would be implemented after a minimum of 1 year and a maximum of 3 years of conducting downstream passage survival studies for smolts, and non-spill passage measures;
 - (9) determine, with final approval from the Commission, the 3-week period during which any log sluice or phased spill measures would occur for downstream passage of smolts;
 - (10) determine the need for an additional 1 or 2 years of downstream passage effectiveness studies for kelts, with final approval from the Commission, if the downstream passage structures meet the 96 percent survival performance standard for kelts after the first year;
 - (11) determine the need to conduct at least 1 year of additional effectiveness study, with final approval from the Commission, if the downstream passage structures do not meet the 96 percent survival performance standard for kelts after the first year;
 - (12) determine the need for future effectiveness studies, and/or downstream passage measures, with final approval from the Commission, if after 3 years of downstream passage effectiveness studies, the downstream passage structures do not meet the 96 percent survival performance standard for kelts;
 - (13) remove the provision to conduct a study to evaluate smolt mortality in the project impoundment;
 - (14) remove the provisions requiring reevaluation of upstream and downstream passage effectiveness every 10 years; and

(15)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.

- Develop an SPP for the federally threatened northern long-eared bat that limits non-hazardous tree removal to the period of November 1 through March 31, which is outside the pup season (June 1 to July 31), and the broader active season (April 1 to October 31).

Staff Alternative with Mandatory Conditions

The staff alternative with mandatory conditions includes all the measures included in the staff alternative, with the addition of all of the section 18 fishway prescriptions filed by Interior (Appendix C) on May 23, 2017⁶ and NMFS (Appendix D) on June 28, 2018.

No-action Alternative

Under the no-action alternative, GLHA would continue to operate the project with no changes. No new environmental protection, mitigation, or enhancement measures would be implemented.

Environmental Effects of the Staff Alternative

Geology and Soils Resources

Continuing to operate the project in run-of-river mode would continue to minimize fluctuations of impoundment water levels, and maintain stable shorelines and cause no measureable shoreline erosion. Limited fluctuations of impoundment levels would also limit the re-suspension or release of impounded sediment, minimizing turbidity and sedimentation to downstream habitats.

Aquatic Resources

Operating the project in run-of-river mode would continue to maintain water quality at levels that protect aquatic resources in the impoundment and downstream. Operating with minimal fluctuations of the impoundment would protect smallmouth bass

⁶ Interior filed a letter on June 27, 2018, indicating that its preliminary fishway prescriptions filed on May 23, 2017, should be included in the license as its final fishway prescriptions.

spawning habitat. Maintaining continuous minimum flows to the tailrace of 1,674 cfs, a daily average minimum flow of 2,392 cfs from July 1 through September 30, and a daily average minimum flow of 2,000 cfs from October 1 through June 30, would maintain water depths and flow conditions downstream that are protective of fish and benthic macroinvertebrates. Further, the development of an operation compliance monitoring plan would help to document that run-of-river operation and downstream minimum flows are maintained as required in any new license that may be issued.

Installing and operating an upstream eel ladder at the project would allow juvenile eels to safely and efficiently pass Weldon Dam and access habitat upstream of the dam. Providing downstream eel passage would reduce the entrainment and impingement mortality of downstream migrating adult eels. Evaluating the effectiveness of the proposed upstream and downstream eel passage measures would help to ensure that the eel passage facilities/measures work effectively, while minimizing generation losses at the project. Finally, implementing an operation and maintenance plan(s) for upstream and downstream eel passage facilities/measures would help support proper function of the eel passage facilities.

Terrestrial Resources

Continuing to operate the project in run-of-river mode would maintain riparian habitat used by wildlife upstream of the dam. Run-of-river operation would also limit fluctuations downstream from the dam, which would protect against erosion and sedimentation, and maintain stable riparian habitat.

Threatened and Endangered Species

One federally listed species occurs (Atlantic salmon) and two federally listed species potentially occur (Canada lynx, and northern long-eared bat) in the Mattaceunk Project vicinity. In addition, the Mattaceunk Project sits within designated critical habitat for Atlantic salmon, but no critical habitat for Canada lynx or northern long-eared bat occurs in the project area.

Atlantic salmon currently migrate upstream and downstream of the Mattaceunk Project using the existing upstream pool and weir fishway and the existing downstream surface bypass, respectively. Continuing to operate the project in a run-of-river mode would maintain the existing good water quality and flow conditions, providing cool oxygenated water and run-of-river flows to support the migration of salmon through the impoundment and downstream, and would maintain the natural cues needed to trigger the smolt migration to sea. This operational mode would also continue to protect water quality and downstream habitat (i.e., flow and bottom substrate) suitable for spawning and rearing of Atlantic salmon.

Continuing to operate the project with the drawdown limits discussed above would prevent rapid fluctuations of the impoundment, which would prevent stranding of salmon in the impoundment and would maintain aquatic vegetation along shallow areas of the impoundment, which can serve as temporary resting areas during the upstream migration of adult salmon. Further, continuing to maintain the minimum flows discussed above would help to maintain suitable water depths downstream of the project for the migration of Atlantic salmon and prevent dewatering of migratory, spawning, and rearing habitat. Developing an operation compliance monitoring plan would provide a means for documenting the operational requirements of the license, including those measures meant to protect Atlantic salmon.

Continuing to operate the existing upstream fishway for Atlantic salmon during the migration season would provide the necessary passage to spawning habitat located upstream of the project. Continuing to operate the downstream fish bypass for smolts and kelts during the migration season would provide passage to downstream habitats and access to the sea, which is needed for continued growth and development. Operating the log sluice for a 3-week period during the spring would provide an additional safe passage route for smolts to help improve downstream passage. In addition, GLHA's adherence to the FPOMP, with staff modifications, would ensure that the existing upstream and downstream fish passage facilities are maintained and operated to maximize passage effectiveness for Atlantic salmon.

Implementing the proposed SPP for Atlantic salmon, with the staff-recommended modifications, would provide the necessary measures to assess the effectiveness of the upstream and downstream fishways, and implement any measures needed to meet passage performance standards for Atlantic salmon. Specifically, conducting up to 3 years of upstream effectiveness studies for adult Atlantic salmon would help determine whether the upstream fishway is able to meet a performance standard of 95 percent effectiveness. However, if the existing upstream fishway is not able to meet the performance standard, structural and/or operational modifications could be implemented, upon additional Commission approval where necessary, through adaptive management until upstream passage meets the performance standard. Maintaining upstream passage at the 95 percent performance standard, would improve upstream passage effectiveness by up to 24 percent over existing levels, allowing a greater proportion of salmon to spawn, which would help in the recovery of the population.

The SPP for Atlantic salmon would also include provisions for conducting a minimum of 3 years of downstream passage effectiveness studies for smolts, which would help determine whether the existing bypass and addition of the log sluice operations would be able to meet a performance standard of 96 percent survival for smolts. In addition, conducting up to 3 years of downstream passage effectiveness studies for kelts would help determine whether the addition of log sluice operations is able to maintain downstream survival of kelts at 96 percent. However, if these passage

measures are not able to meet the performance standards, structural and/or operational modifications could be implemented, upon additional Commission approval, where necessary, through adaptive management until downstream passage for smolts and kelts meets the performance standard.

In spite of the benefits of the measures discussed above, project operation would likely result in the take of some Atlantic salmon smolts and kelts as they attempt to migrate downstream past the project. Therefore, continued operation may affect, and is likely to adversely affect, Atlantic salmon. In addition, with GLHA's proposed SPP for Atlantic salmon with additional modifications, including proposed improvements to upstream and downstream passage to meet specific 95 percent upstream passage effectiveness and 96 percent downstream survival, 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.

The federally threatened Canada lynx and the federally threatened northern long-eared bat are listed as potentially occurring in the project area. However, the preferred habitat for Canada lynx and its preferred prey (snowshoe hare) is sparse in the project area, and, thus, project operation is unlikely to affect the lynx. Summer roosting and foraging habitat for the northern long-eared bat is present in the project boundary, and the project is located inside the white-nose syndrome zone of the northern long-eared bat. Project maintenance activities during the term of a new license could require periodic removal of non-hazardous trees in the project boundary. The staff-recommended SPP for northern long-eared bat would limit non-hazardous tree removal to November 1 through March 31, which is outside of the northern long-eared bat pup season (June 1 – July 31), as well as the broader active season (April 1 – October 31) and therefore, project maintenance would not be likely to adversely affect the northern long-eared bat. Based on available information, relicensing the project would have no effect on the Canada lynx.

Recreation

Continued operation and maintenance of the project's canoe portage and downstream angler access area would protect boating and fishing opportunities in the Penobscot River near the project. The proposed facility enhancement measures for the downstream angler access area would improve access to the project's recreation amenities for persons with disabilities, as well as increase the ease of boater access to the project's tailrace.

Cultural Resources

Continued operation and maintenance of the project has the potential to adversely affect resources that are eligible for listing on the National Register, including Weldon Dam and the Roy V. Weldon Power Station. Developing an HPMP in consultation with

the Maine State Historic Preservation Officer (Maine SHPO) and Penobscot Indian Nation Tribal Historic Preservation Officer (THPO) would help protect historic properties from the effects of operating and maintaining the project over the term of a new license by directing the licensee to avoid, minimize, or mitigate activities that could affect the integrity or significance of a historic property.

No Action Alternative

Under the no-action alternative, the project would continue to operate as it has in the past. None of the proposed or recommended measures would be implemented, and there would be no enhancement of environmental resources.

License Conditions

The application was prepared under the Integrated Licensing Process (ILP), and, therefore, this EA includes draft license articles (see Appendix A).⁷

Conclusion

Based on our analysis, we recommend licensing the project as proposed by GLHA, with staff modifications and additional measures.

In Section 4.2, *Comparison of Alternatives*, we estimate the likely cost of alternative power for each of the four alternatives identified above. Our analysis shows that during the first year of operation under the no-action alternative, project power would cost \$1,026,122 (or \$8.32/MWh) less than the cost of alternative generation. Under the proposed action alternative, project power would cost \$1,524,041 (or \$13.10/MWh) more than the likely cost of alternative power. Under the staff alternative, project power would cost \$101,483 (or \$0.90/MWh) more than the likely cost of alternative power. Under the staff alternative with mandatory conditions, project power would cost \$705,871 (or \$6.26/ MWh) more than the likely cost of alternative power.

We chose the staff alternative as the preferred alternative because: (1) the project would continue to provide a dependable source of electrical energy for the region (112,759 MWh annually); (2) the 19.2 MW of electric capacity comes from a renewable resource that does not contribute to atmospheric pollution, including greenhouse gases; and (3) the recommended environmental measures proposed by GLHA, and additional measures recommended by staff, would adequately protect and enhance environmental resources affected by the project. The overall benefits of the staff alternative would be worth the cost of the proposed and recommended environmental measures. Therefore, issuing a new license for the project, with the environmental measures we recommend,

⁷ 18 C.F.R §5.25(b) (2017).

would not be a major federal action significantly affecting the quality of the human environment.

FINAL ENVIRONMENTAL ASSESSMENT

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

MATTACEUNK HYDROELECTRIC PROJECT Project No. 2520-076 - Maine

1.0 INTRODUCTION

1.1 APPLICATION

On August 31, 2016, Great Lakes Hydro America, LLC (GLHA) filed an application with the Federal Energy Regulatory Commission (Commission or FERC) for a new license to continue to operate and maintain the existing Mattaceunk Hydroelectric Project (Mattaceunk Project). The 19.2-megawatt (MW) project is located on the Penobscot River, in Aroostook and Penobscot Counties, Maine, within the towns of Medway, Woodville, Mattawamkeag, and the unorganized township of Molunkus. The Mattaceunk Project sits about 67 miles upstream of Bangor, Maine (figure 1). It does not occupy federal land.

1.2 PURPOSE OF ACTION AND NEED FOR POWER

1.2.1 Purpose of Action

The purpose of the Mattaceunk 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 GLHA for the Mattaceunk Project 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 enhancement of fish and wildlife resources; (3) the protection of recreational opportunities; and (4) the preservation of other aspects of environmental quality.

Issuing a license for the Mattaceunk Project would allow GLHA to continue 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 final environmental assessment (EA) assesses effects associated with operation of the project, alternatives to operating and maintaining the project, and makes recommendations to the Commission on whether to issue a license, and under what terms and conditions.

In this final EA, we assess the environmental and economic effects of operating and maintaining the project: (1) as proposed by the applicant; (2) the applicant's proposal with our recommended measures (staff alternative); and (3) the staff alternative with mandatory conditions. We also considered the effects of the no-action alternative. The primary issues associated with relicensing the project are upstream and downstream passage for Atlantic salmon, American eel (eel), American shad, alewife, and blueback herring (alosesines, collectively), and cultural resources.

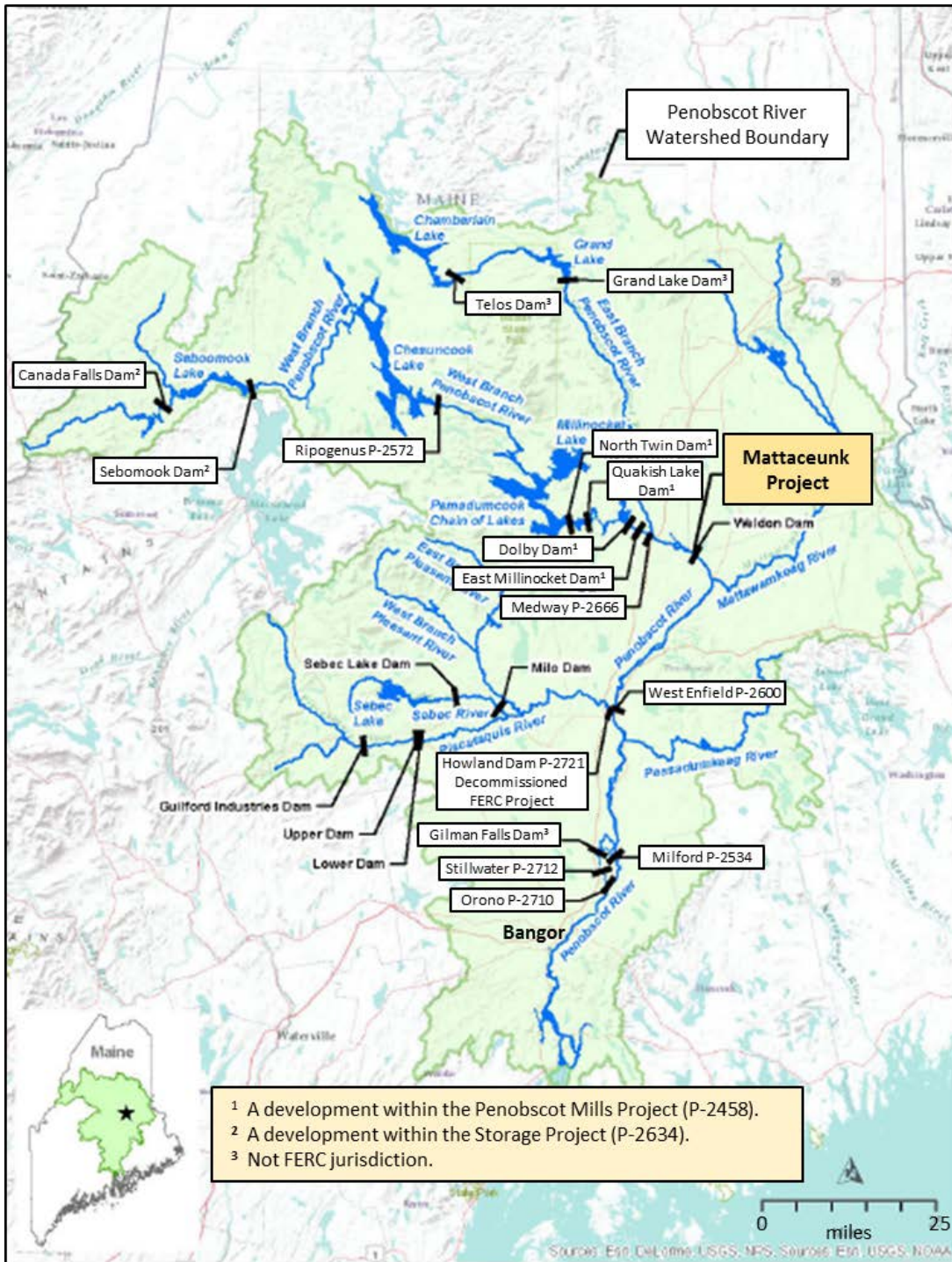


Figure 1. Location of the Mattaceunk Project and other dams in the Penobscot River Basin.
(Source: GLHA, as modified by staff)

1.2.2 Need for Power

The power generated is sold to the Independent System Operator of New England. To assess the need for power, we looked at the needs in the operating region in which the project is located.

The Mattaceunk Project provides power that helps meet part of the region's power requirements, resource diversity, and capacity needs. The project has an installed capacity of 19.2 MW, and generates an average of about 123,332 megawatt-hours (MWh) per year.

The North American Electric Reliability Corporation (NERC) annually forecasts electrical supply and demand nationally and regionally for a 10-year period. The Mattaceunk Project is located within the Northeast Power Coordinating Council's New England region (NPCC-New England) of the NERC. According to NERC's most recent forecast in December 2016, the summer demand for this region is projected to increase by 0.21 percent from 2016 to 2025.

We conclude that power from the Mattaceunk Project helps to meet the need for power in the NPCC-New England region, in both the short and long term. 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

Any 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 states that the Commission is to require 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 May 23, 2017, the National Maine Fisheries Service (NMFS), on behalf of Commerce, and Interior, on behalf of the U.S. Fish and Wildlife Service (FWS), each timely filed a preliminary fishway prescription for the project to include certain fish passage measures and a request that the Commission include a reservation of authority to prescribe fishways under section 18 in any license issued for the project.

On June 27, 2018, FWS filed a letter indicating that no entity requested a hearing, and no comments were filed, on its preliminary fishway prescription filed May 23, 2017. Thus, FWS states that the May 23 preliminary fishway prescription should be incorporated, unchanged and unmodified, as the final prescription for fishways under the new license. On June 28, 2018, NMFS filed its modified fishway prescription for fishways under the new license. The agencies' final and modified fishway prescriptions are summarized in section 2.3, *Modifications to Applicant's Proposal – Mandatory Conditions*, and included in Appendix C (Interior) and Appendix D (NMFS).

1.3.1.2 Section 4(e) Conditions

Section 4(e) of the FPA provides that any license issued by the Commission for a project within a federal reservation shall be subject to and contain such conditions as the Secretary of the responsible federal land management agency deems necessary for the adequate protection and use of the reservation. On May 23, 2017, Interior, on behalf of the Bureau of Indian Affairs (BIA), requested to reserve authority under section 4(e) of the FPA. On July 17, 2017, the Commission issued a request for additional information to clarify the federal reservation for which the reservation of authority applied. On August 11, 2017, BIA replied stating that the boundaries of the Penobscot Reservation and the Penobscot Indian Nation's hunting, fishing, and gathering rights in the waters of the Penobscot River are currently the subject of federal court litigation. On September 23, 2017, BIA provided additional information and indicated that the Penobscot Indian Nation may own the bed of the Penobscot River in fee simple, having never ceded the rights to the bed in treaties with the state (Roy, 2014). We make no claims about the validity of the study provided by BIA; ownership of the river bed is contested, as described in BIA's comments filed on August 11, 2017. However, as a general matter, we note that lands owned in fee simple by a tribe without federal property interest do not constitute a federal reservation under section 4(e) of the FPA. Rather, such lands are treated similarly to other privately-owned lands.⁸

1.3.1.3 Section 10(j) Recommendations

Under section 10(j) of the FPA, 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

⁸ See *Federal Power Commission v. Tuscarora Indian Nation*, 352 U.S. 99, 111-115 (1960).

inconsistency with the agency, giving due weight to the recommendations, expertise, and statutory responsibilities of such agency.

On May 22, 2017, the Maine Department of Marine Resources (Maine DMR) filed timely recommendations under section 10(j). In addition, on May 23, 2017, Interior and NMFS filed timely recommendations under section 10(j). These recommendations are summarized in table 25, and discussed in section 5.3, *Summary of Section 10(j) Recommendations*. In section 5.3, 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 (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 1 year, after receipt of such request.

On May 22, 2017, GLHA applied to the Maine Department of Environmental Protection (Maine DEP) for section 401 certification for the Mattaceunk Project. Maine DEP received this request on the same day. On April 27, 2018, GLHA withdrew and refiled its certification application, which Maine DEP received on the same day. Maine DEP has not yet acted on the application. The certification is due April 27, 2019.

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. During the consultation process, FWS indicated to GLHA that there are three federally listed species known to occur in the Mattaceunk Project vicinity, the endangered Gulf of Maine Distinct Population Segment of Atlantic salmon (*Salmo salar*), the threatened Canada lynx (*Lynx canadensis*), and the threatened northern long-eared bat (*Myotis septentrionalis*).

On November 2, 2017, we accessed FWS's Information, Planning, and Conservation (IPaC) System to determine which federally listed species occur in the project vicinity. According to the IPaC database, the following species potentially occur in the project area: endangered Atlantic salmon, threatened Canada lynx, and threatened

northern long-eared bat.⁹ In addition, designated critical habitat for Atlantic salmon occurs within the project boundary. No critical habitat for Canada lynx is present in the project boundary, and no critical habitat is designated for the northern long-eared bat; however, the project is located within the white-nose syndrome buffer zone for the this species.

Our analysis of project impacts on the Canada lynx, northern long-eared bat, and Atlantic salmon is presented in section 3.3.3.2, *Threatened and Endangered Species*. Based on available information, we conclude that relicensing the project would have no effect on the Canada lynx, and is not likely to adversely affect the northern long-eared bat. We are requesting FWS concurrence with our finding for northern long-eared bat.

In section 3.3.2.2, we also conclude that relicensing the project and its operation may affect, and is likely to adversely affect, the Atlantic salmon, but is not likely to adversely affect the designated critical habitat for the GOM DPS of Atlantic salmon. We requested formal consultation with NMFS on March 15, 2018. On April 12, 2018, NMFS filed a letter stating that the action on which we requested consultation was unclear, and therefore, it would not initiate formal consultation until it receives clarification. On August 8, 2018, we sent a letter to NMFS clarifying that the proposed action on which we requested consultation was the staff alternative with mandatory conditions. We are awaiting NMFS's biological opinion.

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(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.

In an email dated October 29, 2012,¹⁰ the Maine Department of Agriculture, Conservation, and Forestry stated that the Mattaceunk Project is not located within

⁹ See Interior's official list of threatened and endangered species accessed by staff using the IPaC website (<https://ecos.fws.gov/ipac/>) on November 2, 2017, and filed on November 3, 2017.

¹⁰ See Appendix E-1 of final license application.

Maine's coastal boundary and would not affect Maine's coastal resources. Therefore, the project does not require certification of consistency with Maine's CZMA Program.

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 May 1, 2013, the Commission designated GLHA as its non-federal representative for the purposes of conducting section 106 consultation under the NHPA. Pursuant to section 106, and as the Commission's designated non-federal representative, the applicant consulted with the Maine Historic Preservation Commission (Maine SHPO) and potentially affected Indian tribes 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 one archeological site and portions of the project's facilities as eligible for listing on the National Register.

In the license application, GLHA proposes to develop a Historic Properties Management Plan (HPMP) in consultation with the Maine SHPO and the Penobscot Indian Nation. 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.

To meet the requirements of section 106 of the NHPA, we intend to execute a Programmatic Agreement (PA) with the Maine SHPO for the protection of historic properties from the effects of continued operation and maintenance of the Mattaceunk Project. The terms of the PA would ensure that GLHA addresses and treats all historic properties identified within the project's APE through the finalization of its proposed 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," which includes the project area.

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 staff's recommended measures, would provide a net benefit to EFH, and improve access for Atlantic salmon to areas containing EFH. Therefore, over the long term, aquatic habitat and EFH would be enhanced under the applicant's proposal with the additional staff modifications and measures discussed in section 5.1, *Comprehensive Development and Recommended Alternative*. We conclude that relicensing the project, as proposed and with staff's recommended measures, would not adversely affect EFH. As such, no consultation is required with NMFS.

1.4 PUBLIC REVIEW AND COMMENT

The Commission's regulations (18 C.F.R. §§ 5.1 to 5.16) 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. §§ 661-667e), the ESA, the NHPA, and other federal statutes. Pre-filing consultation must be completed and documented according to the Commission's regulations.

Relicensing of the project was formally initiated March 1, 2013, when GLHA filed with the Commission a Pre-Application Document (PAD) and a Notice of Intent to license the project using the Integrated Licensing Process (ILP). The Commission issued a Notice of Commencement of Proceeding on May 1, 2013.

1.4.1 Scoping

Before preparing this EA, we conducted scoping to determine what issues and alternatives should be addressed. During the pre-filing consultation process, scoping meetings were held to determine what issues and alternatives should be addressed in the EA. Scoping Document 1 (SD1) was issued on May 1, 2013. Scoping meetings were held in Medway, Maine, on June 5, 2013, to request comments on the project. 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. An environmental site review was also held on June 5, 2013.

In addition to comments provided at the scoping meetings, the following entities provided written comments pertaining to SD1, the PAD, and additional study needs:

<u>Commenting Entity</u>	<u>Date Filed</u>
Maine DMR	June 24, 2013
GLHA	June 25, 2013
Maine DEP	June 27, 2013
NMFS	June 28, 2013

FWS	July 1, 2013
Maine Department of Agriculture, Conservation, and Forestry (Maine DACF)	July 1, 2013
Maine Department of Inland Fisheries and Wildlife (Maine DIFW)	July 1, 2013
Atlantic Salmon Federation	July 2, 2013
Maine Rivers	July 2, 2013
Natural Resources Council of Maine	July 2, 2013
GLHA	July 2, 2013
Penobscot Indian Nation	July 17, 2013

A revised Scoping Document, addressing these comments, was issued on August 9, 2013.

1.4.2 Interventions

On March 24, 2017, the Commission issued a notice accepting the application and setting May 23, 2017, as the deadline for filing protests and motions to intervene. In response to the notice, the following entities filed motions to intervene (none opposed issuance of a license):

<u>Commenting Entity</u>	<u>Date Filed</u>
Interior	April 25, 2017
Penobscot Indian Nation	May 17, 2017
Maine DEP	May 18, 2017
Maine Rivers	May 18, 2017
Maine DIFW	May 19, 2017
NMFS	May 23, 2017
Atlantic Salmon Federation	May 23, 2017

1.4.3 Comments on the Application

A notice requesting comments, recommendations, and preliminary terms and conditions was issued on March 24, 2017. The following entities responded:

<u>Commenting Entity</u>	<u>Date Filed</u>
Atlantic Salmon Federation	February 2, 2017
BIA	February 6, 2017
BIA	March 23, 2017
Maine DEP	May 4, 2017
Maine Rivers	May 18, 2017
Bruce A. Haines	May 22, 2017
Maine DMR	May 22, 2017
Atlantic Salmon Federation	May 23, 2017

Interior	May 23, 2017
NMFS ¹¹	May 23, 2017
NMFS	May 24, 2017
NMFS	May 26, 2017
Penobscot Indian Nation	May 23, 2017
NMFS	June 2, 2017
FWS	June 5, 2017

GLHA filed reply comments on July 7, 2017.

1.4.4 Comments on the Draft EA

On March 15, 2018, the Commission issued a draft EA for the relicensing of the Mattaceunk Project. Comments on the draft EA were due April 29, 2018. Comments on the draft EA were filed by the following entities:

<u>Commenting Entity</u>	<u>Date Filed</u>
NMFS	April 12, 2018
BIA	April 23, 2018
GLHA	April 27, 2018
Maine DMR	April 27, 2018
NMFS	April 27, 2018
Interior	April 30, 2018
Penobscot Indian Nation	April 30, 2018

¹¹ NMFS's May 23, 2017, filing included its section 18 preliminary fishway prescriptions. On May 24, 2017 NMFS also filed a USB drive containing the administrative record for its section 18 preliminary fishway prescriptions, but the Commission could not accept this form of filing. NMFS filed its administrative record in an acceptable format on May 26, 2017.

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 Mattaceunk Project is located on the Penobscot River, approximately 67 river miles upstream of Bangor, Maine. The project facilities are shown in figure 2.

Mattaceunk Impoundment

The Mattaceunk impoundment is about 8.5 miles long, with a surface area of 1,664-acres and a total storage capacity of 20,981 acre-feet at a normal pool elevation of 240.0 feet USGS datum.¹²

Weldon Dam

Weldon Dam contains: (1) an earthen embankment at the north shoreline; (2) an intake/powerhouse structure (described in more detail below); (3) an upstream pool and weir fishway; (4) a log sluice; (5) a roller gate spillway; (6) an ungated overflow spillway; and (7) the right abutment. These structures have a combined length of approximately 1,060 feet and a maximum height above the riverbed of about 45 feet.

The upstream fishway and log sluice structure are located between the powerhouse and roller gate, and have a total length of 36.5 feet. Discharge to the 10-foot-wide log sluice is controlled by a 10-foot-wide by 8-foot-high vertical slide gate. The log sluice is used for debris management and, in combination with the roller gate, for passing flows in excess of the project's turbine capacity.

The roller gate spillway is a reinforced-concrete structure measuring 114 feet long beginning at the northeast end of the log sluice structure and extending to the ungated spillway. The structure is approximately 75 feet high from its assumed base (i.e., elevation 175 feet to the top of the concrete piers at elevation 250 feet). The spillway contains a single steel roller (drum) gate measuring 90 feet long and 19 feet high, an ogee-shaped spillway section with a crest elevation of 221.0 feet, and a bridge at elevation 250.0 feet spanning 90 feet between the piers. The gate is operated by a motor-

¹² All elevation data are referenced to USGS datum, unless noted otherwise.

driven chain hoist located on the left side. The roller gate is used to release water during plant shutdowns or when flows are in excess of turbine capacity of approximately 7,438 cfs. The roller gate has a discharge capacity of 25,637 cfs at normal pond elevation of 240.0 feet when the gate is opened 13.3 feet.

The ungated overflow spillway is a concrete gravity structure measuring 657.5 feet long, and has a maximum height of approximately 70 feet from the spillway's foundation to the top of the flashboards. The ogee-shaped spillway has a permanent crest elevation of 236.0 feet, and, when equipped with 4-foot-high wooden flashboards, has a flashboard crest elevation of 240.0 feet.

Intake

The intake is a concrete structure integral with the powerhouse having a total length of 142 feet. Individual intake openings, which consist of two openings per generating unit for a total of eight openings, include steel trash racks and 12-foot-wide by 16-foot-high vertical slide headgates. The trash racks and headgates are located within an enclosed gatehouse. The gates are operated by two 12.5-ton electric hoists that travel on a roof-mounted trolley beam. Intakes 3 and 4 also include downstream fish passage inlets. The intake is equipped with trash racks with 1-inch clear bar spacing covering the top 16 feet (at normal pond) of the water column. At depths greater than 16 feet, the trash racks have 2.63-inch clear bar spacing.

Fishways

The current upstream fishway consists of a pool and weir design that has 36 pools with a drop of approximately 14 inches between pools. Fish are able to ascend the fishway by way of either submerged orifices or weir notches. Flows through the fishway consist of 6- to 8-cfs transport flow with an additional attraction water flow of 7 cfs for a total flow of 13 to 15 cfs. The impoundment is maintained with minimal fluctuation in elevation when the flashboards are in place, thereby maintaining relatively stable fishway inflows. The fishway is typically operated from May 1 through November 10. Under the infrequent conditions of high flows causing flashboard failure and the need for replacement or repair, the impoundment is temporarily drawn down (typically no more than 1 to 3 days) up to 1 foot below the permanent crest of the dam. Under these conditions, the upstream fishway is not operational. The upstream fishway also is not operated under flood flow conditions. A fish trap is located at the upstream exit (top) of the fishway, so that fish enter the trap for monitoring purposes through a funnel-like opening.

The downstream fishway (i.e., surface bypass) consists of single surface inlets integral with the trash racks in two of the four turbine forebays (intakes 3 and 4), and a buried 42-inch-diameter stainless steel pipe for passing fish to the tailrace area at a maximum flow capability of 140 cfs. In addition, a trapping and monitoring facility is

present at the outlet of the bypass pipe. This monitoring facility includes an entrance chamber, an inclined dewatering system, and a holding chamber. Water flows passing through the downstream passage system empty into the monitoring facility's entrance chamber from the underground passage pipe.

Powerhouse

The 142-foot-long, 99-foot-wide powerhouse (Weldon Station) is integral to the dam and contains two Kaplan turbines rated at 5,479 kilowatt (kW) and two fixed-blade propeller turbines rated at 5,489 kW, each driving a 6,000-kilovolt-ampere (kVA), 4,800-kW vertical synchronous generator for an authorized installed capacity of 19.2 MW. Water from the powerhouse discharges directly to the river downstream. The Mattaceunk Project generates 123,332 MWh of electricity annually.

Transmission Facilities

Project generators connect to a substation located adjacent to the powerhouse, then to a 9-mile-long, 34.5-kilovolt (kV) transmission line to a point of interconnection.

Recreation Facilities

GLHA operates and maintains a canoe portage on the west side of the Penobscot River, with a takeout located about 650 feet upstream of the dam and a put-in downstream from the dam. GLHA also operates and maintains a downstream angler access area on the east bank of the river, about 1,000 feet downstream from the dam, which includes parking for six to eight vehicles, a covered picnic area, and stairs that provide access from the parking and picnic area to the river.

Project Boundary

The existing project boundary around the Mattaceunk Project includes lands up to contour elevation 240.0 feet (normal pool elevation) and lands associated with project structures, such as the dam, generator leads, powerhouse, recreational facilities, transmission line, and appurtenant facilities.

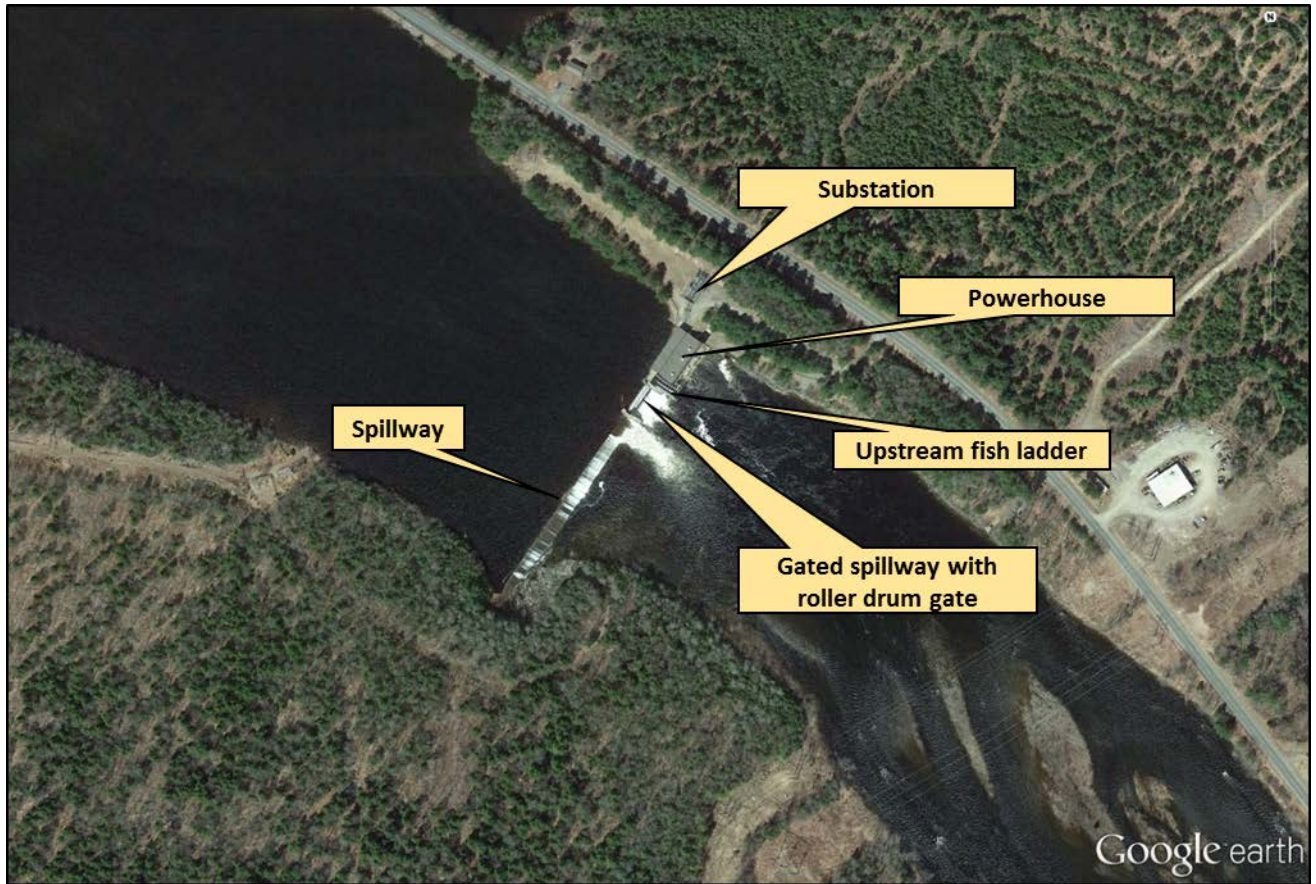


Figure 2. Mattaceunk Project facilities.
(Source: Google Earth, 2014, as modified by staff).

2.1.2 Project Safety

The Mattaceunk 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 relicensing 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 the 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.

2.1.3 Existing Project Operation

The Mattaceunk Project is operated in a run-of-river mode with year-round use of 4-foot-high flashboards,¹³ maintaining the fluctuation of the impoundment surface elevation within 1.0 foot of the flashboard crest elevation of 240.0 feet when the flashboards are in place.¹⁴ In contrast, the existing license requires GLHA to maintain an impoundment surface elevation no lower than 1.0 foot below the dam crest elevation of 236.0 feet when the 4-foot-high flashboards are down (for flashboard repairs), and no lower than 2.0 feet below the top of flashboard crest elevation of 240.0 feet when the 4-foot-high flashboards are in place to allow an adequate margin for debris loads, ice loads, or sudden pool increases that might cause flashboard failure.¹⁵

The project uses flows between 471 cfs (minimum hydraulic capacity) and 7,438 cfs (maximum hydraulic capacity) to generate electricity. When flows exceed 7,438 cfs, excess flows are normally released through the roller drum gate. However, the log sluice is used as the first opened and last closed gate for releasing excess flows during periods when the downstream fishway is in operation. The existing license, as amended on June 21, 1991, also requires a year-round continuous minimum flow of 1,674 cfs or inflow, whichever is less, and a daily average minimum flow of 2,392 cfs or inflow, if less, from July 1 through September 30, and 2,000 cfs or inflow, if less, from October 1 through June 30. The minimum flows are released through the turbines and fish passage structures when in operation. When inflow is less than the minimum hydraulic capacity, the minimum flows are released through the log sluice, roller drum gate, fish passages, and/or over the spillway.

GLHA operates the upstream pool and weir fishway annually from May 1 to November 10 for Atlantic salmon adults, by providing flows through the fishway that

¹³ GLHA refers to project operation as run-of-river with pondage. Rather than use the term “pondage” in this final EA, we have specifically described GLHA’s use of the flashboards.

Pondage refers to the ability of the project to raise the impoundment above the crest of the dam by using flashboards. Although a prior order indicates that the project would be able to operate under a peaking mode, Great Northern Nekoosa Corporation, 55 FERC ¶ 61,472 (1991), the project has never been operated in a peaking mode, nor has there ever been a proposal to operate in a peaking mode.

¹⁴ The limited fluctuation within 1.0 foot of the flashboard crest elevation, is not a requirement of the existing license but represents existing operations, which based on a letter filed on July 7, 2017, GLHA is proposing to continue.

¹⁵ See *Great Northern Paper Co.*, 50 FERC ¶ 61,163 (1990).

consist of 6- to 8-cfs transport flow with an additional attraction flow of 7 cfs at the entrance to the fishway. GLHA operates the downstream surface bypass fishway at its maximum flow capability (140 cfs) to provide downstream passage for Atlantic salmon smolts and kelts from April 1 to June 15 and only kelts from October 17 to December 1. Turbines 3 and 4 are the first units on and the last units off whenever the downstream bypass is operational.

2.2 APPLICANT'S PROPOSAL

2.2.1 Proposed Operation and Environmental Measures

GLHA proposes to:

- Continue to operate the project in a run-of-river mode with year-round use of 4-foot-high flashboards;
- Continue to operate the impoundment with fluctuation limits that consist of maintaining the impoundment surface elevation: (1) within 1.0 foot of the flashboard crest elevation (240.0 feet) on a regular basis when the flashboards are in place; (2) no lower than 2.0 feet below the flashboard crest elevation when needed for maintenance, to allow an adequate margin for wave action, debris loads, ice loads, or sudden pool increases that might cause flashboard failure when the flashboards are in place; and (3) no lower than 1.0 foot below the dam crest elevation of 236.0 feet when the flashboards are not in place;
- Continue to provide a year-round continuous minimum flow of 1,674 cfs, or inflow, whichever is less, downstream from the project, and continue to provide a daily average minimum flow of 2,392 cfs from July 1 through September 30 and 2,000 cfs from October 1 through June 30, or average inflow, whichever is less, to protect aquatic resources downstream from the project;
- Install and maintain, on a seasonal basis, an upstream eel ladder within 2 years of the effective date of the new license;
- Monitor the upstream eel ladder for use and effectiveness for one eel passage season;
- Provide downstream passage for eel by implementing annual nighttime turbine shutdowns (8:00 pm to 4:00 am), for a 6-week period between August 15 and October 31,¹⁶ in combination with opening the project's roller gate and installing

¹⁶ GLHA would develop the annual schedule in consultation with the resource agencies, and based on a predictive model for eel movement through the project. GLHA

full-depth trash racks with 1-inch clear bar spacing (*see* measures included in the Species Protection Plan (SPP) for Atlantic salmon), beginning the first passage season following license issuance;

- Monitor, for two passage seasons, the effectiveness of the downstream eel passage measures;¹⁷
- Install an upstream fishway for American shad, blueback herring, and alewife (alosines, collectively) in year 15 of a new license, expected to be operational in year 16 of a new license;
- Monitor the use and effectiveness of the upstream fishway for alosines for 2 years following its completion;
- Provide downstream passage for alosines after the upstream fishway for alosines is operational (expected in year 16), by: (1) extending the operation of the existing downstream fish bypass such that it operates continuously from April 1 to December 1; and (2) by opening the log sluice (and releasing between 3 percent [225 cfs] and 9 percent [690 cfs] of the station’s hydraulic capacity) from June 1 to December 1, as needed for alosines, based on monitoring results;
- Monitor, for 2 years, the use of existing downstream passage structures by alosines (including the surface bypass and log sluice), once the upstream fishway for alosines is operational;

refined its proposed window for downstream passage events as follows: “until such time that a predictive model is developed, GLHA would implement a night-time shutdown period of up to 6 weeks (8 pm to 4 am nightly) as early as the first significant rain event (defined as greater than 1 inch of precipitation) occurring on, or after, August 15, but that the nighttime shutdown period will start no later than September 15 in years that a significant rain event does not occur during the August 15-September 15 time period. The schedule for nighttime shutdowns within the 6-week period could be reduced based on the predictive model, and after consultation with the resource agencies. *See* GLHA’s July 7, 2017, filing at Attachment 1, page 40.

¹⁷ We assume GLHA’s proposal to monitor the downstream eel passage measures for 2 years constitutes the monitoring effort that would be undertaken to support development of a predictive model for establishing the turbine shutdown period.

- Implement additional operational and structural modifications and/or habitat enhancement measures to provide eel and alosine passage, if the proposed passage measures for eel and alosines are ineffective;
- Continue to implement the Fish Passage Operations and Maintenance Plan (FPOMP), which defines the: (1) operational period for the existing upstream and downstream fishways; (2) annual start-up and shut-down procedures; (3) opening methods; (4) debris management; and (5) safety rules and procedures;
- Continue to maintain and operate the upstream fishway annually from May 1 to November 10 for adult Atlantic salmon, including the 7-cfs attraction flow at the fishway entrance.¹⁸
- Monitor the upstream fishway and count the number of adult Atlantic salmon passing upstream of the project, using a methodology developed in consultation with resource agencies, to provide an estimate of the number of returning spawners;
- Continue to operate and maintain the downstream surface bypass to provide downstream passage for Atlantic salmon smolts and kelts from April 1 to June 15, and only kelts from October 17 to December 1;
- Implement a Species Protection Plan (SPP) for the federally endangered Atlantic salmon to meet a performance standard of 95 percent effectiveness for upstream passage of adults and 96 percent survival for downstream passage of smolts and kelts, including measures to:
 - (1) coordinate with resource agencies to stock uniquely marked smolts upstream of Weldon Dam in the first 3 years after relicensing to serve as a source of upper-Penobscot imprinted¹⁹ adult salmon used for studying upstream passage of adults and downstream passage of kelts;

¹⁸ GLHA proposes to continue operating the existing upstream fishway throughout the duration of any new license, including after construction and operation of the proposed upstream fishway for alosines.

¹⁹ Salmon are able to locate their natal habitat (and future spawning habitat), because they learn as juveniles and remember as adults the chemical cues (e.g., odors) of the habitat they experienced as juveniles (Quinn, 2005). This learning at specific stages in development and remembering without reinforcement is called imprinting. Imprinted adult salmon would be motivated to migrate to habitats upstream of Weldon Dam and, thus, are needed to study upstream passage effectiveness.

- (2) conduct up to 3 years of upstream fishway effectiveness monitoring for adults and up to 3 years of downstream passage monitoring for kelts, using the returning, imprinted adult salmon;
- (3) use trash racks that would have 1-inch clear bar spacing to the full depth of the turbine intakes, and within 2 years after relicensing, be installed seasonally during the downstream migration of eel, alosines, and Atlantic salmon;
- (4) open the project's log sluice (between 3 percent [225 cfs] and 9 percent [690 cfs] of the station's hydraulic capacity) starting the first passage season following relicensing to provide additional downstream passage for smolts for a 3-week period during the spring that would be determined in consultation with the resource agencies;²⁰
- (5) conduct a minimum of 3 years of monitoring to evaluate the effectiveness of existing passage operations and additional measures (installation of the full-depth trash rack with 1-inch clear bar spacing and operation of the log sluice), in passing smolts downstream past the dam;²¹
- (6) conduct a study to evaluate the smolt mortality in the project impoundment;
- (7) implement adaptive management that would include additional operational, structural, and/or habitat enhancement measures, if necessary, to improve passage and/or address performance criteria for upstream and downstream migrating Atlantic salmon;²²

²⁰ In a letter filed on January 25, 2017, GLHA indicated that the 3-week period would be determined in consultation with the resource agencies.

²¹ In the final license application, GLHA stated that it would conduct at least 3 years of monitoring to evaluate the effectiveness of the downstream passage for smolts. However, in response to comments filed on July 7, 2017, GLHA stated that it would conduct a minimum of 3 years of monitoring, until the performance standard for downstream smolt survival is met for a total of 3 years.

²² GLHA's proposed SPP included two adaptive management measures to: (1) address performance criteria for downstream passage, should the proposed measures be inadequate; and (2) implement additional operational and structural modifications and/or habitat enhancement measures, if necessary, to address outmigrating Atlantic salmon smolts and kelts and upstream migrating Atlantic salmon adults. Because of the similarity in these two measures, staff combined them into this single adaptive management measure that captures the intent of the two measures proposed by GLHA.

- Continue to operate and maintain the existing project recreation facilities including: (1) a canoe portage trail; and (2) a downstream angler access area with a parking area, stairs leading to the tailrace area, and a covered picnic area;
- Implement recreation facility improvements at the existing downstream angler access area within 3 years of license issuance, including installation of: (1) a pulley system to assist boaters with moving car top boats and other small watercraft up and down the stairs; and (2) a ramp adjacent to the existing recreation pavilion to provide wheel chair access to the pavilion and associated picnic table; and
- Develop a Historic Properties Management Plan (HPMP) to protect archaeological and historic architectural resources eligible for listing on the National Register of Historic Places (National Register), including the project's dam and powerhouse.

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 specifies that permanent upstream and downstream fish passage for eel at the Mattaceunk Project be operational no later than 2 years after the date of issuance of a new license, and that GLHA:

- Design upstream and downstream fish passage for eel that is sufficient to pass all available upstream and downstream migrating eel that arrive at the project;
- Operate the project to (a) minimize project effects on upstream migration for juvenile eel that approach the project tailwater and spillway,²³ and (b) exceed the minimum downstream survival efficiency criterion of 76 percent of the adult (i.e., silver) eel moving downstream past the project;²⁴

²³ Once eel have entered the eel ramp, 90 percent must move upstream and exit within 24 hours.

²⁴ This performance standard is based upon Sweka *et al.* (2014).

- Design and construct, consistent with FWS’s eel passage design criteria (FWS, 2017a), an upstream eel passage ramp at the west abutment of the spillway within 2 years of license issuance;
- Shutdown all generation nightly (8:00 pm to 4:00 am) from August 1 through October 31, annually, to provide out-migrating eel safe and timely downstream passage;
- Install full-depth trash racks that have 1-inch clear bar spacing, as either permanent structures or seasonal overlays, during the downstream eel passage operations;
- Operate the upstream eel fishway during the months of June through August, and provide downstream passage for out-migrating eel during the months of August through October;²⁵
- Develop a Fishway Operation and Maintenance Plan (Eel Passage Operations Plan) that covers all operations and maintenance of the upstream and downstream eel passage facilities, and make revisions to the plan annually if changes are warranted;²⁶
- Develop a Upstream Fishway Effectiveness Monitoring Plan (Upstream Eel Monitoring Plan) within 6 months of license issuance to document the efficiency and effectiveness of the upstream eel passage measures, including an efficiency study of juvenile eel using the new upstream eel fishway;²⁷
- Develop a Downstream Passage Effectiveness Monitoring Plan (Downstream Eel Monitoring Plan) within 6 months of license issuance to document that 76 percent of the adult eel migrating downstream past the project survive passage;

²⁵ The seasonal schedule for downstream eel passage operations may be modified in consultation with the resource agencies, based upon empirical passage timing data developed for the project, and/or a predictive model for eel movement through project waters.

²⁶ GLHA would also provide information on fish passage operations, and project operation that may affect fish passage, within 10 days of a written request from FWS.

²⁷ The Upstream Eel Monitoring Plan would include standard study methods to evaluate (a) attraction efficiency to the facility, and (b) the effectiveness of passing eel that have entered the upstream eel ladder.

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

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

NMFS's section 18 prescription would require GLHA to:

- Install full-depth trash racks with 1-inch clear bar spacing, during the downstream migration for eel, alosines, and Atlantic salmon;
- Begin installing the seasonal trash racks with 1-inch clear bar spacing to the full depth of the turbine intakes within 2 years;
- Measure approach velocities after installation of the full-depth trash racks with 1-inch clear bar spacing using point measurements, and ensure approach velocities do not exceed 2.0 feet per second (fps);
- Design new fishways using the following provisions: (1) submit design plans to the resource agencies for review and consultation; (2) provide conceptual designs to the resource agencies; (3) provide the resource agencies with conceptual designs for the proposed full-depth trash racks with 1-inch clear bar spacing; (4) submit final design plans to the Commission for final approval after resource agency approval and prior to the commencement of fishway construction activities; and (5) file final as-built drawings with NMFS and FWS;
- Submit fishway design plans for new fishway structures to the resource agencies for review and consultation;
- Follow NMFS's provisions for all fishway effectiveness monitoring, including: (1) develop study design plans in consultation with NMFS, as well as state and federal resource agencies; (2) seek resource agency approval of the study design prior to filing with the Commission for final approval; (3) complete all monitoring with scientifically accepted practices; (4) begin monitoring at the start of the second migratory season after each fishway facility is operational, and continue monitoring for the time frames proposed, or as otherwise required; (5) conduct fishway "shakedowns" the first season after fishways are constructed; (6) provide reports of the monitoring studies to the resource agencies for a minimum 30-day review and consultation, prior to submittal to the Commission for final approval; and (7) include resource agencies' comments in the annual reports submitted to the Commission for final review.

- Monitor the seasonal upstream eel ramp for use and effectiveness during one eel passage season;
- Monitor downstream eel passage for 2 years to determine the effectiveness of the nighttime shutdowns and full-depth trash racks with 1-inch clear bar spacing;
- Install an upstream passage structure for alosines in year 15 of the new license, to be operational in year 16;
- Operate the new upstream alosine fishway from May 1 to July 31 of each year;
- Conduct 2 years of upstream passage monitoring for alosines;
- Implement additional protective measures (e.g., structural or operational modifications of fishways), if necessary based on monitoring results, to attain performance standards for upstream-migrating alosines;
- Extend the seasonal operation of the downstream fishway and log sluice to include the period from June 1 to December 1, as necessary based on alosine study results, once upstream passage for alosines is operational (expected in year 16 of a new license);
- Conduct 2 years of downstream passage monitoring for alosines;
- Implement additional protective measures or alternative actions (e.g., additional spill or intake screening) sufficient to attain performance standards for out-migrating alosines;
- Continue to maintain and operate the upstream fishway annually from May 1 to November 10 for adult Atlantic salmon;
- Operate the existing upstream fishway from May 1 to November 10 for adult Atlantic salmon, unless the Milford fishway begins capturing fish earlier in the calendar year, in which case the fishway should open prior to May 1;
- Maintain and monitor the existing fish trap at the exit of the existing upstream fishway for counting adult Atlantic salmon;
- Continue to operate and maintain the downstream fish bypass to provide downstream passage for Atlantic salmon smolts and kelts from April 1 to June 15, and Atlantic salmon kelts from October 17 to December 1;
- Open the project's log sluice starting the first passage season following relicensing to provide additional passage for downstream Atlantic salmon

smolts for a 3-week period during the spring that would be determined in consultation with resource agencies;

- Conduct up to 3 years of upstream fishway effectiveness monitoring for adult Atlantic salmon and up to 3 years of downstream passage monitoring for kelts, using returning imprinted adult salmon;
- Conduct up to 3 years of monitoring to evaluate the effectiveness of existing downstream passage operations and additional measures (operation of the log sluice and installation of the 1-inch clear spacing full-depth trash racks), in passing Atlantic salmon smolts;
- Count only those smolts that pass the project forebay within 24 hours as a successful passage attempt that can be applied toward the calculation for downstream passage survival of smolts and kelts;
- Implement adaptive management that would include additional operational, structural, and/or habitat enhancement measures, if necessary, to improve passage and/or address performance criteria for upstream and downstream migrating Atlantic salmon;

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

2.4 STAFF ALTERNATIVE

Under the staff alternative, the project would be operated as proposed by GLHA, except for 11 proposed measures, and with all but 16 of the fishway prescriptions filed by Interior (Appendix B) and NMFS (Appendix C). The staff alternative includes the remaining measures proposed by GLHA, with some modifications, and the additional staff-recommended measures described below.

The staff alternative for the project includes modifications of, and additions to, GLHA's proposed measures as follows:

- Develop an operation compliance monitoring plan to document compliance with the proposed operations described above (i.e., run-of-river operation, limited impoundment fluctuations, and minimum flows) for the protection of aquatic resources in the impoundment and downstream of the dam;
- Monitor the effectiveness of the downstream eel passage measures for three passage seasons from August 1 through October 31;

- Develop individual monitoring plans for upstream and downstream eel passage, as required by Interior’s fishway prescription, that include:
 - (1) the goals and objectives of the monitoring;
 - (2) performance criteria for determining the success of the eel passage measures;
 - (3) the methodology used to monitor the effectiveness and efficiency of the upstream and downstream passage measures to pass eel;
 - (4) provisions for reporting the results of the monitoring (i.e., development of a report) and consulting with the agencies regarding the results (including an annual meeting); and
 - (5) a provision to identify and implement (upon Commission approval):
 - (a) additional monitoring studies; or (b) operational and structural modifications and/or habitat enhancement measures to provide eel passage, if after 1 year of upstream monitoring and 3 years of downstream monitoring, the proposed passage measures for eel are ineffective at achieving the upstream and downstream effectiveness and survival performance criteria.

- Modify the FPOMP to include additional provisions for:
 - (1) performing routine maintenance before the migration season, such that the existing fishways would be fully operational during the migratory period;
 - (2) clearing debris from the trash racks of all turbine intakes prior to the migration season, and identify, with final Commission approval, the frequency of debris clearing during the migration season;
 - (3) monitoring flows in the downstream bypass pipe to detect debris blockages using a method approved by the Commission;
 - (4) clearing debris from the downstream bypass pipe when blockages are detected;
 - (5) procedures for filing with the Commission for informational purposes, an annual report on the operation of the existing fishways and on project generation;
 - (6) developing shutdown procedures for the existing fishways; and
 - (7) developing procedures for operation and maintenance of the existing fishways during emergencies and project outages;

- Operate the proposed upstream eel ladder for a “shakedown” period subsequent to installation, and prior to the passage season and pertinent effectiveness studies to ensure it is operating as designed, and to make minor adjustments to facilities and operations, as needed;

- Modify the SPP for Atlantic salmon to include the following additional provisions:

- (1) remove the provision to seasonally install trash racks with 1-inch clear bar spacing to the full depth of the turbine intakes for the purpose of protecting smolts and kelts;
- (2) revise, with final approval from the Commission, the upstream passage effectiveness study methodology to include the type of telemetry tag to be used on upstream migrating adults and the appropriate timing for stocking tagged smolts, and refile the SPP with the revised study plan;
- (3) include the proposed passage effectiveness study plans as attachments to the SPP;
- (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 95 percent performance standard after the first year;
- (5) determine the need for future effectiveness studies or measures, with final approval from the Commission, if after 3 years of upstream passage effectiveness studies, the upstream fishway does not meet the 95 percent effectiveness performance standard;
- (6) revise the number of downstream passage effectiveness studies for smolts to indicate that a minimum of 3 years of study would be conducted;
- (7) revise the criteria for achieving the downstream performance standard for smolts to state that the standard would be considered achieved if a total of 3 years of effectiveness studies for smolts demonstrate that the downstream passage structures meet a 96 percent survival performance standard;
- (8) determine, with final approval from the Commission, when to begin implementation of phased spill measures for downstream passage of smolts, with the restriction that phased spill measures would be implemented after a minimum of 1 year and a maximum of 3 years of conducting downstream passage survival studies for smolts, and non-spill passage measures;
- (9) determine, with final approval from the Commission, the 3-week period during which any log sluice or phased spill measures would occur for downstream passage of smolts;
- (10) determine the need for an additional 1 or 2 years of downstream passage effectiveness studies for kelts, with final approval from the Commission, if the downstream passage structures meet the 96 percent survival performance standard for kelts after the first year;
- (11) determine the need to conduct at least 1 year of additional effectiveness study, with final approval from the Commission, if the downstream passage structures do not meet the 96 percent survival performance standard for kelts after the first year;
- (12) determine the need for future effectiveness studies, and/or downstream passage measures, with final approval from the Commission, if after 3 years of downstream passage effectiveness studies, the downstream passage structures do not meet the 96 percent survival performance standard for kelts;

- (13)remove the provision to conduct a study to evaluate smolt mortality in the project impoundment;
- (14)remove the provisions requiring reevaluation of upstream and downstream passage effectiveness every 10 years; and
- (15)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.

- Develop an SPP for the federally threatened northern long-eared bat that limits non-hazardous tree removal to the period of November 1 through March 31, which is outside the pup season (June 1 to July 31), and the broader active season (April 1 to October 31).

Staff does not recommend GLHA's proposed measure to monitor downstream eel passage for two passage seasons. Staff does not recommend this measure because, as evidenced by an example in the Shenandoah River, more than 2 years of monitoring downstream eel passage effectiveness will likely be needed to develop the proposed predictive model. Staff does not recommend GLHA's proposed measure to install an upstream fishway for alosines in year 15 because alosine spawning habitat downstream of the Mattaceunk Project is currently underutilized (less than 3 percent of its production potential) and it is difficult to predict with any certainty, at this point in time, what the run sizes of alosines in the Penobscot River will be 15 years into the future. Because upstream alosine passage is not needed at this time, staff does not recommend the following measures proposed by GLHA that are contingent on the installation of an upstream alosine fishway: (1) monitor the use and effectiveness of an upstream fishway for alosines for 2 years after its completion; (2) modify operations of the existing downstream passage structures to provide downstream passage of alosines; and (3) monitor, for 2 years, the effectiveness of existing downstream passage structures for alosines. Staff does not recommend GLHA's proposal to implement additional operational and structural modifications and/or habitat enhancement measures, without final Commission approval, to provide eel and alosine passage. Staff does not recommend this measure, as proposed, because the Commission must have final approval over any future changes in project facilities and operation. Staff does not recommend GLHA's proposal to count the number of adult Atlantic salmon passing upstream of the project. Staff does not recommend this measure because counting Atlantic salmon does not protect Atlantic salmon from project effects, mitigate a project effect on Atlantic salmon, or enhance the population. Staff does not recommend GLHA's proposed measure to install full-depth trash racks with 1-inch clear bar spacing during the downstream passage of Atlantic salmon smolts and kelts. Staff does not recommend this

measure because most smolts swim at depths shallower than the full-depth trash racks and 1-inch bar spacing would not prevent entrainment of smolts. In addition, kelts are already protected by the existing trash rack configuration. Staff does not recommend GLHA's proposal to reevaluate upstream and downstream passage effectiveness for Atlantic salmon every 10 years. Staff does not recommend this measure because there would be no benefit to reevaluating passage effectiveness if the upstream fishway and downstream fish passage structures meet the performance standards, and are properly operated and maintained by following the proposed FPOMP with staff modifications. Staff does not recommend GLHA's proposal to conduct a study to evaluate smolt mortality in the project impoundment. Staff does not recommend this measure because existing studies provide no consistent evidence that mortality in the project impoundment is higher than non-impounded reaches. Further, there is already sufficient information to describe and analyze impoundment mortality. Staff does not recommend GLHA's proposal to implement additional operational, structural, and/or habitat enhancement measures, without final Commission approval, to improve passage for upstream and downstream migrating Atlantic salmon. Staff does not recommend this measure as proposed, because the Commission must have final approval over any future changes in project facilities and operation.

Fishway Prescriptions Not Recommended

The staff alternative does not include Interior's fishway prescriptions to:

- Provide downstream passage for eel from August 1 through October 31 each year by implementing annual nighttime turbine shutdowns, in combination with opening the project's roller gate and installing full-depth trash racks with 1-inch clear bar spacing, beginning the first passage season after license issuance.
- Provide FWS personnel, and FWS-designated representatives, timely access to the fish passage facilities at the project, and to pertinent project operational records, to document compliance with the fishway prescription.

The staff alternative also does not include NMFS's fishway prescriptions to:

- Install full-depth trash racks with 1-inch clear bar spacing during the downstream migration of Atlantic salmon.
- Estimate approach velocities in front of the trash racks.
- File final as-built drawings for new fishways with NMFS and FWS.

- Install an upstream passage structure for alosines in year 15 of the new license, to be operational in year 16.
- Operate the upstream fishway for alosines from May 1 to July 31 of each year.
- Conduct 2 years of upstream passage monitoring for alosines.
- Extend the seasonal operation of the downstream bypass fishway and log sluice to include the period from June 1 to December 1, as necessary, based on alosine study results, once upstream passage for alosines is operational (expected in year 16 of a new license).
- Conduct 2 years of downstream passage monitoring for alosines.
- Implement additional protective measures or alternative actions (e.g., additional spill or intake screening) sufficient to attain performance standards for out-migrating alosines.
- Open the existing upstream fishway prior to May 1, if adult Atlantic salmon are caught in the Milford fishway prior to May 1.
- Begin effectiveness monitoring studies at the start of the second migratory season after each fishway facility is operational.²⁸
- Maintain and monitor the existing fish trap at the exit of the existing upstream fishway for counting adult Atlantic salmon.
- Count only those smolts that pass the project forebay within 24 hours as a successful passage attempt that can be applied toward the calculation for downstream passage survival of smolts and kelts;
- Implement adaptive management that would include additional operational, structural, and/or habitat enhancement measures, if necessary, to improve passage and/or address performance criteria for upstream and downstream migrating Atlantic salmon.

²⁸ Specifically, the staff alternative does not include this monitoring requirement for the upstream passage effectiveness studies for adult Atlantic salmon and the downstream passage survival studies for kelts. This requirement was included as one of five provisions in NMFS's fishway prescription that would require GLHA to follow its general provisions for studying the effectiveness of all fishways.

Section 10(j) Measures Not Recommended²⁹

The staff alternative does not include the following section 10(j) recommendations:

- NMFS’s recommendations regarding: (1) developing a flow monitoring plan that includes making historical flow data available on the internet; (2) conducting continuous stream temperature monitoring to assure that operations do not intensify the effects of climate change; and (3) developing a mitigation plan for the loss of Atlantic salmon smolts caused by the project impoundment.
- Maine DMR’s recommendations regarding: (1) fishway “shakedown” periods for existing fishways; (2) as-built fishway drawings; (3) copies of fishway operating procedures; (4) meeting annually to review passage operations data; (5) counting fish passed in fishways and reporting those numbers; (6) drafting an annual fishway operations plan for all fishways; (7) an upstream alosine fishway; (8) modifications to fishway operating schedules; (9) implementation of future operational or structural modifications to meet performance standards for fish passage; (10) nighttime turbine shutdowns for downstream eel passage from August 1 through October 31; and (11) conducting 3 years of studies to assess the source of impoundment mortality for Atlantic salmon smolts.

Section 10(a) Measures Not Recommended

The Staff Alternative does not include the following section 10(a) recommendations:

- NMFS’s recommendation to conduct real-time monitoring of the downstream bypass fishway.
- Penobscot Indian Nation’s recommendation to develop a plan to monitor water temperature in the impoundment for multiple years.
- Bruce Haines’ recommendations to: (1) install upstream and downstream passage for alosines as soon as possible; (2) redesign the downstream bypass to provide 5 percent attraction flow; and (3) operate the downstream bypass 365 days per year.

²⁹ See section 5.3, *Summary of Section 10(j) Recommendations*, for additional details on the recommendations.

- Interior’s recommendation for developing a portage plan, in consultation with the Penobscot Indian Nation, for canoe portage around the project.

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 the measures included in the staff alternative with the addition of the section 18 fishway prescriptions not included in the staff alternative, as discussed above in section 2.4, *Staff Alternative*.

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 lands 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 Retiring the Project

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.³⁰ 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 measures, making decommissioning a reasonable alternative.³¹ This is consistent with 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.³² Either alternative would involve denial of the relicense application and surrender or termination of the existing license with appropriate conditions.

Penobscot Indian Nation has recommended project retirement, but we have no basis for recommending it. The Mattaceunk Project is a source of clean, renewable energy. This source of power would be lost if the project were retired, and replacement power would need to be found. There also could 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 of the remaining facilities. Penobscot Indian Nation has advocated this alternative, but we have no basis

³⁰ 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).

³¹ 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).

³² In the unlikely event that the Commission denies relicensing 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 (2017). 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.

for recommending it. Removing the dam would be more costly than retiring it in place, and removal could have substantial, negative environmental effects.

3.0 ENVIRONMENTAL ANALYSIS

This section includes: (1) a general description of the project vicinity, (2) an explanation of the scope of cumulative effects analysis, and (3) our analysis of the proposed action and 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 5.1, *Comprehensive Development and Recommended Alternative*.³³

3.1 GENERAL DESCRIPTION OF THE PENOBSCOT RIVER BASIN

The Mattaceunk Project is located on the main stem of the Penobscot River. The Penobscot River Basin, which is the largest basin in Maine and the second largest in New England, is 125 miles long and 115 miles wide with a total drainage area of 8,525 square miles. The Penobscot River is formed by two major tributaries, the West Branch Penobscot River (West Branch) and the East Branch Penobscot River (East Branch), that join to form the main stem of the Penobscot River near the town of Medway. The Mattaceunk Project is located about 7 miles downstream of the confluence of the East and West Branches, and this entire stretch of river is impounded by the Weldon Dam. The project impoundment also extends about 800 feet up the West Branch and about 2 miles up the East Branch, including a portion of an East Branch tributary named Salmon Stream. From Weldon Dam, the river then flows southeasterly for about 240 miles to the Atlantic Ocean in Penobscot Bay near Bucksport, about 20 miles south of Bangor, Maine.

Topography in the Penobscot Basin is relatively uniform, with hills and low mountains near the headwaters, and undulating plains, with lakes, ponds, and swamps closer to the coast. The climate has four distinct seasons. The summers are moderately cool, but winters are severe, with an average annual precipitation of approximately 41 inches, uniformly distributed throughout the year. Temperatures range from summer highs in the 90's to winter lows in the -30's on the Fahrenheit scale with snowfall contributing to the water equivalent of six to eight inches per year (Maine Department of

³³ Unless otherwise indicated, our information is taken from the application for license filed by GLHA on August 31, 2016, and responses to requests for additional information filed on January 25, 2017, and March 16, 2017.

Conservation [Maine DOC], 2007). The majority of land in the project vicinity is heavily forested, primarily privately-owned timberland, and is mostly undeveloped.

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 which 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 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.

Based on our review of the license application and agency and public comments, we have identified water quality, downstream aquatic habitat, and diadromous fish (i.e., Atlantic salmon, eel, alewife, American shad, and blueback herring) as resources that could be cumulatively affected by continued operation of the project.

3.2.1 Geographic Scope

The geographic scope of the cumulative 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 Penobscot River Basin.

We have identified the Penobscot River Basin as our geographic scope of analysis for water quality, downstream aquatic habitat, and diadromous fishery resources. We chose this geographic scope because the operation and maintenance of the Mattaceunk Project, in combination with other hydroelectric projects in the Penobscot Basin, may affect habitat quality and access for diadromous fish species from upstream of the Mattaceunk Project down to the mouth of the Penobscot River. The Mattaceunk Project is one of 128 dams in the Penobscot River Basin, consisting of 19 federally-licensed hydropower projects (25 dams) and 102 non-hydropower dams.³⁴ There are six existing FERC-licensed hydroelectric projects on the West Branch and mainstem of the Penobscot River (see figure 1; no federally-licensed projects are located on the East Branch). On the West Branch in descending order are the Ripogenus Hydroelectric Project (FERC

³⁴ The *Strategic Plan for the Restoration of Diadromous Fishes to the Penobscot River* indicates that there are 20 federally licensed hydropower projects (27 dams) and 102 non-hydropower dams in the Penobscot River watershed. The number of federally licensed dams in the strategic plan includes Great Works Dam and Veazie Dam, which were removed in 2012 and 2013, respectively. Thus, there are now 25 federally licensed dams in the Penobscot River watershed.

Project No. 2572), Penobscot Mills Hydroelectric Project (FERC Project No. 2458), and Medway Hydroelectric Project (FERC Project No. 3440). The Mattaceunk Project is one of three hydroelectric projects on the mainstem of the Penobscot River, with the West Enfield Hydroelectric Project (FERC Project No. 2600) and the Milford Hydroelectric Project (FERC Project No. 2534) located about 29 miles and 54 miles downstream of the Mattaceunk Project, respectively. Operation of these dams may cumulatively affect diadromous fish species due to migratory barriers and loss of spawning habitat. Other contributors to cumulative effects on water quality, downstream aquatic habitat, and diadromous fishery resources in the basin include introductions of non-native fish species, high intensity land development, logging, and industrial phosphorus discharge (paper mills and municipal treatment facilities).

In section 3.3.2.2, *Aquatic Resources*, we discuss the cumulative effects of licensing the project on water quality and fishery resources, and in section 3.3.4.2, *Environmental Effects, Atlantic Salmon* we discuss the cumulative effects of licensing the project on Atlantic salmon.

3.2.2 Temporal Scope

The temporal scope of analysis includes a discussion of the past, present, and reasonably foreseeable future actions and their effects on fishery resources. Based on the potential new license term, 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 for each resource. 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 specific cumulative and 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 soils, aquatic resources, terrestrial resources, threatened and endangered species, land use, recreational access and facilities, and cultural resources may be affected by the proposed action and alternatives. We have not identified any substantive issues related to aesthetic resources or socioeconomics associated with the proposed action; therefore, these resources are not addressed in the EA. We present our recommendations in section 5.1, *Comprehensive Development and Recommended Alternative*.

3.3.1 Geology and Soil Resources

3.3.1.1 Affected Environment

Geology

The Mattaceunk Project is situated within the New England Upland Physiographic Region. The majority of this region is characterized by gentle slopes and flat plains, but steep, mountainous terrain also occurs. Topography of the area surrounding the project is primarily low, rolling hills and valleys. The region is bounded to the north and south by the Allagash and Kennebec River basins, respectively.

The region is principally underlain by resistant metasedimentary rock, including shale, slate, and schist, with some igneous intrusions. Bedrock within the project vicinity is delineated by the Lawler Ridge Formation, part of the greater Madrid Formation, consisting of medium-to-thick bedded greywacke, a calcareous sandstone, dissected by planes of gray to black slate (Roy, 1981). Quartz, disseminated pyrite, and carbonate cement are also prevalent in the greywacke formation. The bedding is steeply inclined, dipping between 80 degrees and the vertical, and striking parallel to the dam.

The project stretches across two biophysical regions, the Western Foothills and the Eastern Interior (Maine DIFW, 2005). The majority of the Western Foothills region is characterized by hilly terrain underlain by moderate-to-strongly metamorphosed pelite,³⁵ limestone, and dolostone.³⁶ Small bodies of granitic rock are also present in the southwest of the region. Average elevations in this region range from 600 feet to 1,000 feet.

The Eastern Interior biophysical region consists of gently rolling terrain underlain by pelite, calcareous sandstone, and sulfidic quartz sandstone (Maine DIFW, 2005). Small formations of gabbro³⁷ and granodiorite³⁸ are also present along the eastern

³⁵ A fine-grained sedimentary rock consisting of clay or mud particles.

³⁶ A sedimentary carbonate rock composed of the mineral dolomite.

³⁷ A dark, coarse-grained intrusive igneous rock composed mainly of the mineral plagioclase.

³⁸ A coarse-grained intrusive igneous rock composed mainly of quartz and plagioclase feldspar.

boundary of the region. Elevations in the Eastern Interior range from 200 feet to 400 feet.

The surrounding area was exposed to significant glacial modification. Surficial geologic materials adjacent to the project consist of glacial till and glacial stream deposits of permeable sands and gravel. The glacial till is primarily a stiff, bouldery, clayey soil with sporadic lenses of sand and gravel (Osberg *et al.*, 1985). Glaciomarine deposits and pockets of esker³⁹ surround the project impoundment. These deposits, in addition to stream alluvium, are also present along the length of the transmission line.

Soils

The primary soils found within the project boundary are the Monarda, Burnham, Howland, Plaisted, and Thorndike series. The most significant variance in soil type occurs between the transmission line right of way (ROW) and the project impoundment.

Soils along the transmission line ROW consist of Thorndike very stony silt loam (29 percent), Plaisted very stony loam (22 percent), Howland very stony loam (21 percent), and Monarda and Burnham very stony silt loams (21 percent) (GLHA, 2016a). Thorndike soils, formed in loamy till,⁴⁰ are shallow and excessively drained. Plaisted soils, derived from dense glacial till on drumlins⁴¹ and ridges, are very deep and well drained. Similarly, Howland soils form on drumlins and till ridges, and are a very deep, fairly well-drained series. The slope of soil ranges from 0 to 45 percent in the Thorndike and Plaisted series, and from 0 to 25 percent in the Howland series.

Monarda very stony silt loam is a poorly drained soil developed in dense glacial till on till plains. Burnham soils, formed in dense glacial till on glaciated uplands, are very deep and very poorly drained. The slope of the Monarda series ranges from 0 to 15 percent, and from 0 to 3 percent in the Burnham series.

Soils surrounding the project impoundment, impoundment shoreline, and stream banks include Plaisted very stony loam (14 percent), Limerick silt loam (5 percent),

³⁹ A winding ridge of gravel and sand deposited by glacial drift.

⁴⁰ Till refers to unsorted glacial sediment produced by erosion and entrainment of substrate by the movement of ice.

⁴¹ A landform consisting of glacial till, sand, and gravel, typically in the shape of an elongated hill, formed by the movement of glacial ice across underlying rock and substrate.

Monarda and Burnham very stony silt loams (4 percent) (GLHA, 2016a). Limerick soils are deep and poorly drained, and form in loamy alluvium on flood plains.

Sediment

Geophysical and sediment sampling surveys of the Penobscot River were conducted in 1999 by the USGS in collaboration with the BIA and Penobscot Indian Nation Department of Natural Resources (Dudley and Giffen, 2001). As reported in the study, the surveys indicate that substrate within the main river channel consists primarily of gravel, sand, and rock. This is consistent with a more recent mussel survey conducted in the Mattaceunk impoundment in 2012, which indicated that substrate consists primarily of silt, followed by sand, gravel, and small cobble in the lower half of the Mattaceunk impoundment. The 1999 survey also identified fine-grained sediment deposits in thin bands along both island and mainland shorelines, at the mouth of streams and brooks, and at the downstream ends of islands. The most extensive deposition of fine-grained, readily-transportable sediment types was found in the Mattaceunk impoundment.

Ground-penetrating radar and sediment grab samples were used to identify sediments in the main river channel and the project impoundment (figure 3). The impoundment contained the largest deposit of fine-grained sediment, consisting of sand, silt, and clay, within the 50-mile river reach sampled as part of the study. The depth and composition of deposits in the impoundment also differed from any other site surveyed along the river. The thickness of sediment deposits ranged upwards of 15 feet in some areas, and samples from the bottom of those deposits yielded fines homogenously mixed with wooden fibers. Moreover, streambed samples taken near the dam yielded gray and brown, gelatinous material emitting an unusual odor. The cause or source of that material was not identified by the study.

The study attributes the depth of the deposits in the Mattaceunk impoundment to the size and location of the dam, and the relatively large, deep impoundment that has formed as a result. The predominantly low velocities in the project impoundment, as compared to the main reaches of the river, allow transported sediment to settle out of the water column and accumulate along the streambed. The impoundment has in the past, and may continue to, receive high loads of suspended sediment and wooden fibers from historical uses of the river for industry and wood product manufacturing upstream of the dam.

A preliminary contaminant screening of the Penobscot River was conducted in 2015 by the EPA in collaboration with the Penobscot Indian Nation, USGS, FWS, and the Agency for Toxic Substances and Disease Registry (ATSDR), and referenced in the

Penobscot Indian Nation's comments and recommendations⁴² on the final license application (EPA, 2015). The objective of the research study was to evaluate the health of the riverine system and assess tribal exposure to potentially contaminated sediments as a consequence of cultural and sustenance practices surrounding the river.

Sediment and biota samples were collected from six reaches along an 87-mile stretch of the river between Old Town and Medway (figure 3). The study reaches were chosen based on the aforementioned sediment mapping conducted by USGS in their 1999 study, the presence of riverine features with the potential to impact sediment transport, such as dams and impoundments, and known or suspected depositional zones of fine-grained materials. The samples were analyzed for the presence of polychlorinated biphenyl⁴³ (PCB) congeners,⁴⁴ total PCBs, dioxins and furans,⁴⁵ total organic carbon (TOC), methyl mercury,⁴⁶ and total mercury.

⁴² See letter filed by the Penobscot Indian Nation on May 23, 2017.

⁴³ PCBs are toxic organic compounds composed of chlorinated hydrocarbons that are produced intentionally, or as by-products of industrial processes.

⁴⁴ Congeners are unique, individual PCB compounds that specify the total number and position of each chlorine atom in the compound.

⁴⁵ Dioxins and furans are common names for a group of toxic organic compounds with shared chemical characteristics, including polychlorinated dibenzo-p-dioxins, polychlorinated dibenzofurans, and polychlorinated biphenyls.

⁴⁶ Methyl mercury is a toxic organic compound formed by the dilution of inorganic mercury in freshwater and saltwater.

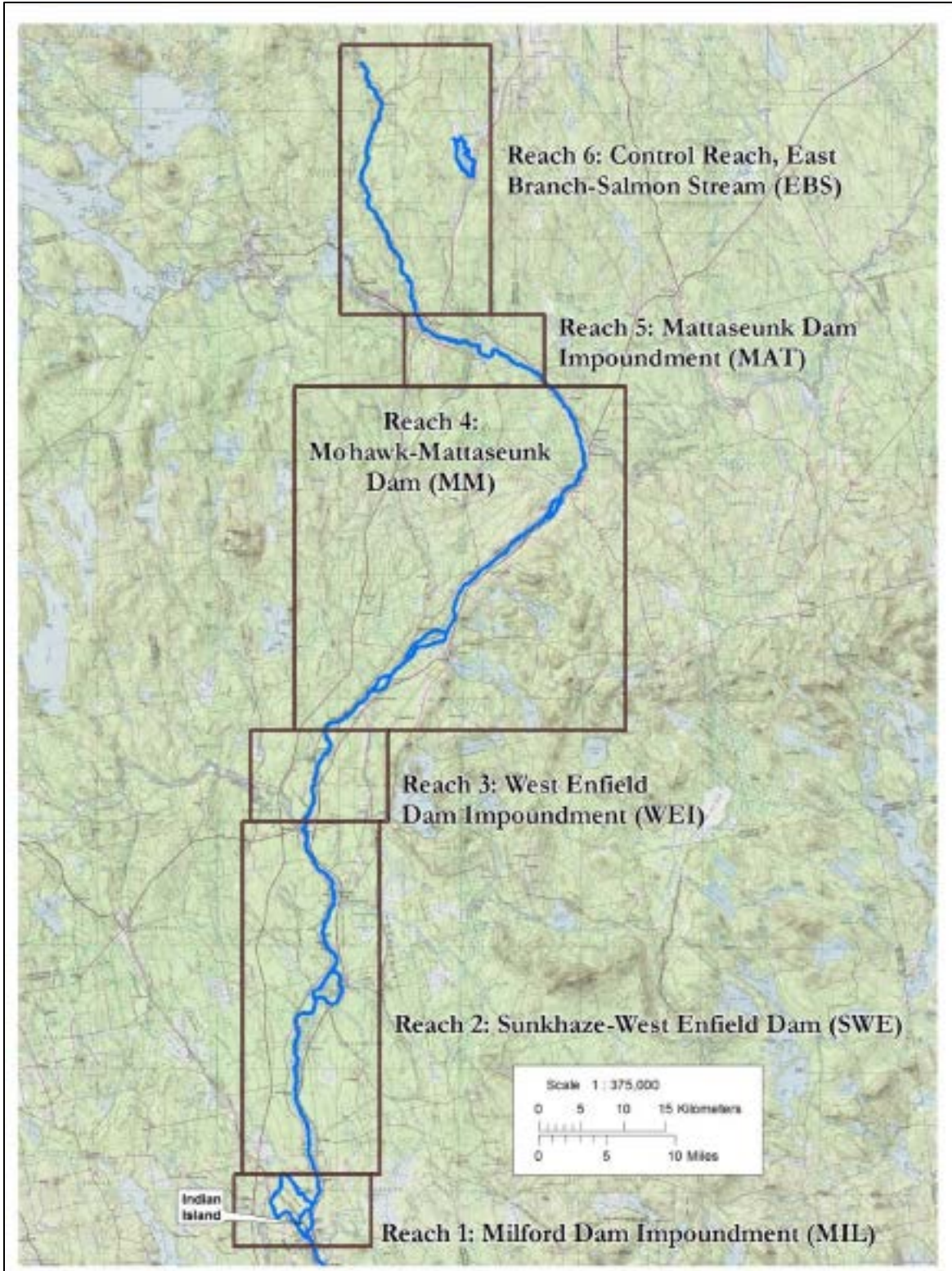


Figure 3. Penobscot River study reaches 1 through 6.
(Source: EPA RARE Report, 2015).

Analysis of sediment samples from reach 5, in the Mattaceunk impoundment, indicated the presence of several target contaminants, including dioxins and furans, PCBs, and mercury (table 1). Impoundment sediments contained the largest single and average concentrations of polychlorinated dibenzo-p-dioxins and polychlorinated dibenzofurans,⁴⁷ and co-planar PCBs than any of the other 5 reaches. These contaminants were present in quantities more than 200-times and 15-times greater, respectively, than the quantities identified in sediment samples from reach 6 (table 2), the East Branch of the Penobscot River and Salmon Stream Lake. Both the East Branch and Salmon Stream Lake are upstream of any known pollution sources and thus constituted the study's control reach.

⁴⁷ These are both chemically-related toxic organic compounds, more broadly classified as dioxins and furans, which occur as by-products of various industrial processes.

Table 1. Contaminant concentrations in sediment and biota in Reach 5 (see figure 3), Mattaceunk Project impoundment.

Contaminant concentrations in sediment and biota in Reach 5, Mattaseunk Dam Impoundment (MAT)							
SAMPLES (A,B,C,D)		Dioxins/Furans (17 Congeners) Concentration TEQ pg/g	WHO-PCBs (12 Congeners) Concentration TEQ pg/g	Total TEQ (29 Congeners) Concentration TEQ pg/g	Total PCBs (142 Congeners) Concentration ng/g	Methyl Mercury Concentration ng/g	Mercury Concentration µg/g
Sediment (SED)	A ^{Imp}	19.9 ^a	0.407 ^a	20.3 ^a	76.7 ^a	1.15 ^a	0.24 ^a
	B	54.8 ^a	0.952 ^a	55.8 ^a	168 ^a	5.28 ^a	0.56 ^a
	C	94.9 ^a	1.23 ^a	96.1 ^a		3.65 ^a	0.64 ^a
	D	93.8 ^a	4.41 ^a	98.2 ^a		8.98 ^a	3.46 ^a
	Average	65.9 ^a	1.75 ^a	67.8 ^a	122 ^a	4.77 ^a	1.23 ^a
Chain Pickerel (CP)	A	0.0579 ^b	0.0677 ^b	0.126 ^b			0.588 ^b
Yellow Perch (YP)							
White Perch (WP)	A A ^d	0.495 ^b 0.531 ^{b,d}	0.311 ^b 0.281 ^{b,d}	0.806 ^b 0.812 ^{b,d}			0.627 ^b 0.545 ^{b,d}
Smallmouth Bass (SMB)	A	0.0740 ^b	0.109 ^b	0.183 ^{b,c}	1.10 ^b		0.961 ^b
Brown Bullhead (BBH)	A	0.534 ^b	0.193 ^b	0.727 ^b			0.416 ^b
American Eel (EEL)	A	4.02 ^b	1.43 ^b	5.45 ^b			0.739 ^b
Wood duck (WODU)							
Fiddlehead Ostrich Fern (OSF)							
Medicinal Plant (MP)	A	0.0240 ^b	ND ^{b,e}	0.0240 ^b		ND ^b	0.00853 ^b
Snapping Turtle (SNTU)	A	2.26 ^b	0.536 ^b	2.80 ^b		938 ^b	1.046 ^b

(Source: EPA RARE Report, 2015).

Table 2. Contaminant concentrations in sediment and biota in Reach 6 (*see* figure 3), Control Reach – East Branch and Salmon Stream Lake.

Contaminant concentrations in sediment and biota in Reach 6, Control Reach- East Branch-Salmon Stream Lake (EBS)							
SAMPLES		Dioxins/Furans (17 Congeners)	WHO-PCBs (12 Congeners)	Total TEQ (29 Congeners)	Total PCBs (142 Congeners)	Methyl Mercury	Mercury
(A,B,C)		Concentration TEQ pg/g	Concentration TEQ pg/g	Concentration TEQ pg/g	Concentration ng/g	Concentration ng/g	Concentration µg/g
Sediment (SED)	A	0.651 ^a	0.126 ^a	0.777 ^a	25.2 ^a	1.65 ^a	0.058 ^a
	B	0.0760 ^a	0.0650 ^a	0.141 ^a		0.197 ^a	0.026 ^a
	C	0.148 ^a	0.0784 ^a	0.226 ^a		ND ^{a,f}	0.084 ^a
	Average	0.292 ^a	0.0898 ^a	0.381 ^a	25.2 ^a	0.924 ^a	0.056 ^a
Chain Pickerel (CP)	A	0.0161 ^b	0.0395 ^b	0.0556 ^b			0.544 ^b
Yellow Perch (YP)	A	0.00370 ^b	0.0117 ^b	0.0154 ^b			0.284 ^b
White Perch (WP)	A	0.146 ^b	0.173 ^b	0.319 ^b			0.477 ^b
Smallmouth Bass (SMB)	A	0.0428 ^b	0.168 ^b	0.211 ^b	0.899 ^b		0.809 ^b
Brown Bullhead (BBH)	A	0.107 ^b	0.102 ^b	0.209 ^b			0.135 ^b
American Eel (EEL)	A A ^d	0.178 ^b	0.283 ^b	0.461 ^b			0.209 ^b 0.214 ^{b,d}
Wood duck (WODU)							
Fiddlehead Ostrich Fern (OSF)	A	ND ^{b,e}	ND ^{b,e}	ND ^{b,e}	0.170 ^b	0.9 ^a	ND ^{a,e}
Medicinal Plant (MP)	A A ^d	ND ^{b,e} ND ^{b,d,e}	0.0360 ^b ND ^{b,d,e}	0.0360 ^b ND ^{b,d,e}		ND ^b ND ^b	0.00289 ^b 0.00292 ^{b,d}
Snapping Turtle (SNTU)	A ^f B ^g	0.0213 ^{b,f} 0.0198 ^{b,g}	0.0876 ^{b,f} 0.124 ^{b,g}	0.109 ^{b,f} 0.144 ^{b,g}	0.170 ^b	277 ^b 166 ^b	0.215 ^{b,f} 0.228 ^{b,g}

(Source: EPA RARE Report, 2015).

Erosion

On June 10, 2010, HDR Engineering, Inc., conducted independent field inspections of the project site and structures, including the upstream and downstream impoundment shorelines. No significant erosion issues were observed. Based on HDR's findings, which are included in the 2010 Ninth Independent Consultant's Safety Inspection Report,⁴⁸ GLHA concludes that erosion does not appear to be a significant issue on the project impoundment and downstream river reach.

3.3.1.2 Environmental Effects

Operational Effects on Geology and Soils

Sediment Resuspension

Our Analysis

Findings from the USGS and EPA studies indicate that the Mattaceunk impoundment contains large quantities of fine-grained silt, sand, and clay deposits, as well as chemically contaminated sediments. The primary concern associated with the presence of impacted sediment behind the dam is the potential for resuspension and downstream mobilization of contaminants as a result of project operations.

The identified contaminants, dioxins and furans, PCBs, and mercury, are considered bioaccumulative toxins that have the potential to pose a significant ecological risk to aquatic species. These contaminants are relatively insoluble and can remain in various environmental media for long periods of time. The pollutants have a tendency to bind with fine-grained sediment and progressively bioaccumulate within biota.

The applicant does not propose any new construction, major modification to project structures, or changes to existing operations. Under normal operating conditions, impoundment drawdowns are limited to within 2.0 feet, at most, of the normal pond elevation of 240.0 feet. Temporary drawdowns due to flashboard failures, could require drawdowns to 235.0 feet, or 5.0 feet below normal pond elevation, but are typically limited to a period of less than three days. Further, based on recorded data of impoundment elevations from 2008 to 2015, these types of drawdowns occur on average, less than once per year (GLHA, 2016). Thus, the drawdowns required for flashboard repair are infrequent and short in duration, and unlikely to cause any substantial resuspension of sediments. Larger drawdowns of 20.0 to 25.0 feet for maintenance and repair activities are relatively infrequent and occur, on average, once every 15 to

⁴⁸ See the 2010 Ninth Independent Consultant's Safety Inspection Report filed by GLHA on December 7, 2010.

20 years. During these events, GLHA conducts resource agency consultation beyond what is required under FERC license protocol.

Existing and historic sources of contaminants entering the impoundment are fairly well documented. Numerous point sources of pollution exist within the Penobscot River Basin, including five major discharging facilities currently regulated by the National Pollutant Discharge Elimination System (NPDES). The primary industrial uses of the river include paper manufacturing, saw mills, lumber preservation, and wood product manufacturing. Other uses include textile, leather, and allied product manufacturing. According to the EPA study, known discharges into the river from both public and private facilities include chlorinated organics, dioxin, and mercury.

Given that the source of contaminants entering the river basin is not project-related, and because GLHA is not proposing any activities that would disturb impounded sediment, staff does not anticipate that continued operation of the project would substantially contribute to the resuspension or mobilization of impacted sediment. At present, Weldon Dam acts as a barrier sequestering and preventing further downstream transport of existing contaminants. While limited quantities of fine-grained or contaminated sediments may be carried with flow during normal project operation, the resulting risks, primarily short-term increases in turbidity or sedimentation downstream, would be temporary. At present, the project does not appear to have a significant effect on the resuspension or release of contaminated sediments.

Erosion

Our Analysis

GLHA proposes to continue to operate the project in run-of-river mode, with minimal fluctuation in impoundment surface elevation for the installation and operation of the project flashboards. Interior,⁴⁹ NMFS, and Maine DMR all provide recommendations that are consistent with GLHA's proposed limits on impoundment surface elevations.

⁴⁹ Interior provided a 10(j) recommendation that was consistent with GLHA's proposal, except that rather than maintaining impoundment surface elevations within 1.0 foot of normal pond elevation (240.0 feet) on a regular basis, Interior recommended that GLHA maintain impoundment water levels at or near normal pond elevation (240.0 feet) during normal operations. Because Interior's recommendation is not specific, and because operating within 1.0 foot of normal pond elevation is near normal pond elevation, we interpret Interior's recommendation to be consistent with GLHA's proposal.

Fluctuations of impoundment surface elevations associated with hydroelectric project operations can cause or exacerbate soil and shoreline erosion. Historically, impoundment drawdowns at the project have been infrequent and limited to within 2.0 feet of the normal pond elevation of 240.0 feet under normal operating conditions, and within 5.0 feet of the normal pond elevation during flashboard failure. Temporary drawdowns associated with flashboard repairs have typically been limited to a period of less than three days and have occurred, on average, less than once per year (GLHA, 2016a). As a result, the project has operated in a manner that maintains relatively stable flows and minimizes fluctuations in surface water levels, in turn minimizing the potential for bank erosion, as evidenced by the conclusions presented in HDR Engineering Inc.'s Safety Inspection Report. Continuing to operate the project in run-of-river mode would continue to limit fluctuations in impoundment water levels, and, therefore, result in no measurable shoreline erosion.

Given the existing site and sediment characteristics, and because GLHA is not proposing any new construction or changes in project operations, staff does not anticipate that continued operation of the project will significantly affect geology and soil resources. While limited and natural amounts of erosion may occur within the project boundary, the project has a limited effect, if any, on mass soil movement or erosion, and these events are not exacerbated by project operations.

3.3.2 Aquatic Resources

3.3.2.1 Affected Environment

Water Quantity

The Mattaceunk Project receives water from both the West Branch and East Branch and has a total drainage area of about 3,310 square miles. The majority of inflow to the Mattaceunk Project impoundment is from the West Branch, which is partially regulated by the Ripogenus Project⁵⁰ and the Penobscot Mills Project.⁵¹ The Penobscot Mills Project's storage impoundment regulates the river flows on a seasonal basis to

⁵⁰ *Great Northern Paper Co.*, 77 FERC 61,316 (1996) (order issuing new license). The Ripogenus Hydroelectric Project is located about 39.5 miles upstream from the project.

⁵¹ *Great Northern Paper Co.*, 77 FERC ¶ 61,068 (1996) (order issuing new license). The Penobscot Mills Hydroelectric Project is located about 8.5 miles upstream from the project and consists of five developments; one storage (Millinocket Lake) and four generation facilities (North Twin, Millinocket, Dolby, and East Millinocket Developments).

provide flows downstream to the Mattaceunk. Additional flow in the project area comes from the East Branch, which is unregulated, and has no hydroelectric developments.

Table 3 shows the monthly flow data for the Penobscot River at the Mattaceunk Project. The mean annual flow is approximately 6,204 cfs,⁵² with monthly flows generally highest from April through June and lowest in August. Flows exceed 7,438 cfs (i.e., the maximum hydraulic capacity of the project) less than 20 percent of the time and exceed 1,674 cfs (i.e., the minimum flow required by the current license) about 99.9 percent of the time.

Table 3. Mean, minimum, and maximum monthly discharge in cfs for the Penobscot River (1996-2015^a).

Month	Average Flow	Minimum Flow	90% Exceedance	10% Exceedance	Maximum Flow
January	5,437	1,163	2,821	8,338	24,645
February	5,216	1,287	3,003	8,002	22,111
March	5,800	1,231	2,908	9,148	25,699
April	9,715	1,740	3,687	17,911	59,738
May	9,280	1,673	3,428	17,964	69,936
June	6,269	2,189	3,204	10,243	27,541
July	5,071	1,899	2,851	8,760	41,321
August	4,427	1,891	2,873	6,636	27,796
September	5,106	2,232	3,431	6,890	31,691
October	6,152	1,726	2,987	9,808	45,108
November	5,738	1,266	2,773	10,188	33,421
December	6,215	1,087	2,824	9,541	46,240
Annual	6,204	1,087	2,999	10,529	69,936

(Source: GLHA, 2016a).

^a The Ripogenus and Penobscot Mills projects located upstream from the Mattaceunk Project were relicensed in 1996, resulting in water management modifications. This period of record reflects the current flow management on the Penobscot River and at the Mattaceunk Project.

⁵² Average annual flow using data collected from 1996 to 2015 based on combined, prorated, and adjusted data from four USGS gauges (i.e., gauge number 01028000 at West Branch of the Penobscot River near Medway, gauge number 01030000 Penobscot River near Mattawamkeag, gauge number 01029500 the East Branch of the Penobscot River at Grindstone, and gauge number 01030500 the Mattawamkeag River near Mattawamkeag).

Water Quality

The Mattaceunk Project impoundment is largely contained within the main stem of the Penobscot River, but extends 2 miles into the East Branch and several hundred feet into the West Branch. The portion of the impoundment located in the mainstem of the Penobscot River is classified as Class C waters.⁵³ Class C waters' designated uses include drinking water supply after treatment, fishing, agriculture, recreation in and on the water, industrial process and cooling water supply, hydroelectric power generation, navigation, and as a habitat for fish and other aquatic life. The portion of the impoundment located in the East Branch is classified as Class AA waters.⁵⁴ Class AA waters have the designated uses of drinking water after disinfection, fishing, agriculture, recreation in and on the water, navigation, and as habitat for fish and other aquatic life. Habitat in Class AA waters is characterized as free-flowing and natural. Currently, Maine has no standards for temperature, although dissolved oxygen percent saturation is dependent on temperature. Table 4 summarizes the stream classifications and associated water quality criteria in the vicinity of the project.

Table 4. Summary of stream classifications and water quality criteria.

Stream Classification	Class C	Class AA
Dissolved Oxygen (DO)	May not be less than 5 milligrams per liter (mg/L) or 60 percent of saturation, whichever is higher.	As naturally occurs.
Aquatic life (Biological)	Discharges may cause some changes to aquatic life, provided that the receiving waters shall be of sufficient quality to support all species of fish indigenous to the receiving water and maintain the structure and function of the resident biological community.	Habitat shall be characterized as natural and free flowing. Aquatic life shall be as naturally occurs.

⁵³ Class C waters include the reach from the confluence of the East Branch and the West Branch to the confluence of the Mattawamkeag River, including all impoundments.

⁵⁴ Class AA waters include the East Branch from a point located 1,000 feet downstream from the dam located at the outlet of Grand Lake Mattagammon to its confluence with the West Branch.

Stream Classification	Class C	Class AA
pH (measure of water acidity)	6.0 - 8.5	6.0 - 8.5
Water column chlorophyll-a	≤ 8.0 micrograms/liter (µg/L)	≤ 3.5 µg/L (≤ 5.0 µg/L ^a)
Secchi disk depth	≥ 2.0 meters	≥ 2.0 meters

^a Applicable to low gradient Class AA waters with water velocity less than 5.0 cfs. (Source: Me. Stat. tit. 38, § 465; Me. Stat. tit. 38, § 583 [June 12, 2012, Draft])

In 1997, 2001 and 2007, Maine DEP conducted water quality monitoring throughout the basin for DO, temperature, and nutrients (i.e., total phosphorus, chlorophyll *a*,⁵⁵ and Secchi disk transparency⁵⁶) during the summer months at low flows (Maine DEP, 2008). Based on the monitoring results, Maine DEP categorized the Penobscot River mainstem above the Mattawamkeag River (located 4.3 miles downstream from the Mattaceunk Project) as impaired for failing to attain DO and nutrient/eutrophication levels. In 2007, Maine DEP linked excess phosphorus discharged from industrial sources within the basin to eutrophication, phytoplankton blooms, and extreme diurnal DO swings⁵⁷ leading to DO non-attainment classification⁵⁸ (Maine DEP,

⁵⁵ 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.

⁵⁶ 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.

⁵⁷ Diurnal DO is the difference in DO concentrations measured in the early morning and late afternoon at a specific sampling location on a given day. Large diurnal DO fluctuations indicate the presence of algal activity and a productive system; marked by low early morning DO occurring after an extended period of nighttime plant respiration and high mid- to late-afternoon daily maximum DO concentrations (Maine DEP, 2008).

⁵⁸ In 2002 through 2008 and 2010 through 2014, respectively, Maine DEP categorized the Penobscot River mainstem, above Mattawamkeag River, as impaired for failing to attain adequate DO concentrations and showing signs of high nutrient levels, indicating eutrophication. In May 2014, Maine delisted this area and imposed limits on

2011a). In 2011, Maine DEP monitored the 13-mile stretch of the river between the upstream Dolby Pond⁵⁹ and the Mattaceunk Project's impoundment to determine the cause for listing this segment for eutrophication, phytoplankton blooms, and DO non-attainment classification in 2001, 2004, and 2007. The 2011 monitoring report linked phytoplankton blooms in the Mattaceunk impoundment to excess phosphate discharged into Dolby Pond and to conditions favorable to phytoplankton growth in the 13-mile reach flowing into the Mattaceunk Project impoundment. The excess phosphate was attributed to two industrial sources and a municipality located in this river reach.⁶⁰ Based on their findings, Maine DEP developed nutrient restrictions for point sources within this 13-mile stretch (Maine DEP, 2011b) to decrease phosphate discharge into Dolby Pond and significantly reduce the likelihood of algae blooms recurring in the Mattaceunk Project impoundment (Maine, 2011a).

Water Quality Monitoring

During the summer and early fall of 2014, GLHA conducted continuous water quality monitoring in the deepest part of the project impoundment (i.e., at a 39-foot depth, about 1,030 feet upstream from the dam). Parameters sampled included water temperature and DO.

nutrient loads discharged from point sources (industrial, permitted dischargers) upstream from the project (Maine, 2014).

⁵⁹ Dolby Pond is one of five developments in the Penobscot Mills Project. This development is located on the West Branch of the Penobscot, about 13 miles upstream of the Mattaceunk Project.

⁶⁰ Between Dolby Pond and the Mattaceunk impoundment, the river flows through a series of four dams, where laminar flows and extended hydraulic residence times foster algae blooms (Maine, 2011b).

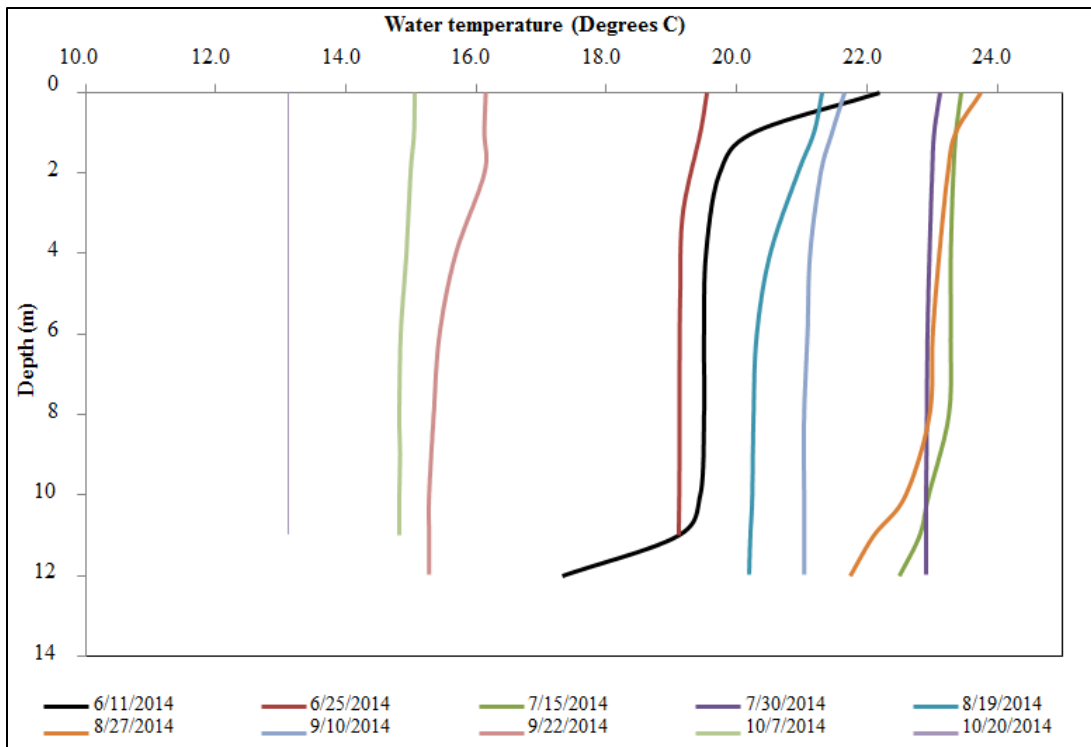


Figure 4. Temperature profiles taken mid-channel, 1,030 feet upstream from Weldon Dam from June through October 2014. (Source: GLHA, 2016a).

Water temperatures ranged from 13.1° to 23.8° Celsius (°C) (about 56° to 75° Fahrenheit [°F]) and were uniform throughout the water column (figure 4). Temperatures were lowest in early fall (late September through October) and highest in late summer (June through early September). The greatest difference in temperature occurred on June 11, 2014, when water temperatures declined by about 2°C (about 3.6°F) between the water surface and bottom of the impoundment (a depth of 12 meters). The rapid change in the surface water temperature on that day was likely a rapid spring turn over, which can occur in lakes with a relatively small surface area, and do not experience a lasting contrast in seasonal conditions (Wetzel, 2001). Further, this temperature difference across depths did not extend into the summer, indicating that the impoundment does not stratify.⁶¹

⁶¹ Stratification occurs when there is a change of one degree Celsius per one-meter depth change (Maine DEP, 1997).

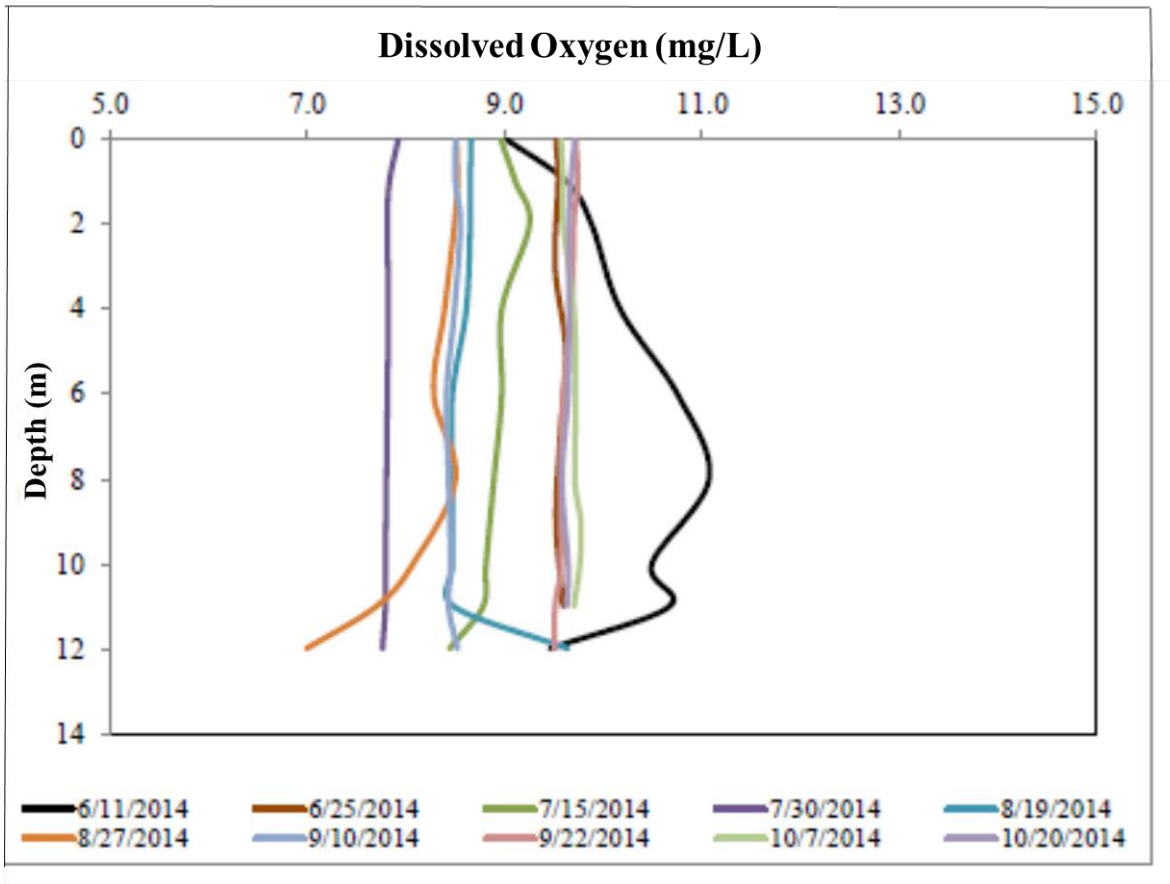


Figure 5. DO profiles taken mid-channel, 1,030 feet upstream from Weldon Dam from June through October 2014. (Source: GLHA, 2016a).

DO levels in the impoundment exceeded 5.0 mg/L, the minimum DO level for Class C waters. Generally, DO water surface concentrations ranged from 8.0 to 9.8 mg/L and were lowest in late summer and highest in the early fall (figure 5). Concentrations were relatively stable throughout the water column, except for June 11, 2014, when DO levels were relatively erratic with a range of 9.0 to 11.1.

GLHA also sampled water in the impoundment to evaluate its trophic status (i.e., nutrient loads). The values for total phosphorus, chlorophyll *a*, and Secchi depth indicated that the impoundment could be characterized as intermediate between oligotrophic and mesotrophic based on Maine’s lake trophic status guidelines (Maine DEP, 2014).

Tailwater Macroinvertebrates

During the low-flow period of the late summer of 2014, GLHA conducted benthic macroinvertebrate sampling in the riffle/run habitat of the project tailwater about 1,198 feet downstream from the dam. The purpose was to further assess attainment of the

Maine DEP water quality classification. The macroinvertebrate community downstream from the project was found to have a high mean abundance, with an estimated 3,000 organisms per sample. The community was found to attain Class C aquatic life criteria.

Continuous Water Temperature Data

From May to September 2012, GLHA collected continuous water temperature data at the project (GLHA, 2016a). Water temperature data were collected from three locations: at the upstream end of the impoundment next to the Interstate 95 Bridge, the downstream end of the impoundment near the powerhouse, and about 1,000 feet downstream from Weldon Dam near the angler access area (see figure 20). Continuous water temperature data were similar among all sample sites, with similar warming and cooling patterns throughout the season (figure 6) (GLHA, 2016a).

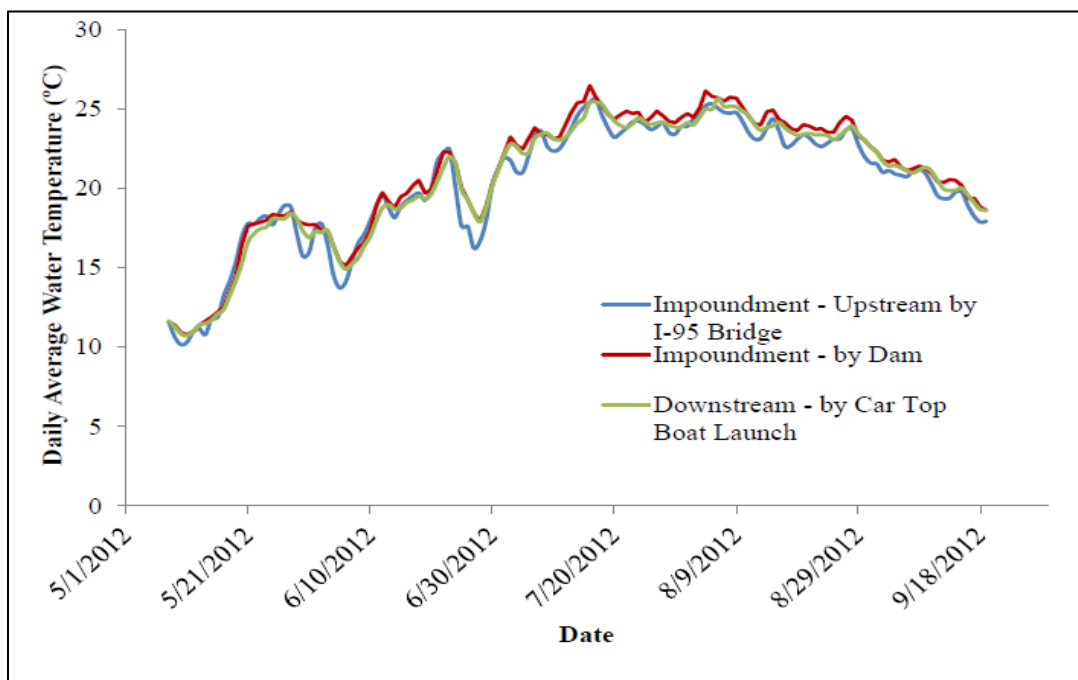


Figure 6. Daily average water temperature at the Mattaceunk Project, May to September 2012.

(Source: GLHA, 2016a).

Aquatic Habitat

Impoundment Habitat

An impoundment bathymetry map shows that the upper reach of the impoundment is narrow and relatively shallow, with depths less than 16.5 feet at full pond (figure 7). More broadly, during a mussel survey conducted by GLHA in 2012, the average depth surveyed across 12 transects was 21.4 feet (Normandeau, 2012). The middle reach of the impoundment, in the vicinity of Lawrence Island, contains large areas of shallow water

habitat, while the lower reach of the impoundment was characterized by a wide, deep channel interspersed with shallow-water cove and wetland complexes. The main channel is the deepest area of the impoundment, with depths up to 39 feet measured in the lower portion of the impoundment (Normandeau, 2012).

As discussed in section 3.3.1.1, *Sediment*, the substrate consists primarily of silt, followed by sand, gravel, and small cobble in the lower half of the Mattaceunk impoundment. Wood and bedrock are infrequently observed along the shoreline (Normandeau, 2012).

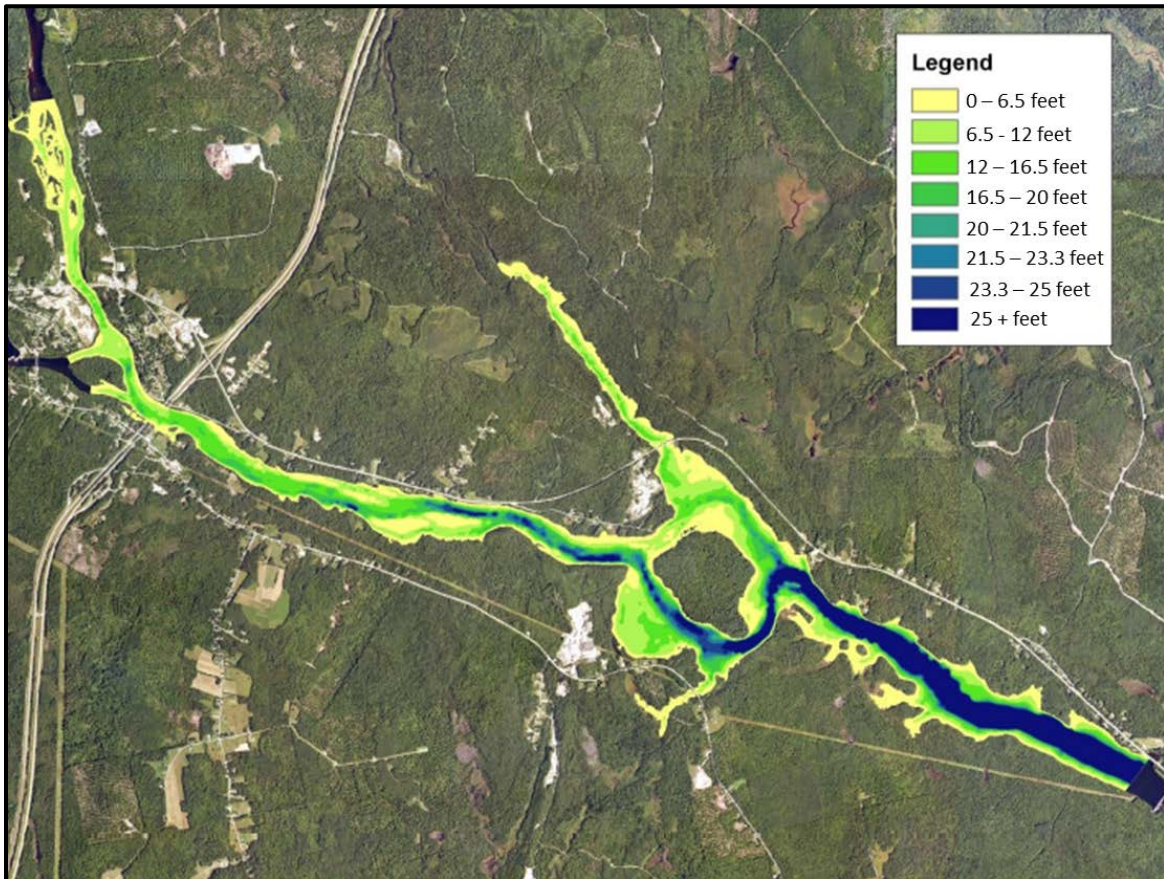


Figure 7. Mattaceunk impoundment bathymetry.
(Source: GLHA, 2016a, as modified by staff).

Along island perimeters and in shallow water there are beds of submerged aquatic vegetation (GLHA, 2015 and 2016b). The largest areas of emergent wetlands occur in protected coves in the eastern portion of the impoundment. Along forested floodplains of the project there are palustrine, forested wetlands. Shrub swamps are also common in the project vicinity. These vegetated, wetland habitat types provide suitable cover as well as forage, spawning, and rearing habitats for various fish and other aquatic species.

Downstream Habitat

GLHA conducted a study to evaluate aquatic habitat downstream of the project dam under the minimum base flow of 1,674 cfs, which is both the existing and proposed, year-round, continuous minimum flow. Actual flows during the survey ranged from 1,765 to 1,783 cfs. In addition to characterizing the types of habitat available at the minimum flow, the study addressed whether a migratory corridor, or zone of passage, would be maintained during minimum flow conditions. The survey was conducted from Weldon Dam to a location about 3,117 feet downstream of the dam.

Immediately below the dam GLHA found that there is a large, deep pool that extends about (800 feet) to a downstream area that transitions into run habitat (figure 8). The pool has a maximum depth of 24.3 feet. Substrate consists primarily of cobble and boulders.

A small portion of habitat occurring along the southern shoreline is relatively shallow with a couple of isolated pools. The average depth of this habitat is 0.5 feet, with a maximum depth of 2.5 feet. This habitat consists primarily of bedrock with large woody debris cover, some of which is exposed during minimum flows. There also is a high-gradient, bedrock outcropping that extends to the toe of the dam. This habitat receives leakage flow from the spillway.

The thalweg⁶² runs along the northern shoreline, or generation side, of the channel through the study reach and is characterized by relatively fast water that extends more than 100 feet from shore into the channel, with maximum depths up to about 10 feet (figure 8). Riffles, which typically occur between the islands, range from 0.3 to 2.5 feet in depth and are dominated by cobble substrate. Glide habitat, which is present near gravel bars and islands, is dominated by finer substrate while other shallow water habitats are characterized by rockier substrate. Multiple gravel bars are exposed under minimum flow conditions and a few isolated pools are present. Though shallow areas exist on the thalweg margins, GLHA concluded that there are no areas in the thalweg that would impede fish migration at minimum flow (GLHA, 2015).

⁶² The thalweg is the path of the fastest flow in a river and usually is centered over the lowest point of any cross section of the river.

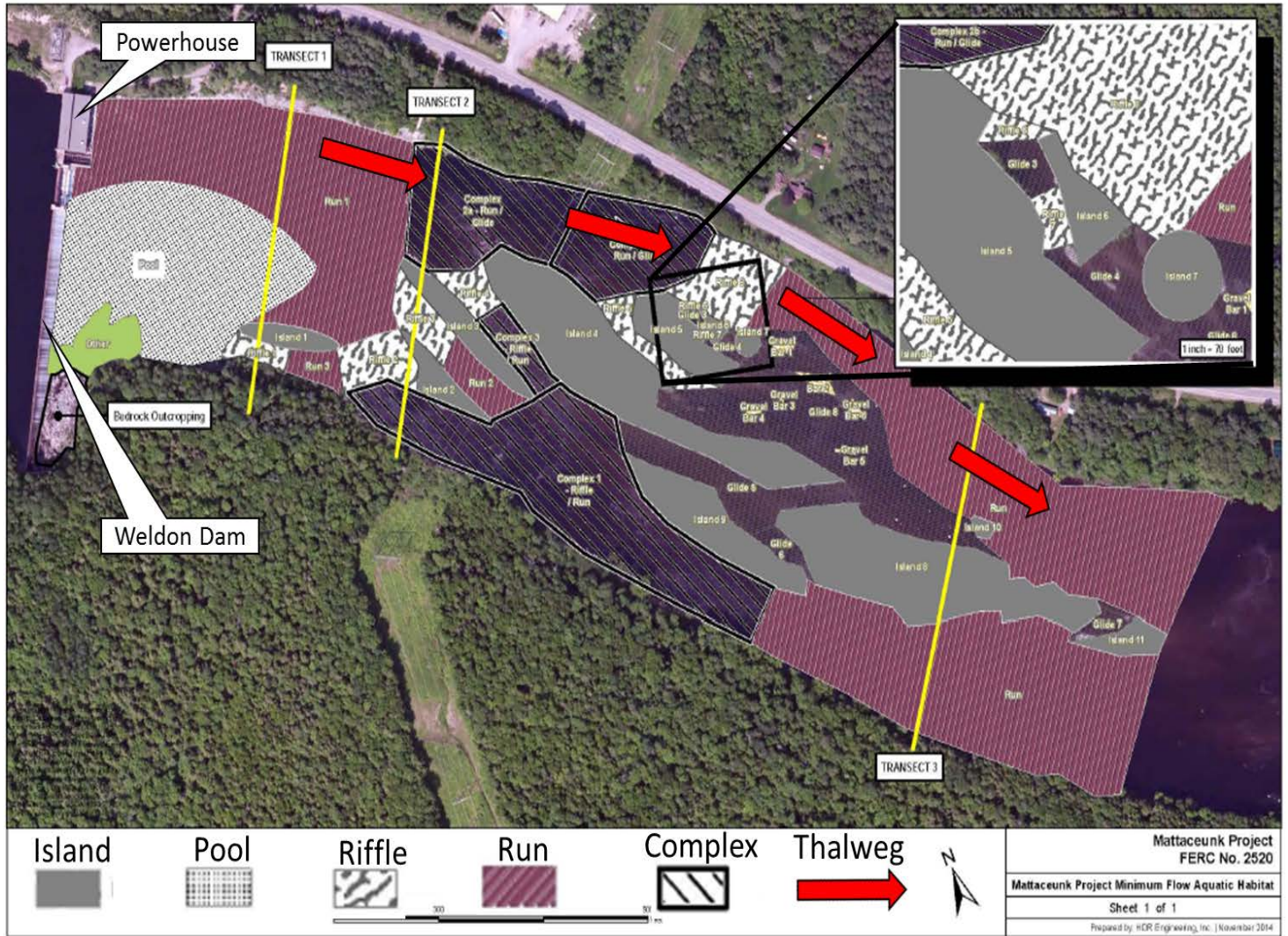


Figure 8. Habitat characteristics downstream of Weldon Dam.
 (Source: GLHA, 2016a, as modified by staff).

GLHA also evaluated the wetted width of downstream habitat under the same minimum flow study conditions discussed above. The results indicate that the wetted width, at a flow volume near that of the minimum flow, averaged 77.2 percent of the bankful wetted width across the three habitats that were investigated (pool, riffle, and run habitat).⁶³ The wetted width in the riffle area, which is typically the focus of wetted width analysis, was 87.4 percent of that of bankful.

Fish Community

The Penobscot River Basin has historically supported diverse populations of resident and diadromous⁶⁴ fish, as well as other aquatic organisms (*e.g.*, freshwater mussels and macroinvertebrates). Pre-colonial conditions supported a robust diadromous fishery, including Atlantic salmon,⁶⁵ alosines (*i.e.*, American shad, blueback herring, and alewife), striped bass, rainbow smelt, sea lamprey, Atlantic sturgeon, Shortnose sturgeon, and sea run brook trout, Atlantic tomcod, and eel.

The native inhabitants of the region harvested American shad for at least 8,000 years, and sturgeon for at least 3,000 years (Penobscot River Restoration Trust [Penobscot Trust], 2012), and the Penobscot Indian Nation still uses the Penobscot River for subsistence fishing. Commercial harvesting of diadromous fish from the Penobscot River began in the 1760s, and the lower river was dammed in the 1830s with the construction of the Veazie and Great Works dams (both now removed). Historically, the primary species harvested from the Penobscot River have been alewife, American shad, and Atlantic salmon. As a result of effects associated with the Industrial Revolution and subsequent development, the Penobscot River fishery and aquatic resources (*e.g.*, freshwater mussels and macroinvertebrates) have declined from the historical levels (Penobscot Trust, 2012).

In addition to diadromous species, the Penobscot River contains a variety of resident riverine fish species that offer high quality sport fishing. Such species include

⁶³ Flows during the survey were slightly above the proposed minimum and ranged from 1,765 to 1,783 cfs.

⁶⁴ The term “diadromous” is used to describe a life history strategy where fish migrate between freshwater and saltwater to complete their life-cycle.

⁶⁵ Atlantic salmon (*Salmo salar*) in the Penobscot River was listed as endangered on June 19, 2009, under the ESA. Because the salmon is a listed species under the ESA, we describe the species and its habitat, as well as discuss any potential effects of the proposed action in section 3.3.3, *Threatened and Endangered Species*.

brook trout, landlocked salmon, white perch, and chain pickerel, as well as the non-native smallmouth bass and northern pike. *See* description below.

Penobscot River Fisheries Management

Fisheries management on the Penobscot River is guided by several state and federal management plans. Maine DMR and Maine DIFW completed the “Strategic Plan for the Restoration of Diadromous Fishes to the Penobscot River” in 2008, which was developed in conjunction with FWS, NMFS, Penobscot Indian Nation, and other interested stakeholders. The plan defined four strategic goals: (1) coordinating fisheries management activities into a cohesive multispecies management program; (2) providing safe, timely, and effective fish passage (upstream and downstream); (3) maintaining or improving habitat for diadromous and select resident species; and (4) adopting an adaptive, ecosystem-based management program. The plan outlines production estimates for American shad and alewife for reaches of the Penobscot River, including the project area, and identifies effective upstream and downstream fish passage at the project as a strategic goal.

Maine DMR and Maine DIFW prepared the “Operational Plan for the Restoration of Diadromous Fishes to the Penobscot River” in 2009 (Maine DMR and Maine DIFW, 2009). The goal of this plan is to “restore and guide management of diadromous fish populations, aquatic resources, and the ecosystems on which they depend, for their intrinsic, ecological, economic, recreational, scientific, and educational values for use by the public” by removing barriers and improving access to the Penobscot River. The plan identifies operational objectives, measures, and strategies for the restoration of diadromous fish, including alosines, over a 50-year period. The plan identifies river habitat historically occupied by alosines in the project area, identifies increased upstream and downstream fish passage effectiveness at mainstem dams as a strategic goal, and provides estimates for quantity of suitable habitat and production potential for American shad and alewife in the Penobscot River watershed.

To facilitate the restoration of diadromous fish in the Penobscot River, the Penobscot Trust⁶⁶ undertakes the activities of the Penobscot River Restoration Project (Penobscot Restoration Project). The activities have included: (1) the removal of the Veazie and Great Works Dams (in 2012 and 2013, respectively), the two lowermost dams on the Penobscot River;⁶⁷ (2) construction of a nature-like fishway around Howland Dam on the Piscataquis River, a major tributary to the Penobscot River downstream from the

⁶⁶ The Penobscot Trust is a consortium of conservation groups, federal and state agencies, and hydropower companies.

⁶⁷ With the removal of Veazie and Great Works dams, Mattaceunk Dam is now the third dam on the mainstream of the Penobscot River.

Mattaceunk Project; and (3) construction of new fish lifts at the Milford and Orono Dams.

Management of American shad in the Penobscot River is also guided by Maine DMR's American Shad Habitat Plan (Maine DMR, 2014). The plan provides river-specific information for the major American shad spawning rivers, including the Penobscot River. It also identifies nearly 500 river miles of potential American shad habitat, and specifies that one of the main goals of the Penobscot Restoration Project is to expand available habitat for American shad. The timeline to begin implementing several goals of the plan is 2020, with the exception of water quality sampling and shad counts/surveys. Water quality sampling and shad counts/surveys already occur, and will continue to occur, annually (Maine DMR, 2014).

Management of Atlantic salmon in the Penobscot River is guided by the Final Recovery Plan for the Gulf of Maine distinct Population Segment of Atlantic Salmon (*Salmo salar*) (Recovery Plan) (NMFS and FWS, 2005). The goals and objectives of the Recovery Plan are further discussed in section 3.3.3, *Threatened and Endangered Species*.

Finally, the section of the Penobscot River within the project area is managed as a smallmouth bass fishery, and is known to provide some of the best smallmouth bass fishing in the eastern United States, particularly the 60-mile stretch of river from Medway to downstream of Old Town (Maine DIFW, 2006). Management activities include periodic sampling to determine size quality and growth rates of smallmouth bass, which is used to develop fishing regulations to improve the size quality of the species. Maine DIFW encourages anglers to harvest smaller bass to increase growth rates (Maine DIFW, 2006).

Resident Fish

The Penobscot River near the Mattaceunk Project supports a community of common cool and warm water riverine fish species (Dube *et al.*, 2011). Kiraly *et al.* (2015) found 27 resident fish species in the Penobscot River tributaries and mainstem, in addition to 7 anadromous and 1 catadromous⁶⁸ fish species (American eel), and land-locked Atlantic salmon.⁶⁹ In sampling focused only in the mainstem of the river

⁶⁸ The term “catadromous” is used to describe a life history strategy where fish reproduce and spend early life stages in saltwater, move into freshwater to rear as sub-adults, then move back into saltwater to spawn as adults.

⁶⁹ The data analyzed by Kiraly *et al.* (2015) was collected using a boat-based electroshocking device, with which researchers sampled several stretches of shoreline along the river and its tributaries.

downstream of the Mattaceunk Project, 24 resident species were collected (Kiraly *et al.*, 2015).⁷⁰ Resident fish most abundant by number were common shiner, fallfish, redbreast sunfish, white sucker, smallmouth bass, pumpkinseed sunfish, and golden shiner. Those most abundant by mass were smallmouth bass, redbreast sunfish, white sucker, fallfish, brown bullhead, chain pickerel, and common shiner.⁷¹

In spite of the riverine appearance of the impoundments, Kiraly *et al.* (2015) observed differences in the composition between the impounded waters and faster flowing sections in the mainstem. In the impoundments, fewer fish were captured for the same amount of effort applied, and the catch was less varied in species composition than in flowing reaches (table 5).

Table 5. Catch per unit effort of fish species (Atlantic salmon excluded) observed in 2009 and 2010 in the Penobscot River Watershed.

Fish Species Observed			Number Observed	
Common Name	Scientific Name	Native	2009	2010
Brook trout	<i>Salvelinus fontinalis</i>	X	25	10
Smallmouth bass	<i>Micropterus dolomieu</i>		38	71
Largemouth bass	<i>Micropterus salmoides</i>		43	0
White sucker	<i>Catostomus commersonii</i>	X	41	67
Fallfish	<i>Semotilus corporalis</i>	X	73	56
Eastern blacknose dace	<i>Rhynchithys atralulus</i>	X	487	554
Creek chub	<i>Semotilus atromaculatus</i>	X	244	12
Common shiner	<i>Notropis cornutus</i>	X	189	17
Slimy sculpin	<i>Cottus cognatus</i>	X	393	236
Burbot	<i>Lota lota</i>	X	16	6
American eel	<i>Anguilla rostrata</i>	X	188	1
Sea lamprey	<i>Petromyzon marinus</i>	X	10	4

⁷⁰ One species, the slimy sculpin, was found only in tributaries to the Penobscot River and not in the mainstem. Two species, the black crappie and mummichog, were found only below Veazie Dam, where the river is under tidal influence and the habitat differs from the area near the Mattaceunk Project.

⁷¹ Similar results were found in the river by NOAA in 2008 and Kleinschmidt Associates in 2009 and 2010.

Fish Species Observed			Number Observed	
Common Name	Scientific Name	Native	2009	2010
Sunfish ^a	<i>Lepomis spp.</i>	X	40	0
Golden shiner	<i>Notemigonus crysoleucas</i>	X	30	0
Yellow perch	<i>Perca flavescens</i>	X	2	0
Chain pickerel	<i>Esox niger</i>	X	1	0
Alewife	<i>Alosa pseudoharengus</i>	X	4	0

^a Redbreast sunfish (*L. auritus*) and pumpkinseed (*L. gibbosus*) are both native species (Dube *et al.*, 2011).
(Source: GLHA, 2016a).

Kiraly *et al.* (2015) found that there was some evidence that smallmouth bass were spawning in impoundments and using flowing reaches for most of the remaining time. The movement of resident fish species was also indicated in upstream fish passage studies conducted at the Mattaceunk upstream fishway between 1983 and 1986. Resident species appearing in the fish ladder at the project were brook trout, fallfish, landlocked Atlantic salmon,⁷² longnose sucker, white sucker, and smallmouth bass (GNP, 1983, 1984, 1985, 1986) (table 6).

Table 6. Resident fish species counted within the Mattaceunk upstream fishway trap between 1983 and 1986.

Species	1983	1984	1985	1986
American eel*	many	many	many	many
Brook trout	1	2	32	29
Fallfish	1	0	3	0
Landlocked salmon	14	115	77	133
Longnose sucker	-	-	-	27
Smallmouth bass	39	22	65	35
White sucker	5	1	109	8

* Juvenile eels (likely elvers) were observed in the upstream fishway, but were not counted or captured in the fish trap. (Source: GNP, 1983, 1984, 1985, 1986).

⁷² Landlocked salmon generally have the same life history as Atlantic salmon, with the exception of smolts outmigrating to lakes or reservoirs (rather than the ocean) to mature before migrating back to their natal streams to spawn.

Six of the resident species identified by Kiraly *et al.* (2015) were introduced into the Penobscot River and have become residents. Four of those six, smallmouth bass, chain pickerel, largemouth bass, and yellow perch, are predators, with smallmouth bass and chain pickerel both being abundant by mass. The presence of the introduced predators, particularly smallmouth bass and chain pickerel, could influence the community composition through top-down effects on the food web (Kiraly *et al.*, 2015).

The upper mainstem of the Penobscot River is a popular sport fishing area, where common target species include smallmouth bass, brook trout, white perch, landlocked salmon, and chain pickerel. Brook trout are commonly stocked and managed in the Penobscot River and its tributaries. Maine DIFW manages a popular smallmouth bass sport fishery throughout Maine, including in the project area, as discussed above.

Diadromous Fish⁷³

Of the diadromous species historically found in the Penobscot River, Atlantic sturgeon, shortnose sturgeon, rainbow smelt, Atlantic tomcod, and sea-run brook trout likely did not migrate upstream of the historic falls located at the site of Milford Dam (Maine DMR and Maine DIFW, 2009), which is located approximately 54 river miles downstream from the Mattaceunk Project. The Mattaceunk Project is located in the historical range of Atlantic salmon, alosines (American shad and river herring), striped bass,⁷⁴ sea lamprey, and eel. Because of the presence of an upstream fish lift at the Milford Project, as well as the upstream vertical slot fishway and eel ladder at the West Enfield Project, all of those species whose ranges currently include, or historically included, the upper Penobscot River Basin have upstream routes to the Mattaceunk Project. Downstream fishways at West Enfield and Milford also allow those species that migrate downstream from the Mattaceunk Project to reach the ocean. Currently, NMFS, FWS, Maine DMR, Maine DIFW, and Penobscot Indian Nation are working to restore diadromous fish populations in the Penobscot River through the Penobscot Restoration Project and the “Operational Plan for the Restoration of Diadromous Fishes to the Penobscot River” (Maine DMR and Maine DIFW, 2009).

⁷³ The term “diadromous” is used to describe a life history strategy where fish migrate between freshwater and saltwater for the purposes of reproduction.

⁷⁴ There is no available information on the historical distribution of striped bass. While this species was commonly captured in the Veazie fish trap, and currently at the Milford fish lift, the species is not expected to reach the Mattaceunk Project (Maine DMR and Maine DIFW, 2009).

Catadromous Fish

American eel

The American eel is the most widely distributed diadromous fish in the Penobscot River (Yoder *et al.*, 2005; NOAA, 2008). The species spends most of its life in fresh or brackish water before migrating to the Sargasso Seas 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, 2000).

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 eel are completely transparent and make their way into brackish waters by the use of flood tides. Once skin pigments develop in glass eel, they are considered “elvers.”⁷⁵

As eel mature, elvers become juvenile, or “yellow” eel. The majority of eel collected in freshwater rivers are typically yellow eel, which is considered the primary growth phase of its life cycle (Ross *et al.*, 2001). Yellow eel 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 final maturation into the silver eel and out-migration in the fall and mid-winter months to spawning grounds (*i.e.*, Sargasso Sea) occur (Boschung and Mayden, 2004).⁷⁶ Adult eel are presumed to die after spawning (Boschung and Mayden, 2004; Jenkins and Burkhead, 1993).

⁷⁵ Elvers often serve as important forage fish for striped bass and other large piscivores.

⁷⁶ Juvenile eel that reside in estuaries reach maturity and migrate earlier than juveniles found in freshwaters, and that these eel can reach full maturation while never migrating to freshwater (FWS, 2007).

Eel are opportunistic carnivores, selecting a range of prey items from small aquatic insects and crustaceans to larger macroinvertebrates and fish (Ross *et al.*, 2001).⁷⁷ Eel may live up to 40 years, depending on latitude, and grow greater than 39 inches in total length (Boschung and Mayden, 2004; Jenkins and Burkhead, 1993).

In the Penobscot River, the eel has been commercially harvested as far upstream as Millinocket on the West Branch as recently as the 1990s, and is still present (Yoder *et al.*, 2005; NOAA, 2008; and HDR, 2013, 2014). Juvenile and adult eel are known to occur upstream of the Mattaceunk Project, though there is currently no upstream passage provided for eel at the project. Upstream eel passage has been observed at the project using the upstream pool and weir fish ladder.⁷⁸

In a 2008 river-wide fish assemblage study, the National Oceanic and Atmospheric Administration (NOAA) documented that eel composed a significant portion of the biomass sampled via electrofishing in the Penobscot River (NOAA, 2008). More specifically, juvenile eel represented 35 percent of the overall fish biomass upstream of the Mattaceunk Project on the East Branch of the Penobscot River near Grindstone (in September 2008), and 12 percent of the fish biomass near river mile 2.5 on the East Branch of the Penobscot River (in June 2008).

In 2014, GLHA conducted an American Eel Passage Study at the Mattaceunk Project to identify areas where upstream migrating juvenile eel concentrate, and to assist in developing a conceptual upstream eel passage design (GLHA, 2015). Surveys were conducted during no spill conditions from mid-May through September. The estimated number of eel observed during each survey ranged from 11 to 200. The total number of eel observed was about 456, with peak numbers occurring in July (table 7).

Table 7. Summary of 2014 night-time American eel counts at the Mattaceunk Project.

Survey Location *	Survey Date					Total Number	Relative Abundance (%)
	6/25	7/21	7/29	8/19	9/9		
Spillway	0	0	0	0	0	0	0
Lower TOD	15	35	24	0	0	74	16.2
Upper TOD	45	80	52	12	5	194	42.6

⁷⁷ Larger eel (greater than 13.8 inches) may consume more fish or large macroinvertebrates, and even scavenge, while smaller (5.9 to 13.8 inches) or younger eel may feed primarily on benthic invertebrates (Boschung and Mayden, 2004).

⁷⁸ Elvers have been observed but not counted, with the greatest numbers being observed within the fishway when it was shut down for maintenance activities (GNP, 1983, 1984, 1985, 1986).

Survey Location *	Survey Date					Total Number	Relative Abundance (%)
	6/25	7/21	7/29	8/19	9/9		
Bedrock	15	20	124	23	6	188	41.2
TOTAL	75	135	200	35	11	456	100.0

* TOD = Toe of dam.

(Source: License Application at E-85).

The eel observed during the Weldon Dam night-time surveys ranged from an estimated 4 to 24 inches in length. Approximately 366 were 5 to 8 inches in length, which were the most abundant sizes observed. Approximately 55 eel were 4 to 5 inches in length; 34 eel were 10 to 18 inches in length; and 1 eel was about 24 inches in length. The majority of the eel were observed staging or in the process of migrating up the face of Weldon Dam, along the right descending bank (looking downstream from the dam), in leakage flow at the upper portion of the toe of the dam, or within the two upper pools of the bedrock habitat (figure 9).⁷⁹

⁷⁹ Based on the night-time observations, most of the eel navigated to the right descending bank portion of the toe of the dam by ascending the cascading bedrock habitats. Eel were also observed within crevices along the lower portion of the toe, either climbing directly up the spillway or toward the upper portion of the toe. See figure 9.



Figure 9. Upstream American eel migration routes for Weldon Dam. Arrows indicate upstream eel migration routes: yellow arrows indicate the primary upstream eel migration routes and red arrows are secondary routes.

(Source: License Application at E-86).

Based on the upstream eel passage study, GLHA developed a conceptual design for seasonal upstream passage for eel at the project (figure 10; GLHA, 2015). The design would consist of a seasonal, upstream eel ladder, which would be located adjacent to the right descending bank, along the west abutment of the spillway. This type of eel passage is similar to typical upstream eel ramps installed at other hydropower facilities in Maine. The facility would include: (1) a siphon or pump system installed in the headpond (to provide attraction and conveyance flow); (2) a sloped aluminum or wooden eel ramp with Enkamat attached as the climbing substrate; (3) a temporary trapping component (*e.g.*,

holding tank); and (4) a small-diameter flexible conduit extension leading directly into the headpond (for future volitional passage).



Figure 10. Conceptual design of upstream American eel passage facility at Weldon Dam.
(Source: GLHA, 2015).

Downstream passage for eel has been studied for a number of years at the Medway Project, which is located approximately 7 miles upstream of the Mattaceunk Project on the West Branch of the Penobscot River. The studies focused on the timing and relative abundance of silver migrating eel in an attempt to secure an adequate number of eel to conduct a scientifically defensible downstream passage study. These studies were conducted over the expected migration season from August to October. Few eel were caught between 2004 and 2006 (Aquatic Science Associates, 2005, 2007). The consensus among the resources agencies, the Penobscot Indian Nation, and GLHA, at the time, was that insufficient numbers of silver eel were available for the study.

GLHA re-assessed downstream migrating eel abundance at the Medway Project in 2012 and 2013. In 2012, a total of 11 eel were captured, with six eel potentially being out-migrating (silver) eel. An additional 16 eel were observed and not captured during the 2012 study (HDR, 2013). In 2013, 20 eel were captured, but only two were potentially silver eel. An additional 30 eel were observed, but not captured during the

2013 study (HDR, 2014). As with the earlier studies, resource agencies, the Penobscot Indian Nation, and GLHA concluded that there were insufficient silver eel to conduct a statistically valid downstream passage study, though downstream passage remains a concern at the Medway and Mattaceunk Projects.⁸⁰

Anadromous Fish⁸¹

*Alosines (American shad and River Herring)*⁸²

American shad, blueback herring, and alewife spend most of their lives at sea, but return to their natal (home) rivers along the eastern seaboard of North America to reproduce (Melvin *et al.*, 1986; Greene *et al.*, 2009). Spawning runs of alewives 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 and American shad primarily spawn in lotic (mainstem river) habitats, whereas alewives generally spawn in lentic (lake or pond) habitats within a river basin (Loesch, 1987). In the Penobscot River, the historical spawning range of American shad extends upstream at least as far as the mouth of Wassataquoik Stream (on the East Branch of the Penobscot River) based on historical commercial catch data (Foster and Atkins, 1867). Although not well documented, the historical spawning range of blueback herring in the Penobscot River is thought to be similar to American shad based on their similar spawning habitat preferences (Maine DMR and DIFW, 2008). The current upstream extent of wild American shad and blueback herring⁸³ in the Penobscot River is thought to

⁸⁰ GLHA plans to evaluate the new downstream fishways for eel at the downstream Milford, Stillwater, and Orono Projects in 2016. The information obtained from this evaluation would be used to inform decisions about downstream eel passage measures and future studies at other hydropower projects, including the Medway and Mattaceunk Projects. See GLHA's March 31, 2016 filing at 3.

⁸¹ The term "anadromous" is used to describe a life history strategy whereby adults spend most of their time (feeding and overwintering) at sea but return to freshwater to reproduce.

⁸² Blueback herring and alewife are difficult to distinguish visually and, therefore, are often collectively referred to as river herring.

⁸³ American shad and blueback herring are not currently targeted for stocking in the Penobscot River, but alewives are. The primary collection source of adult alewives for stocking purposes is the fish trap at the Milford Project. During these collections, some blueback herring are incidentally collected and stocked as they are similar in appearance to alewives.

be Weldon Dam, as river herring have been observed in, but have not successfully passed, the Mattaceunk upstream fishway, and American shad have been observed passing through the upstream fishway at the West Enfield Project (next dam downstream), but not at Mattaceunk (GLHA, 2016a; HDR, 2017).

In northern latitudes (New England), alosines 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;⁸⁴ and in the nearby Connecticut River, Loesch and Lund (1977) estimated that 81 percent of blueback herring were repeat spawners.

Young alosines generally remain in river habitats for a few months before out-migrating to the sea as juveniles during late summer and early fall, as peak out-migration occurs once water temperatures begin to steadily fall below 66-69°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). Juveniles generally spend three to five years at sea, where they mature, and subsequently return to their natal rivers in the spring to spawn to complete their life cycle (Saunders *et al.* 2006; Greene *et al.*, 2009).

Sea Lamprey

Like the alosines described above, 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 (ammocoetes) life stages 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.

The historical distribution and abundance of sea lamprey in the Penobscot River is not well understood (Maine DMR and Maine DIFW, 2008). Sea lamprey were collected upstream of the project in the Piscataquis River in 1832, and in the East Branch in 1903 (Kendall, 1914). However, the numbers collected by Kendall (1914) are not known, and

⁸⁴ The term “repeat spawners” refers to adult shad that survive spawning and return to the river in subsequent years to spawn.

there is no other historical documentation of sea lamprey abundance upstream of the project. Recently (2010-2011), but prior to the removal of Veazie and Great Works dams, sea lamprey were collected between Milford Dam and West Enfield Dam (Kiraly *et al.*, 2015). Since the removal of Veazie and Great Works Dams, sea lamprey have been captured at the new Milford Dam fish lift and released upstream. A total of 485 sea lamprey were counted and passed upstream of the Milford Dam fish lift in 2015, and 3,833 were counted and passed in 2016 (Maine DMR, 2015; 2016). In addition, an unknown number of lamprey have been observed passing the Milford fish lift sorting facility. Preliminary data from the West Enfield fish passage facility indicates that about 2,432 sea lamprey passed upstream of West Enfield Dam (the next dam downstream from Mattaceunk) in 2016.

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. Seven freshwater mussel species have been reported to occur in the project area (table 8).

In September 2012, GLHA conducted a mussel survey to document species presence, distribution, and relative abundance within the project impoundment in anticipation of a substantial impoundment drawdown (20-25 feet) for dam maintenance. After an initial reconnaissance survey along the impoundment perimeter, GLHA visually surveyed 12 transects: 2 transects each within the East and West Branches of the Penobscot River in the upstream section of the impoundment and eight transects in the middle and downstream sections. A total of 18,574 mussels representing seven species were observed during the survey. In June and July 2013, 11,157 mussels were surveyed and relocated to suitable areas before and during impoundment drawdown.

Table 8. Freshwater mussel species reported occurring in the project area.

Common Name	Location	Percentage Relative abundance
Eastern elliptio	East Branch, West Branch, and impoundment	81.9
Eastern lampmussel	East Branch, West Branch, and impoundment	16.9
Tidewater mucket floater	Southeastern side of Nicatou Island, 0.3 miles downstream of Interstate 95, and near the western point of Lawrence Island	0.8
Yellow lampmussel	Southeastern side of Nicatou Island, 0.3 miles downstream of Interstate	0.2

Common Name	Location	Percentage Relative abundance
	95, and near the western point of Lawreance Island	
Creeper	West Branch and impoundment	0.1
Eastern floater	West Branch	0.1
Triangle floater	West Branch	0.1

(Source: Normandeau 2012, modified by staff)

The overwhelming dominant species was the eastern elliptio, followed by the eastern lampmussel, and tidewater mucket, which were found in all transects. Yellow lampmussel's relative abundance increased from upstream to downstream and creeper's relative abundance increased from downstream to upstream. Eastern elliptio's relative abundance increased from upstream to downstream with the highest concentration at the confluence of the East and West Branches of the Penobscot River. GLHA observed brook floater during the survey in the upper reach of the impoundment in the West Branch with no specific numbers detailed in the report.

3.3.2.2 Environmental Effects

Impoundment Levels

GLHA proposes to continue to operate the project in run-of-river, while maintaining impoundment fluctuations: (1) within 1 foot or less from the top of the 4-foot-high flashboard crest elevation (240.0 feet) during normal project operation, or within 2.0 feet of normal flashboard crest elevation when necessary (i.e., to allow an adequate margin for debris, or sudden pool increases that might cause flashboard failure); and (2) within 1 foot of the dam crest elevation (236.0 feet) when the flashboards are down for repair or installation. Thus, other than when drawdowns are needed, the project is operated as a run-of-river facility, with inflow approximately equal to outflow. Interior, NMFS, and Maine DMR all provide recommendations that are consistent with GLHA's proposed limits on impoundment surface elevations.

Our Analysis

GLHA recorded the impoundment fluctuation curves for 2008 through 2015 (figure 11), depicting typical water levels of the Mattaceunk Project during normal impoundment elevations.

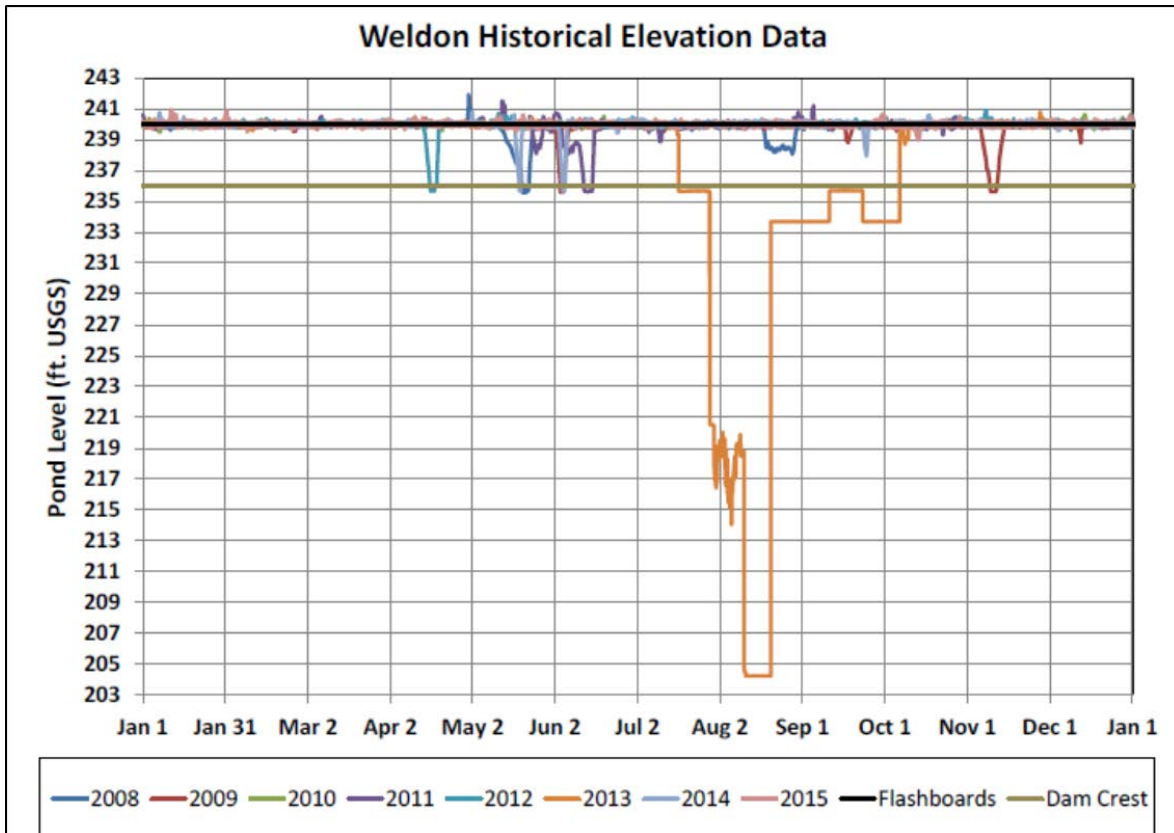


Figure 11. Summary of impoundment fluctuation curves from 2008 through 2015. (Source: GLHA, 2016a)

Based on analysis, water levels rarely deviated by more than 0.2 to 0.5 feet from the normal pond elevation of 240.0 feet when the 4-foot-high flashboards were in place (figure 11). The only exceptions were for flashboard replacement and downstream fishway repairs, which occurred 8 times over 9 years, including several scheduled maintenance activities. In addition, GLHA conducted numerous studies for the purpose of relicensing that considered the effects of impoundment fluctuation on aquatic resources, soil and geology, terrestrial, and cultural resources. These studies indicated that under normal operation, minimal impoundment fluctuations resulted in stable impoundment and downstream habitats.

An impoundment fluctuation of anything less than 0.2 to 0.5 feet from the normal pond elevation of 240.0 feet would be hard to maintain in the presence of variations in wind, inflow, and other factors. Therefore, a buffer greater than 0.5 feet from the top of the flashboards is needed to allow an adequate margin for wave action. Finally, some flexibility regarding impoundment elevations is needed to remove debris and to prevent flashboard failure under stress from ice and flooding.

Minimum Flows

Minimum flows downstream from hydropower projects have the potential to affect the quality of habitat for fish and aquatic organisms and potentially create fish migration barriers by affecting the frequency, timing, and duration of flows released downstream of a project. As previously discussed, GLHA proposes to continue to provide a year-round continuous minimum base flow of 1,674 cfs, or inflow, whichever is less as it does under its current license. Additionally, GLHA proposes to continue to maintain a daily average minimum flow of 2,392 cfs, or average inflow, whichever is less, from July 1 through September 30, and 2,000 cfs, or average inflow, whichever is less, from October 1 through June 30. Maine DMR and NMFS recommend these minimum flows.

Our Analysis

The existing and proposed continuous minimum flow of 1,674 cfs initially was based on providing a flow volume approximating the historical, unregulated, median August flow in the Penobscot River. Because the aquatic communities downstream from the project have adapted to the effects of the August low-flow period on water quality and aquatic habitat (e.g., higher temperatures, lower dissolved oxygen, and reduced habitat availability), FWS, in their response to Great Northern’s application for a new license in 1984, concluded that providing at least the median streamflow in August was sufficient to sustain aquatic communities throughout the year. It also would not interfere with the project’s mode of operation. Based on historical data, the project would release 1,674 cfs about 99.9 percent of the time.

In 2014, GLHA conducted a Minimum Flow Habitat Study, as discussed in 3.3.3.2, *Affected Environment, Aquatic Habitat*. GLHA concluded that there are no areas in the thalweg that would impede fish migration at minimum flows (see figure 8). Additionally, GLHA analyzed the historical river flow data from 1996 – 2012 to evaluate the frequency, timing, and duration of minimum flow releases during the migratory seasons of eel and Atlantic salmon in the Penobscot River (table 9). And, as discussed previously, flows were the highest in the spring (April through June), as a result of annual spring runoff (see table 3).

Table 9. Aquatic Passage Seasonal Flows in cfs (1996-2012).

Species / Life stage	Primary Migratory Period	Average Flow	Minimum Flow	90 percent Exceedance	10 percent Exceedance	Maximum Flow
American Eel Upstream	Early June to late August	5,100	1,891	2,893	8,410	41,321

Species / Life stage	Primary Migratory Period	Average Flow	Minimum Flow	90 percent Exceedance	10 percent Exceedance	Maximum Flow
American Eel Downstream	Early August to Lake November	5,433	1,266	2,925	8,838	45,108
Atlantic Salmon (adult upstream)	Early June to Late October	5,366	1,726	2,943	8,714	45,108
Atlantic Salmon (smolt downstream)	May	9,664	1,673	3,409	18,807	69,936
Annual		6,258	1,163	2,948	10,868	69,936

(Source: GLHA, 2016a).

The Minimum Flow Habitat Study demonstrated that aquatic habitat and a zone of passage for fish migration remain suitable during minimum flow conditions. During the 1996-2012 period, average minimum flows at, or below, 1,674 cfs only occurred on 48 days from 1996 to 2012, or less than 1 percent of the total days (table 10). The majority of these days occurred from January to March. From May to November, the months when migration is known to occur, flows at, or below, 1,674 cfs only occurred four times from 1996-2012, or on about 0.1 percent of the days during these months. Minimum flows at, or below, 2,000 cfs occurred on 120 days from 1996 to 2012, but occurred every month except June and September. There were 16 days during the potential migration period of eel and Atlantic salmon when flows were between 1,674 cfs and 2,000 cfs.

Table 10. Number of days daily average low flows occurred at the project (POR 1996-2012).

Month	Less than or equal to 1,674 cfs	Less than or equal to 2,000 cfs
January	16	28
February	17	29
March	10	34
April	0	1
May	1	3
June	0	0
July	0	1
August	0	3
September	0	0
October	0	2

Month	Less than or equal to 1,674 cfs	Less than or equal to 2,000 cfs
November	3	7
December	1	12
Total	48	120

Under the proposed and existing minimum flow of 1,674 cfs at the Mattaceunk Project, the reach downstream from Weldon Dam provides adequate habitat to support aquatic life and a zone of passage for fish migration. Based on the habitat mapping and transect profile data, which show extensive connectivity of deep-water habitats along both shorelines; the deep-water habitats extend well into the channel. Additionally, GLHA assessed the wetted perimeter of three transects for pool, riffle, and run habitats (see figure 8), located in the outlet stream habitat below the dam. The calculated wetted perimeters at low flow for the three transects were 78.4, 87.4, and 71.2 percent, respectively, and averaged 79 percent of the bankfull perimeter. This information supports the conclusion that the minimum flow of 1,674 cfs provides access to pool, riffle, and run habitat downstream from the project, as well as provides a zone of passage for fish migration.

In addition to the wetted-perimeter information, the flow data from 1996 to 2012 shows that the 1,674 cfs minimum flow was almost always exceeded at Weldon Dam during months when eel and Atlantic salmon migrations typically occur (May to November). The rare occurrences when flows dropped below 1,674 cfs typically represented drought conditions within the watershed that were out of the GLHA's control. Providing GLHA's proposed minimum and daily average flows would continue to provide aquatic habitat and an adequate zone of passage for migratory fish during minimum flow conditions.

Water Quality

Dissolved Oxygen

GLHA does not propose any new water quality measures. Maine DEP states that the results of GLHA's water quality study demonstrate that: (1) the Mattaceunk Project's impoundment is free of culturally-induced algae blooms⁸⁵ and so is expected to meet the designated use for swimming and recreation in and on the water; (2) the current and proposed project operations (impoundment drawdowns) do not appear to have significant

⁸⁵ Algae blooms are sudden, massive growths of green or blue-green algae, which naturally develop in lakes or reservoirs, when conditions are sufficient, and the water contains enough nutrients to support rapid algae growth. Excessive organic loading (nutrients) into a receiving water body from industry or a non-point sources can cause culturally-induced algae blooms.

adverse impacts on the aquatic life in the impoundment and is expected to meet the applicable aquatic life and habitat standards and designated use of habitat for fish and other aquatic organisms; (3) DO concentrations in the outlet stream meets or exceeds applicable Class C standards for DO under critical water quality conditions; and (4) outlet stream effects on benthic macroinvertebrates exhibit some adverse effect from the impoundment, but that those effects are not greater than the effects seen downstream of a natural lake or pond and, thus, are expected to meet Class C aquatic life criteria under the current and proposed minimum flows.

Our Analysis

As described above, in section 3.3.2.1, *Aquatic Resources, Affected Environment*, Maine DEP reported that the water quality at the Mattaceunk Project was within the state water quality standards for Class C waters. The data also indicated that the impoundment did not stratify. Vertical water temperatures and DO concentrations in the impoundment were relatively uniform throughout the water column. Water temperatures in the impoundment reflected seasonal air temperatures, with lowest temperatures in early fall and highest temperatures in late summer. Inversely, DO concentrations decreased as temperature increased. DO concentrations ranged from 7.0 mg/L to 9.8 mg/L, consistently above the minimum concentration of 5.0 mg/L for Class C waters. The impoundment had low levels of nutrients and did not foster high densities of algal populations, suggesting that the impoundment was oligotrophic. The macroinvertebrate data were consistent with the characteristics fitting the Class C aquatic life criteria and demonstrating that the structure and function of the resident biological community were maintained and would be expected to continue to be maintained with no change to project operation.

Water Temperature

GLHA does not propose any temperature monitoring measures. Though some dam operations have the potential to increase water temperature, Maine does not have a state standard for temperature to address such potential affects.⁸⁶ However, NMFS recommends that GLHA conduct continuous stream temperature monitoring between April 1 and October 31 to ensure that the dam and its operations do not intensify the effects of climate change that can affect smolt emigration, adult immigration, and juvenile development in nursery habitats downstream of the dam.⁸⁷ The Penobscot

⁸⁶ Me. Stat. tit. 38, § 465.

⁸⁷ NMFS did not specify the location of stream temperature monitoring; however, because its recommendation includes references to “habitats downstream of the dam” and “stream temperature” (not impoundment), we assume the recommendation is to monitor temperature downstream of the dam.

Indian Nation comments that GLHA's 4.5-month water temperature monitoring in 2012 does not adequately characterize the water temperature for the project (see figure 6), and states that a plan for monitoring for multiple years is necessary.

Our Analysis

Dam operations that increase downstream water temperatures are normally the result of one or both of two processes. In one process, increasing the residence time of the water in the impoundment upstream of the dam allows more time and exposure to the heat of the sun, causing the water released to be warmer than it otherwise would be. In another, sometimes related process, water in an impoundment can physically stratify into horizontal layers by water temperature. If the project water intake is at a depth of a warmer layer of water, the project release would be higher in temperature than in the impoundment inflow. Changes in temperature are most evident during low flow periods when residence time is already longer because of the reduced volume of water reaching the impoundment. High temperatures are associated with lower DO⁸⁸ and shifts in water chemistry that can be harmful to fish and other aquatic organisms.

GLHA proposes to continue to operate the project in a run-of-river mode, as occurs under existing conditions (*see* discussion in section 2.1.3, *Existing Project Operation*). GLHA's studies of the impoundment from June to October 2014, indicate that impoundment does not stratify by temperature, is generally shallow (20,891 acre-feet storage capacity), and has a hydraulic residence time of about 41 hours⁸⁹ (see figures 4 and 5 in section 3.3.2.1., *Aquatic Resources, Affected Environment*). The relatively short residence time and lack of temperature stratification indicate that project operation would be unlikely to cause substantial increases in water temperature through the impoundment.

GLHA also monitored water temperatures upstream of the project, within the impoundment, and in the downstream tailrace from May to September 2012 (see figure 6). As discussed in 3.3.2.1, *Aquatic Resources, Affected Environment*, the 2014 monitoring data indicates that: (1) there is little temperature deviation between the three sites; (2) DO concentrations exceeded the minimum DO standard of 5.0 mg/L; and (3) the macroinvertebrate community was consistent with Class C aquatic life criteria.

⁸⁸ The quantity of dissolved gas, such as oxygen, decreases with increasing temperature.

⁸⁹ The hydraulic residence time is a measurement of the average length of time that water is stored in an impoundment. Residence times can range from less than 40 days for relatively small impoundments to many years for the largest reservoirs (Baxter, 1977; Petts, 1984; Kelly, 2001). At the Mattaceunk Project, the residence time is calculated as 40.7 hours using 20,891 acre-feet storage capacity divided by 6,204 cfs, mean annual flow.

Additionally, the existing, resident fish population within the project vicinity is diverse, self-sustaining, and similar to other areas of the river. Taken together these findings support the conclusion that there are no substantial project-related temperature issues associated with current project operation.

Regarding the NMFS recommendation that GLHA continuously monitor stream temperature downstream from the dam, water temperature, of course, will vary both through natural, short-term factors, and global trends. During dry periods, the water temperature will tend to be higher and conditions more stressful for aquatic organisms. The project, however, is not substantially changing the temperature of water in the Penobscot River, nor is there a proposal to change how the project operates that would alter the river's water temperature.

The Penobscot Indian Nation is concerned that GLHA's 4.5 months of water temperature monitoring in 2012 is inadequate to characterize the water temperature variation at the project. While the 4.5 months of monitoring data was collected over only one season, it was a relatively dry, low-flow year.⁹⁰ Thus, the existing data shows the effects of project operation when the effects would likely be greater than normal. The existing monitoring data supports the finding that even under relatively dry conditions, the project has little effect on water temperature in the Penobscot River. In addition, because existing conditions provide good water quality that supports aquatic life, and because GLHA does not propose any changes to project operation, there would be no benefit to monitoring water temperature continuously.

Operation Compliance Monitoring

Although 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, operational compliance monitoring and reporting are typical requirements in Commission-issued licenses. Under the existing license, GLHA monitors compliance with project operation and minimum flows using an existing

⁹⁰ According to the U.S. Drought Monitor, Maine was abnormally dry in the spring of 2012 (U.S. Drought Monitor, ND). In April 2012, one month prior to GLHA's water temperature monitoring, Maine was categorized as D1 (moderate drought) with rain deficits between 25 and 50 percent. During the 2012 monitoring period, Maine's drought category improved from D1 to D0 (abnormally dry – used for areas not yet in or recovering from a drought) and low stream-flow and groundwater concerns. <http://droughtmonitor.unl.edu/DroughtSummary.aspx>

monitoring system⁹¹ that allows GLHA to: (1) maintain and store mean daily and hourly data for inflow to the impoundment, outflow from the project, and water levels in the project impoundment; and (2) provide these data to the agencies within 30 days of a request.

GLHA proposes no changes to project operation, and GLHA would continue to monitor impoundment elevations and tailwater levels remotely, using records of gate setting and turbine operation (GLHA, 2016a), as described above. GLHA also proposes to continue to make recent flow data available on the internet in near-real time.⁹² GLHA also has agreed, as an outcome of the 10(j) meeting held on June 7, 2018, to develop an operation compliance monitoring plan,⁹³ in consultation with NMFS, FWS, Maine DMR, and Maine DIFW that would include: (1) methods used to verify the accuracy of the existing monitoring system, including recalibration, as necessary;⁹⁴ (2) a schedule of

⁹¹ Impoundment water level is measured directly by the system and transmitted to the power dispatcher within the control center located in Marlborough, Massachusetts. GLHA uses curves to estimate flows that pass through the turbines (i.e., kilowatts of generation versus flow), and flows that pass through the dam's roller gate or over the flashboards (i.e., gate setting versus flow) (*See* Summary of 10(j) Meeting filed on June 19, 2018). Flow data is stored in the computer in mean hourly increments. Mean daily summaries are printed and archived. Impoundment water level is monitored continuously and stored in hourly increments. Data are supplied to the resource agencies within 30 days of a request for the data. *See* 55 FERC ¶ 62,259 (1991).

⁹² GLHA provides single estimates of flow online (National Waterline website: <http://www.h2oline.com/default.aspx?pg=si&op=235118>) about every 15 minutes. The flow data are displayed online with a delay of about 5 minutes. Thus, the data are made available in near-real time, but not in real-time (i.e., without delay). GLHA does not maintain historical logs of flow data online.

⁹³ GLHA filed an operation compliance monitoring plan on September 14, 2018. We will address the merits of the plan in the license order.

⁹⁴ GLHA agreed to include in the plan, methods used to verify the accuracy of the flow curves and gate settings, including recalibrating the curves and gate settings, as necessary.

verification and recalibration events;⁹⁵ and (3) a provision to make flow data available to the public upon request.⁹⁶

Maine DEP recommends that GLHA develop a project operation and monitoring plan that specifies the methods used to monitor project operation, and to maintain minimum flows and impoundment elevations within the licensing limits.⁹⁷ NMFS recommends that GLHA conduct a study, within 1 year of any new license issued, to verify the accuracy of the existing flow monitoring system and develop a minimum flow monitoring plan. This plan would include making near-real time⁹⁸ and historic flow data electronically accessible to the public via the internet within one year of any new license issued. NMFS also recommends that GLHA develop a plan to monitor impoundment water levels, and consult with the resource agencies and USGS in developing the plan.

Our Analysis

Impoundment Surface Elevation Monitoring

GLHA's records indicate that GLHA has maintained the project impoundment within a narrow elevation range. Historically, fluctuations have ranged from 0.2 to 0.5 feet from the normal pond elevation of 240.0 feet, when the 4-foot-high flashboards are in place (figure 11). The only exceptions occur during flashboard replacement, downstream fishway repairs, and scheduled maintenance activities.

GLHA's records show that impoundment fluctuations are minimal under normal operation. However, monitoring impoundment levels on a more regular basis would

⁹⁵ GLHA agreed that field verification and recalibration events would occur soon after license issuance and at future dates during the term of the license. The future dates would be determined based on discussions with fluid dynamics consultants and the turbine vendor, as well as after consultation with the resource agencies.

⁹⁶ The flow data that GLHA makes available online does not include historical logs of data. This provision would allow the public to request and receive all data, including historical data.

⁹⁷ In a letter filed on July 7, 2017, GLHA indicated that it was amenable to the type of operation and monitoring plan recommended by Maine DEP.

⁹⁸ In a letter filed on June 28, 2018, NMFS recommended making flow data available in real-time (i.e., without delay). However, based on discussions during the 10(j) meeting held on June 7, 2018, we assume that NMFS is recommending that GLHA use the existing National Waterline website which provides data with about a 5 minute delay.

allow GLHA to verify and evaluate operations throughout the term of the license. As recommended by Maine DEP, formalizing GLHA's existing monitoring protocol in an operation compliance monitoring plan would help GLHA 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, and ensure the protection of resources that are sensitive to impoundment fluctuations.

Minimum Flow Monitoring

The existing system used by GLHA has been fully adequate for monitoring the minimum flow requirements of the existing license, and would continue to be fully adequate for monitoring minimum flow requirements of any new license issued. Using the existing system, GLHA has been compliant with the existing minimum flow requirements, and there is no reason to believe GLHA would not be compliant under a new license. Because GLHA does not propose any changes in minimum flows, has an existing system that is fully adequate for monitoring minimum flows, and has operated the project without any evidence of deviating from the required minimum flows, there is no basis for installing additional flow monitoring equipment. Nevertheless, the curves (i.e. relationship between generation and flow) used to estimate flows through the turbines have not been verified since 2005, when the turbine runners were replaced.⁹⁹ Because turbine efficiency changes over time, the relationship between generation and flow can change. Thus, the existing curves used to determine compliance with minimum flows may be inaccurate. To correctly determine compliance with minimum flows, it would be beneficial to verify the accuracy of the curves using in-stream field measurements, and recalibrate as necessary, within 1 year of any new license issued. Because the relationship between generation and flow could change during the term of a new license, it would also be beneficial to verify and recalibrate the curves subsequent to the first verification event on a schedule appropriate to the specifications of the project's turbines.

GLHA currently makes recent project flow data available on the internet in near-real time, allowing resource agencies and the public an opportunity to review recent flow conditions at the project. GLHA currently provides historical flow data to the agencies upon request, and for transparency it would be beneficial to also provide historical flow data to the public upon request. Because the data could be accessed upon request, there would be no additional benefit to providing historical flow data on the internet.

Maine DEP and NMFS both recommend a plan for monitoring impoundment surface elevations and minimum flows, but NMFS recommends two separate plans. We discussed, herein, the benefits of two separate plans that would be based on use of the

⁹⁹ See Summary of 10(j) Meeting filed on June 19, 2018.

existing monitoring system. However, considering the strong interrelationship of the two issues, it appears to us that they would be best planned together.

Smallmouth Bass Spawning Habitat

Hydropower project operations can create unstable water levels, which can negatively affect smallmouth bass spawning. If the water becomes too shallow after spawning, eggs can be exposed to the atmosphere, and/or abandoned and not guarded by adult bass. In addition, the water around the eggs can become warm and low in oxygen content, as well as exposed to the action of surface waves.

As discussed in section 2.1.3, *Existing Project Operation*, GLHA proposes to continue to operate the project with minimal impoundment surface fluctuations. Interior and NMFS prefer that the impoundment surface elevations be maintained as close to the top of the flashboards as possible under normal conditions, although NMFS specifies a need to limit the impoundment water level within 1 foot of the flashboards, as proposed by GLHA. Maine DMR's recommendation is consistent with GLHA's proposal, but it does not specify the need to maintain impoundment water levels within 1 foot of the flashboards during normal operations.

Our Analysis

To investigate the potential effects of impoundment fluctuations on smallmouth bass nesting habitat, GLHA conducted smallmouth bass spawning surveys in the project impoundment in 2014 (GLHA, 2015). The 2014 study results indicate that adequate smallmouth bass spawning habitat exists in both the shallow (upper 5 feet) and deeper portions (between 5 and 12 feet) of the project impoundment. Based on the estimated number of nests observed within the available shallow water (280 nests) and deepwater habitat (850 nests),¹⁰⁰ it is evident that a greater proportion of smallmouth bass spawning takes place between elevations 228.0 and 235.0 feet in the impoundment.

Based on the study, the shallower water habitat could be affected by the proposed impoundment drawdown limits. Drawdowns of up to 5 feet below the flashboards could negatively affect a large number of nests. Such a drop would eliminate most of the shallow water spawning habitat. However, as indicated in figure 11, these types of drawdowns are rare and only occur about once per year. Under normal operations, the project impoundment is maintained no more than 1 foot below the flashboards, and usually within 0.2 to 0.5 feet of the flashboards. Thus, under normal operation, smallmouth bass nests would be minimally affected. Further, there is no evidence that the smallmouth bass population has been negatively affected by the drawdowns, which

¹⁰⁰ Given the limited data (seven nests across three locations), we consider the number of deep water nests to be an estimate.

have occurred about once per year under the existing license. Consequently, restricting impoundment drawdowns to those limits proposed by GLHA would have little to no effect on smallmouth bass spawning.

Smallmouth Bass and White Sucker Impingement and Entrainment¹⁰¹

At the Mattaceunk Project, there are currently two intake openings per generating unit. Each opening is covered by a trash rack with a 1-inch bar spacing that covers the top 16 feet of the water column (at normal impoundment elevation of 240.0 feet) and a 2.63-inch bar spacing covering the lower 36 feet of the water column. To improve downstream passage for eel, alosines, and Atlantic salmon, GLHA proposes to install full-depth trash racks with 1-inch clear bar spacing during the fish passage season.

Our Analysis

Water intake structures at hydropower projects can injure or kill fish that are either impinged on intake screens/trash racks, or entrained through turbines. Larger aquatic organisms (typically fish and larger invertebrates) can be trapped against the intake screens or trash racks by the water flowing into a penstock. This process is known as impingement and can cause physical stresses and/or suffocation that lead to the death of some organisms (EPRI, 2003).

If fish are able to pass through screens or trash racks (i.e., are entrained), fish injury or mortality can result from collisions with turbine blades or from exposure to pressure changes, sheer forces in turbulent flows, and water velocity accelerations created by turbines (Rochester *et al.*, 1984). The number of fish entrained and at risk of turbine mortality at a hydroelectric project is dependent upon site-specific factors, including physical characteristics of the project, as well as the size, age, and seasonal movement patterns of fish present within the impoundment (EPRI, 1992).

As discussed in the section 3.3.2.1., *Affected Environment, Resident Fish*, smallmouth bass and white sucker are two resident fish species found in the Penobscot River. As part of a 2014 fish entrainment and impingement study, GLHA qualitatively evaluated the entrainment risk for the two species at the Mattaceunk Project (GLHA, 2015). Results of the study indicated that many smallmouth bass and white sucker were of sufficient size to be impinged (table 12), but had a low impingement risk, because they have swim speeds greater than the approach velocity (1.7 fps) in front of the trash racks, which would allow them to avoid contact with the trash racks (table 11).

¹⁰¹ Impingement and entrainment issues for eel, alosines, and Atlantic salmon are discussed below in separate sections where downstream passage of those species is analyzed.

Table 11. Target species burst swimming speeds.

Life Stage	Target Species	Size Range (inches)	Burst Swim Speed	
			fps	Reference
Adult	Smallmouth bass	10-15	3.2 – 7.8	Bunt <i>et al.</i> , 1999
	White Sucker	7-15	4.96	Hunter and Mayor, 1986
Juvenile	Smallmouth bass	4	2.6 - 3.6	Webb, 1998

For fish small enough to pass through the trash racks, entrainment risks were found to be moderate to high, because both smallmouth bass and white sucker were observed in the vicinity of the intake year-round. For smallmouth bass, entrainment risk was predicted to be highest in the summer months when juveniles less than 6 inches in length would be common. However, most sizes of smallmouth bass (i.e., those 4 inches and larger) could avoid entrainment with burst speeds of 2.6 fps or greater (table 11). For white sucker, entrainment risk was predicted to be greatest during the early summer, and fall-winter months when juvenile or sub-adult fish less than 8 inches would be common. Like the smallmouth bass, many white sucker would be able to avoid entrainment with a burst speed of 4.96 fps. The proposed installation of full-depth trash racks with 1-inch bar spacing would further decrease the vulnerability to entrainment by excluding smallmouth bass 8 inches in length or longer and white suckers 7 inches in length or longer (table 12).

Table 12. The minimum lengths of smallmouth bass and white sucker that would be excluded by the upper 1-inch clear spacing trash racks, and lower 2.63-inch clear spacing trash racks.

Target Species	Maximum Size Reported (inches)	Minimum Size (inches) Excluded at Respective Trash rack Clear Spacing	
		1	2.63
Smallmouth bass	25	8	21
White sucker	25	7	18

As described above, the impoundment supports thriving white sucker and smallmouth bass populations, and the project area is known to provide some of the best smallmouth bass fishing in the eastern United States. Given the quality of the existing populations that occur under current and proposed project operations, the qualitative arguments for a low risk of entrainment or impingement under current and proposed operations, and some potential additional benefit from the proposed installation of full-

depth trash racks with 1-inch bar spacing, the project would continue to provide adequate protection from impingement and entrainment of smallmouth bass and white sucker.

Upstream Eel Passage

GLHA proposes to develop, install, and maintain (in consultation with Interior and NMFS), on a seasonal basis, an upstream eel passage facility within 2 years of the effective date of the new license. Interior, in its fishway prescription, requires that GLHA design and construct an upstream eel passage ladder at the west abutment of the spillway within 2 years of license issuance, consistent with the FWS's eel passage design criteria.¹⁰² Interior also requires that GLHA's upstream eel ladder be designed to pass 90 percent of the eel entering the ladder within 24 hours (*see Sweka et al.*, 2014), and operate the eel ladder from June through August. Finally, Maine DMR recommends that GLHA install an upstream passage facility for eel at the Mattaceunk Project with 2 years of license issuance, and operate it from June 1 through September 15.

Our Analysis

Currently, upstream fishways for juvenile eel exist at the downstream West Enfield and Milford Dams and at the upstream Medway Dam, but none are provided for juvenile eel at the Mattaceunk Project. Thus, upstream migrating juveniles (elvers and yellow eel) are affected by the presence of the Mattaceunk Project.

Juvenile eel reaching the Mattaceunk Project must climb over or around the project dam. During the 2014 upstream eel passage evaluation, GLHA observed a total of 456 juvenile eel searching for passage over the project dam along the right descending bank (west abutment of the spillway). In addition, juvenile eel have been observed using the existing upstream fishway (designed to pass Atlantic salmon). The presence of adult eel upstream of the project confirms that eel do ascend the project, to some extent. However, while an increasing number of juvenile eel are ascending the West Enfield and Milford Dams downstream, no juvenile eel have ascended the Medway Dam upstream,¹⁰³ suggesting that there are some differences in the relative abundance of eel between the upper and lower Penobscot River.

While climbing over or around dams is a well-documented behavior for juvenile eel (GMCME, 2007), the climbing ability of eel declines as they grow longer than 4 inches (Legault, 1988). In its final license application for the Mattaceunk Project, GLHA stated that eel observed during the night-time upstream eel passage survey were primarily between 5 and 8 inches long. However, the eel observed during the night-time

¹⁰² *See* 2017 Fish Passage Engineering Design Criteria Manual (FWS, 2017a).

¹⁰³ *See* Interior's Preliminary Fishway Prescription at 16.

surveys ranged in length from 4 to 24 inches, suggesting that the existing route(s) for passage at the project may not be effective for most eel that reach the project dam. A dedicated upstream eel passage facility at the project would increase upstream passage effectiveness and improve access to upstream habitat. Operating the facility from June through September 15 encompasses the time when the majority of the juvenile eel are expected to migrate upstream at the project, and is consistent with the operational period of upstream eel fishways at other mainstem Penobscot River projects.

As part of its proposal, GLHA provided a conceptual design for an upstream eel passage ladder (GLHA, 2015; *see* Appendix F, Attachment F.2). The ladder would be located adjacent to the west abutment of the dam's spillway, along the right descending bank, where the majority of the observed juvenile eel staged and ascended the project dam during the 2014 night-time eel survey. GLHA's conceptual design would enhance the attraction of juvenile eel to this area by providing a more consistent attraction flow than the current leakage flow. In addition, the proposed ramp would provide protection from predation and desiccation and would improve the passage effectiveness over current conditions. Thus, locating the eel ladder in this location would provide the best opportunity for improving the ability of eel to migrate upstream of the dam, and enhancing the eel population in the Penobscot River.

GLHA would design, install, and maintain the upstream eel passage facility in consultation with the fisheries agencies. Such consultation would ensure that the plans include effective design concepts and criteria used at other dams, while considering the conditions and constraints at the Mattaceunk Project.

Downstream Eel Passage

GLHA proposes to implement measures for downstream eel passage at the Mattaceunk Project, beginning the first passage season following license issuance. The measures include: (1) implementing annual night-time turbine shutdowns from 8:00 pm to 4:00 am;¹⁰⁴ and (2) opening the project roller gate.¹⁰⁵ In addition, GLHA proposes to

¹⁰⁴ The annual schedule for providing downstream eel passage would be developed in consultation with the resource agencies and be based on a predictive model for eel movement through the project. In the interim, GLHA would implement a night-time shutdown period (8 pm to 4 am nightly) for up to 6 weeks, beginning as early as the first significant rain event (1 inch or greater of rain) occurring on or after August 15. The night-time shutdown period, however, would start no later than September 15. This schedule could be modified based on the predictive model, and after consultation with the resource agencies.

¹⁰⁵ The gate setting would be adjusted to maintain stable impoundment levels.

install full-depth trash racks with 1-inch clear bar spacing (*see* measures included in the Species Protection Plan for Atlantic salmon; section 3.3.4, *Threatened and Endangered Species*).

Interior's fishway prescription, would require that GLHA (a) shut down all generation nightly (8:00 pm to 4:00 am) from August 1 through October 31 to provide out-migrating eel safe and timely downstream passage, and (b) install full-depth trash racks with 1-inch spacing. The condition would also require that GLHA operate the Mattaceunk Project and the downstream eel passage measures such that survival of adult (silver) eel exceeds a minimum downstream survival performance standard of 76 percent.¹⁰⁶

Maine DMR recommends that GLHA, beginning the first passage season following license issuance, institute annual night-time turbine shutdowns (from 8:00 pm to 4:00 am), in combination with opening the project's roller gate and installing full-depth trash racks having 1-inch clear bar spacing. Maine DMR also recommends that downstream passage for eel be provided from August 1 through October 31. The downstream passage season for eel could be modified based on the results of the effectiveness study. The Penobscot Indian Nation, in its comments filed on the draft EA, recommends that the downstream fish passage facilities developed and constructed at the Mattaceunk Project, including those for eel, conform to the FWS Region 5 Criteria (FWS, 2017a; Sojkowski, 2017).

Our Analysis

In New England, adult eel out-migration typically occurs from mid-August to December (Haro *et al.*, 2003; GMCME, 2007). Adult eel often move downstream in pulses with large numbers of eel moving during short periods of activity followed by longer periods with relatively little movement (EPRI, 2001). Peak 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 movement of out-migrating eel (EPRI, 2001; Haro *et al.*, 2003).

Under existing project conditions, downstream routes for adult eel migrating through the project area include passing over the spillway when the project spills, through the upstream fish ladder and log sluice when they are being used, or through the turbines during generation. Data collected at USGS gauge numbers 01034500 (located downstream from the project) and 01030500 (located upstream of the project), indicate

¹⁰⁶ The performance standard is based upon Sweka *et al.* (2014), which indicates that survival of silver eel passing three to four dams (33 percent cumulatively) must exceed a minimum of 76 percent at each dam, and must be higher to rebuild eel populations.

that the project spills about 7.5, 8.5, 22.5, 20.5, and 21.0 percent of the time in August, September, October, November, and December, respectively. While the license application provides information on the maximum hydraulic capacity of the log sluice (estimated to be 690 cfs, or 9 percent of the station's hydraulic capacity), it does not describe frequency of operation of the structure; therefore, it is unclear how often this route may be available to eel migrating downstream. Regardless, because the turbines have a maximum hydraulic capacity of 7,438 cfs, and GLHA generally passes all river flow through the project turbines when possible, turbine passage is the most likely downstream passage route during the adult eel migration period from August to December.

Eel Survival

Estimates of survival for adult eel passing through turbines are highly variable and range from 0 percent to 94 percent (EPRI, 2001). Factors that can influence downstream passage survival include eel size (Richkus and Dixon, 2003) and turbine design (EPRI, 2001).

GLHA conducted a fish entrainment and impingement study for the Mattaceunk Project in 2014 (GLHA, 2015). As part of the study, GLHA evaluated the qualitative entrainment risk for several target species, including eel. Based on this evaluation, GLHA determined that the existing upper trash rack with 1-inch clear bar spacing would exclude an eel with a length of 27 inches or greater. The lower portion of the trash rack, which has a clear bar spacing of 2.63 inches, provides no protection, and all eel would be vulnerable to entrainment. Adult eel in the Penobscot River range in size from 24 to 30 inches (ASMFC, 2000).

As part of the entrainment and impingement study, GLHA also estimated whole-station survival for target diadromous species, including eel, using parameters that included operations, hydrology, downstream migration periodicity, turbine blade strike survival rates, empirical spillway survival, bypass survival, and bypass effectiveness data. The whole station survival was determined for each month of the eel's out-migration season, then combined for an overall whole-station out-migration survival estimate for the species. Varying inflows representing dry, wet, and normal years were applied to this evaluation, which translated into developing individual estimates for the 75, 50, and 25 percent monthly exceedance flows. The estimated whole-station survival for adult eel (24-30 inches in length, and during flow out-migration months of July-November) was 80.2, 80.6, and 80.3 percent for the 75, 50, and 25 percent exceedance flows, respectively.

Based on the results of the entrainment study (GLHA, 2015), the Mattaceunk Project has the potential to adversely affect downstream adult eel (silver eel) passage at the project. Silver eel have a relatively high risk of entrainment at the project because of

their benthic-orientation during out-migration, and their likelihood to pass through the lower trash racks that have a clear bar spacing of 2.63 inches. Empirical entrainment rate information for eel suggest that rates are higher in the late summer to winter time periods, with individuals greater than 10 inches composing the majority of the eel.

GLHA's proposed measures would enhance downstream eel passage effectiveness and minimize potential entrainment of eel at the project. Opening the project roller gate would increase spill during the eel downstream passage period. Because eel tend to exhibit greater attraction to bypasses located near the river bottom (Haro *et al.*, 2000; Durif *et al.*, 2003; Brown *et al.*, 2009), it is likely that the roller gate would be more effective than surface spill, because it has a lower-level release point than the sluice gate or any other surface release structure (e.g., roller gate spill elevation is 221.0, and the surface release elevation is 240.0 feet). However, projects on the Kennebec River typically use surface spill, combined with other measures, to provide interim downstream eel passage. This suggests that a deeper release point may not be critical to providing improved downstream passage survival.

Design Criteria

Trash racks with 0.75-inch or 1-inch clear bar spacing, or overlay screens, are used at some hydropower projects during the downstream eel migration season to reduce turbine entrainment of adult eel. The existing trash racks at the Mattaceunk Project have 1-inch clear bar spacing that covers the upper 16 feet of the intake area, and 2.63-inch clear bar spacing that covers the remaining lower portion of the intake area. The 2.63-inch spaced bar racks would not prevent adult eel from passing into the turbines, because adult out-migrating eel are more likely than not to approach the project intake lower in the water column. However, GLHA estimates that eel have low impingement and entrainment risk because the burst swimming speed of an adult eel (3.1-4.4 fps; Bell, 1991, as cited in GLHA, 2015) exceeds the project's intake velocity (approach velocity of about 1.7 fps and through rack velocity of about 3.4 fps; GLHA, 2015). Notwithstanding the burst swimming speed argument, we would expect that most eel are passing through the project turbines since this is the primary downstream passage route available for most of the August to December period. Installation of new trash racks or overlay screens that have 1-inch clear bar spacing and cover the full depth of the intake would reduce entrainment. This structural enhancement, along with providing a low-level passage route, which GLHA proposes to provide by opening the project's roller gate, would likely enhance the overall survival of downstream migrating eel.¹⁰⁷

¹⁰⁷ The out-migration of adult eel in the Penobscot River has been enhanced by the installation of downstream passage facilities at the Milford, Orono, and Stillwater Projects that include full-depth trash racks with 1-inch clear bar spacing and downstream

Sojkowski (2017) assessed the fish passage needs at the Mattaceunk Project, including identifying the design criteria of greatest importance for fish passage at the project. The four most important criteria are: (1) hydraulic capacity (i.e., fish bypass flow should be at least 5 percent of the station's hydraulic capacity); (2) normal intake velocity (i.e., not greater than 2 fps in front of the trash racks);¹⁰⁸ (3) sweeping to normal velocity ratio (i.e., ratio should be equal to, or greater than 1);¹⁰⁹ and (4) trash rack clear bar spacing of 0.75 inch for eel. The assessment done by Sojkowski (2017) found that three of nine alternatives evaluated met the aforementioned four criteria. The three alternatives include: (1) angled racks within each bay with training walls; (2) an inclined rack with training walls; and (3) dual angled racks within each bay.

The assessment done by Sojkowski (2017) indicates that there are multiple options for providing safe, timely, and effective passage for eel at the Mattaceunk Project. We do not address the merits of the three alternatives identified by Sojkowski (2017), but we do evaluate the merits of the aforementioned design criteria.¹¹⁰

HYDRAULIC CAPACITY - GLHA proposes to continue operating the downstream bypass at its maximum flow capacity of 140 cfs (2 percent of station hydraulic capacity) and use the log sluice (225 cfs to 690 cfs; or between 3 and 9 percent of the station's hydraulic capacity). These measures, together, would provide a bypass flow of 5 to 11 percent of the station's hydraulic capacity. However, as we previously noted, surface bypasses are not ideal for efficiently passing adult eel downstream. Therefore, GLHA proposes to open the roller gate, which has a maximum capacity of 25,637 cfs, to provide a low-level downstream passage route for eel. The actual flow releases through the gate would depend on river flows and the need to maintain stable impoundment levels. While this flow is not known, any additional flow provided through the roller gate would only add to the amount of flow released through the surface bypass and log sluice, which meets the design criteria of 5 percent of the station's hydraulic capacity. Thus, using the existing surface bypass and the proposed log sluice, as well as opening the roller gate to provide a low-level bypass route for adult eel would provide downstream passage flows

bypasses with surface and deep openings. *See* Maine DMR May 16, 2017 Comments at 8.

¹⁰⁸ Normal velocity is the component of velocity in front of the trash racks that is perpendicular to the trash rack bars.

¹⁰⁹ Sweeping velocity is the component of velocity in front of the trash racks that is parallel to the trash rack bars.

¹¹⁰ All proposed, prescribed, and recommended trash rack designs included in this EA would meet a normal velocity of 2 fps, and, thus, adherence to this criteria is not discussed further (Sojkowski, 2017).

that would be more than capable of attracting fish to these safe routes. The criteria recommended by Sojkowski (2017) for providing attraction flows of 5 percent of the station's capacity would be not only met, but exceeded.

RATIO OF SWEEPING VELOCITY TO NORMAL VELOCITY – To improve downstream passage for eel, GLHA proposes, among other measures, to install full-depth trash racks with a clear bar spacing of 1 inch. This proposal is consistent with Interior's and NMFS's fishway prescriptions and Maine DMR's 10(j) recommendation. The Penobscot Indian Nation, on the other hand, recommends that the trash rack conform to FWS's Region 5 fish passage design criteria (FWS, 2017a). One such criteria is maintaining a ratio of sweeping velocity to normal velocity equal to or greater than 1.

Under existing and proposed conditions, the sweeping velocity would be 0.4 fps, which results in a ratio of sweeping velocity to normal velocity of 0.25 (i.e., 0.4:1.6),¹¹¹ which is less than 1 (Sojkowski, 2017). To achieve this design criteria, Sojkowski (2017) indicates that either the angle of the trash racks relative to the face of the powerhouse or the incline of the trash racks relative to streambed would need to increase. Both of these changes would require extending the walls between 24 to 41 feet along the intake bays of all four turbine units (Sojkowski, 2017).

Trash racks designed to meet the sweeping to normal velocity ratio criteria would typically be expected to enhance downstream passage by reducing entrainment and improving guidance toward a bypass (Sojkowski, 2017). However, designing trash racks to meet this criteria may not improve downstream passage at the Mattaceunk Project, because FWS (2017a) presents general design criteria that have not been tested or modeled at the project. Further, the Penobscot Indian Nation has not demonstrated the added benefit of installing trash racks that have a sweeping to normal velocity ratio of at least 1, compared to GLHA's proposed measures for protecting downstream migrating eel. In addition, modifying the trash racks to meet this design criteria would require rather substantial structural changes to the project.

GLHA is proposing to conduct downstream passage effectiveness for eel at the project. This monitoring would be useful in helping to determine if the implemented measures are sufficient to achieve Interior's prescribed downstream passage efficiency goals for eel. Based on this monitoring, should the measures implemented at the project, including the full-depth trash racks with 1-inch clear bar spacing and having a ratio of sweeping velocity to normal velocity of less than 1, not achieve the downstream passage efficiency goals prescribed by Interior, structural changes, such as those recommended by the Penobscot Indian Nation, or other operational changes could be explored at that time.

¹¹¹ GLHA's existing and proposed trash rack designs would result in a normal velocity of 1.6 fps.

TRASH RACK BAR SPACING – GLHA proposes, and the agencies either prescribe or recommend, trash racks with 1-inch clear bar spacing. FWS’s criteria for eel is 0.75-inch clear bar spacing (FWS, 2017a). We indicated above that trash racks with a clear bar spacing of 1 inch would exclude eels 27 inches in length and larger. For comparison, the documented size of adult silver eel in the Penobscot River is between 24 and 30 inches. Thus, eels less than 27 inches in length would remain vulnerable to entrainment with GLHA’s proposal and the agencies’ prescribed and recommended clear bar spacing of 1 inch. The Penobscot Indian Nation’s recommended clear bar spacing of 0.75 inch would exclude eels of about 20 inches and larger, which would be more than is needed to protect adult silver eel migrating past the Mattaceunk Project.¹¹² To exclude the majority, if not all, of the eels expected to out-migrate through the project area (eels greater than 24 inches in length), the clear bar spacing would need to be about 0.9 inch.¹¹³ Given the eel’s burst swimming speed, the protective value of 0.9-inch versus 1-inch clear bar spacing is likely negligible. Moreover, a trash rack with clear bar spacing of 0.75 is not likely to afford downstream migrating eel significantly more protection than a trash rack with a 1-inch clear bar spacing.

The downstream passage measures that would be implemented at the Mattaceunk Project include not only the full-depth trash racks with 1-inch clear bar spacing, but also opening the roller gate and log sluice as passage routes, and shutting down the turbines. Together, these measures are expected to significantly improve survival of downstream migrating adult eel at the project, regardless of whether the clear bar spacing is 0.75 inch or 1 inch. If GLHA’s proposed, and the agencies’ recommended, measures do not achieve the downstream passage efficiency goals prescribed by Interior, additional measures, such as a different trash rack configuration (including bar rack spacing), can be implemented to achieve the prescribed level of downstream passage efficiency for eel.

Turbine Shutdowns

Several hydropower projects in New England and the Mid-Atlantic use temporary shutdowns as a protective measure for eel migrating downstream, because the cost of lost generation is less than the cost of building and maintaining permanent downstream eel

¹¹² In addition to the biological rationale for using trash racks with a clear bar spacing of 0.75 inch versus 1 inch to protect downstream migrating adult eel, there could be some additional, incremental head loss associated with the narrower-spaced bar racks. This would lead to some amount of lost generation at the project.

¹¹³ We estimated the value of 0.9 inch based on information provided in Table 2.6-5 in GLHA (2015). We multiplied the scaling factor of 0.037 by 24 inches (the length of eel to be excluded from entrainment), and the result is a clear bar spacing of 0.888 inch.

passage and protection structures. Nightly shutdowns would fully protect eel migrating downstream through the project area from turbine entrainment injury and mortality, although some injuries and mortalities could occur from the corresponding increased spillway passage. In implementing nighttime shutdowns, some projects institute 24-hour shutdowns for the entire migration season, while others only shut down from dusk to dawn during the period of peak migration based on site-specific monitoring or information from upstream projects (Richkus and Whalen, 1999).

GLHA and the resource agencies state that nighttime shutdowns are an effective measure for protecting out-migrating adult eel. Interior, in its fishway prescription, requires that GLHA shutdown all generation nightly (8:00 pm to 4:00 am) from August 1 through October 31 annually. Maine DMR, in its section 10(j) recommendation, concurs with Interior's seasonal operating schedule. GLHA, however, proposes to develop the seasonal operating schedule in consultation with the agencies, and based on a predictive model for eel movement through the project. In the interim GLHA would implement a night-time shutdown period of up to 6 weeks (8:00 pm to 4:00 am nightly) as early as the first significant rain event (defined as greater than 1 inch of precipitation) occurring on or after August 15, but that the nighttime shutdown period will start no later than September 15 in years that a significant rain event does not occur during the August 15-September 15 time period.

The protective benefits of shutting generation down, annually, through the entire out-migrating season depends upon the degree to which the eel population (a) migrates downstream at night during the fall, (b) migrates during the specified out-migration period, and/or (c) migrates at all in a particular year. For example, studies on the Shenandoah River showed that downstream migration, which predominantly occurred in the fall, may not occur every year (Eyler *et al.*, 2016). While the Shenandoah River study is not directly applicable to the Penobscot River and downstream silver eel migration-timing at the Mattaceunk Project, the results do demonstrate that implementing a nightly shutdown at the Mattaceunk Project throughout the entire out-migration period, without accounting for behavioral cues and other factors, (a) may be inefficient at reducing eel mortality, and (b) would cause unnecessary turbine shutdowns and associated generation losses (Eyler *et al.*, 2016).

Downstream eel migration is known to occur largely in episodic events based on environmental cues such as increased river flows following rain events, cooling temperatures, and moon phase. Thus, timing shutdowns based on site-specific eel monitoring data and environmental conditions could substantially reduce project-related eel mortality, while also reducing the cost of lost generation (Haro *et al.*, 2003). Studies conducted in the lower Penobscot River, as well as information provided by Maine DMR appear to support this conclusion. For example, a 2015 study conducted at the

downstream Stillwater Project showed that during the 7 week study period,¹¹⁴ 86 percent (33 of 36) of the eel observed passed downstream during the week of September 27 – October 3 (Black Bear Hydro Partners [BBHP], 2016). In fact, 97 percent (30 of 31) of the eel passing the project were observed over a 5-hour period on September 30 during a rain event. In addition, according to Maine DMR’s monthly silver eel out-migration data collected at 19 commercial weirs from 1987 to 2000,¹¹⁵ 80.7 percent of the silver eel in Maine migrate downstream during September and October. An additional 11.6 percent migrated downstream in August. These August eel migrations are likely to occur during the last 2 weeks of the month as the peak migration builds into September.¹¹⁶ This trend is also supported by multiple silver eel migration studies conducted at the upstream Medway Project, which we described in section 3.3.2.1, *Aquatic Resources – Affected Environment*.

GLHA proposes to target night-time shutdowns for downstream eel passage based on a predictive model that considers environmental variables that are expected to occur in late August (beginning August 15), September, and/or October. The goal is to protect downstream migrating eel, and to reduce unnecessary lost generation during periods of time when eel are not migrating. Similar to GLHA’s proposal, a predictive model is being developed as a means to protect downstream migrating eel on the Shenandoah River (Smith *et al.*, 2017).¹¹⁷ In addition, FWS endorses the use of a predictive model in the 2015 American Eel Biological Species Report Supplement.¹¹⁸ Based on available information, implementing such an approach (with the use of a cut-off probability value), along with opening the project’s roller gate and the addition of full-depth trash racks with

¹¹⁴ Downstream passage of adult eel was monitored at the Stillwater Powerhouse B from August 30 to October 17.

¹¹⁵ See Maine DMR’s May 22, 2017 Filing at 8 (Figure 1) and Attachment A of Interior’s May 23, 2017 Filing at 11 (Figure 2).

¹¹⁶ See GLHA’s July 7, 2017 Filing at 30.

¹¹⁷ The predictive model for the Shenandoah River attempts to predict the fraction of the potentially migrating eel moving on a given day, where eel movement is modeled as a function of (a) the time of year, (b) the lunar phase, (c) the discharge rate, and (d) the eel stock (or the population within the river system subject to migrating past the hydropower station). The reduction in eel mortality is dependent upon the cut-off probability value chosen, which is the probability where a decision is made to cut off the generating units.

¹¹⁸ See American Eel Biological Species Report Supplement to: Endangered and Threatened Wildlife and Plants, 12-Month Petition finding for the American eel (*Anguilla rostrata*). Docket No. FWS-HQ-ES-2015-0143.

1-inch clear bar spacing, is expected to reduce mortality of downstream-migrating eel and lost power generation.

GLHA proposes to consult with the resource agencies in developing the predictive eel out-migration model. This would presumably include the data collection effort needed to support the development of the model. This consultation would assist in the successful development and implementation of the predictive modeling approach. The cut-off probability value, as well as the environmental triggers for shutting down project operations and for restarting operations, should be identified during consultation. In addition, the mechanism for measuring the success of implementing the predictive model, both in terms of eel passage and lost generation, should be identified.

Finally, GLHA's proposed effectiveness monitoring, which is discussed more fully below, would provide a mechanism for GLHA and the resource agencies to identify the need for model refinements, and determine the period of time the project's generating units would be shut down to aid in downstream eel passage. The goal of such monitoring would be to improve the overall performance of the downstream passage system for eel.

The Penobscot Indian Nation does not believe that the measures proposed by GLHA and prescribed/recommended by the resource agencies will be enough to protect the Penobscot River eel population. The Penobscot Indian Nation states that recent out-migrating data from the Shenandoah River in Virginia/West Virginia shows that: (1) only 50 percent of the eel migrated past the dam(s) during the September 15th to December 15th shutdown periods; and (2) eel out-migrate from the system during 11 months of the year. While this may be true for the Shenandoah River and the mid-Atlantic region, it does not appear to be the case on the Penobscot River or in New England. For instance, analysis of migration timing data from multiple Maine rivers¹¹⁹ shows that more than 92 percent of the adult silver eel out-migrated in the months of August, September, and October. Moreover, BBHP (2016) showed that over 85 percent of tagged silver eels moved downstream passed the Stillwater Project during a rain event in late September and early October.

The Penobscot Indian Nation indicates that a predictive model needs to be developed, and the duration of nighttime shutdowns extended for all months with no spill occurring at the dam, as well as for those months identified by the predictive model.¹²⁰ We interpret this to mean that the project would cease generation at night for the entire month for which there would be no spill occurring at the dam for any portion of the month. Based on our review of the project's flow duration curves, this would require GLHA to cease generation at night for all 12 months, as every month there are periods of

¹¹⁹ See n. 115, *supra*.

¹²⁰ See Penobscot Indian Nation's May 23, 2017 filing at 13.

no spill. Given the substantial reduction in annual generation that would occur under this measure, and that the measure would only protect less than 10 percent of the outmigrating eel population, we do not consider this a reasonable measure and eliminate it from further analysis.

Timing of Downstream Eel Passage Implementation

GLHA proposes to implement downstream eel passage measures beginning the first downstream eel passage season after license issuance, which would involve: (1) seasonally ceasing generation from 8:00 pm to 4:00 am; (2) opening the project's roller gate; and (3) installing, within 2 years after license issuance,¹²¹ full-depth trash racks having a 1-inch clear bar spacing (*see* measures included in the Species Protection Plan for Atlantic salmon; section 3.3.4, *Threatened and Endangered Species*). Interior, in its fishway prescription, requires that GLHA provide downstream passage for eel, including installing full-depth trash racks with 1-inch clear bar spacing, but does not specify a timeframe for providing the measures. Maine DMR recommends that GLHA provide downstream passage for eel beginning the first passage season following license issuance, including night-time generation shutdowns in combination with opening the project's roller gate and installing full-depth trash racks with 1-inch clear bar spacing.

The actual measures proposed by GLHA and recommended by the agencies for providing downstream eel passage appear to be consistent. However, there are differences as to the timing for when the measures are implemented.¹²²

Our Analysis

The number of adult eel upstream of the project dam is unknown, but appears to be low based on the available data. GLHA conducted an eel passage study at the Mattaceunk Project in 2014. A total of about 456 juvenile eel were observed during the study, but the actual number passing the dam is unknown. In addition, passage studies at the upstream Medway Project provided additional insights into the number of adult eel found upstream of Weldon Dam. For example, the Medway upstream eel ladder, which began operation in 2001, passed 69 eel in its first 5 years of operation, and none since

¹²¹ This timeframe is consistent with that required by NMFS in its fishway prescription.

¹²² GLHA proposes to implement downstream eel passage measures beginning the first passage season following license issuance, yet would not install the full-depth trash racks until year 2 of the license. Maine DMR recommends GLHA implement all downstream eel passage measures beginning the first passage season after license issuance, including the trash racks.

2008. Also, few confirmed out-migrating silver eel have been collected during downstream passage studies at the Medway Project. This information could indicate that the lack of efficient upstream passage at the Mattaceunk Project may contribute to low eel abundance in upstream waters.

The proposed upstream eel ladder, which would be installed within 2 years of license issuance, should improve upstream passage conditions and efficiency of juvenile eel at the Mattaceunk Project, which ultimately would increase the overall eel population upstream of the project. However, the eel passing upstream via the new eel ladder would not migrate back downstream as adult silver eel until at least 2030.¹²³ Nonetheless, eel presently occupy habitat upstream of Weldon Dam, though numbers are currently low. Given the low numbers, downstream eel passage measures do not appear necessary at the Mattaceunk Project during at least the first year after a new license would be in effect.

The downstream eel passage measures proposed by GLHA may not sufficiently protect downstream migrating adult eel if they are not all implemented in the same passage season. For example, downstream-migrating adult eel tend to migrate low in the water column. Such behavior would result in eel continuing to enter the project's intake should full-depth trash racks not be in place at the same time generation shutdowns and opening the project's roller gate are employed. This could potentially result in (a) turbine entrainment and mortality,¹²⁴ or (b) migration delays or a complete failure to pass downstream. Thus, implementing the proposed downstream eel protection measures, during the second passage season, as a combined strategy, would be the most biologically beneficial or effective approach to enhancing the eel population in the Penobscot River, while also minimizing the cost of providing downstream eel passage at the project.

Eel Passage Effectiveness Studies

GLHA proposes to: (1) monitor the seasonal upstream eel ladder for use and effectiveness for one eel passage season; and (2) monitor the effectiveness of the annual nighttime turbine shutdowns and roller gate opening for passing downstream migrating silver eel for two passage seasons. Interior, in its fishway prescription, requires that

¹²³ The majority of eel in Maine waters (about 95 percent of the females and 70 percent of the males) become mature at 12 years of age and out-migrate to spawn (Oliveira and McCleave, 2000).

¹²⁴ The effectiveness of the open roller gate would be compromised, since there would not be a protective guidance system in place.

GLHA develop upstream¹²⁵ and downstream¹²⁶ eel passage effectiveness plans. Maine DMR, as part of its terms and conditions, recommends that GLHA monitor the effectiveness of the installed upstream fish passage facility for 1 year and the downstream eel passage measures for 2 years.¹²⁷

Interior and Maine DMR, in their comments on the draft EA,¹²⁸ state that the Shenandoah model was informed by an extensive telemetry study that included radio-tagging 145 eels over a 4-year period, as well as monitoring the eels at five run-of-river dams along a 122-mile stretch of the Shenandoah River. Thus, to develop a sufficient model for downstream passage of silver eel at the Mattaceunk Project, Interior indicates that 4 years of monitoring in the upper Penobscot River may be needed, and Maine DMR recommends a 3-year radio-telemetry study, using a similar number of tagged eels to that used in the Shenandoah study.

¹²⁵ The upstream eel passage effectiveness plan would consist of: (1) evaluating attraction efficiency to the facility; and (2) evaluating effectiveness of passing eel that have entered the upstream eel passage structure. Attraction efficiency would be assessed with night-time observations of migrating eel at the project in comparison to the number of eel passed. Passage effectiveness (targeted at 90 percent) would be based on the number of eel that enter the facility and ultimately pass through the facility within 24 hours.

¹²⁶ Downstream eel passage effectiveness would be assessed with radio-telemetry to determine migratory delay, route of downstream passage, immediate survival, and later survival passing the project. The project would be required to meet a 76-percent adult survival rate for downstream passage. If the established survival rate is not met, the plan would include a provision to assess additional passage enhancements (*e.g.*, extended passage season, 0.75-inch trash rack spacing, a deep bypass gate, or new downstream passage facilities that incorporate angled trash racks).

¹²⁷ Maine DMR recommends that GLHA implement additional operational and structural modifications and/or habitat enhancement measures, if necessary, to improve eel passage at the Mattaceunk Project. Maine DMR's recommendation is not specific with regards to specific measures to be implemented, and, thus, is premature. Nonetheless, any effectiveness plan(s) developed for eel passage at the project could include a provision for modifying project facilities/operations to facilitate eel passage at the project, which would ensure that established performance criteria are met.

¹²⁸ See Interior's April 30, 2018, draft EA comments at 3, and Maine DMR's April 27, 2018, draft EA comments at 2.

Our Analysis

Upstream and downstream eel passage effectiveness studies would verify whether any eel passage measures implemented are providing safe, timely, and efficient passage. Passage effectiveness studies typically evaluate factors such as attraction flows, attraction efficiency, passage efficiency, passage delay, and survival rates. This type of information could help guide modifications to the design or operation of any eel passage measures, and potentially improve upstream or downstream eel passage effectiveness at the project.

With regard to how long downstream migrating eel should be monitored at the Mattaceunk Project, we evaluated the Shenandoah River model and the data collection effort that supported the model (Eyler *et al.*, 2016; and Smith *et al.*, 2017). Smith *et al.* (2017) developed the model based on an extensive data set that included: (1) collecting information on specific environmental variables (*e.g.*, time of year, lunar phase, discharge rate, and the eel stock); and (2) a telemetry study, where Eyler *et al.* (2016) tagged 145 silver eels and monitored the eels' downstream movement continuously for 3 years (from September 2007 through August 2010) using an array of stationary telemetry receivers positioned at five hydropower stations along the Shenandoah River. Given the relative novelty of using such an approach to protect downstream migrating silver eel, there is no reason to doubt that a similar effort may be needed to develop a comparable model for the Penobscot River and the Mattaceunk Project. Therefore, development of a predictive model should be supported by at least 3 years of monitoring downstream-migrating silver eel at the project, using radio-telemetry.

Eel Passage Facility Operation and Maintenance Plan

Interior's fishway prescription would require that GLHA develop a fishway operation and maintenance plan for the upstream and downstream passage measures proposed for eel. The condition would also require annual plan updates, reflecting any changes in fishway operation and maintenance planned for the upcoming year. Maine DMR recommends that GLHA develop eel passage operating procedures and an operation and maintenance plan for any upstream and downstream eel fishways or measures implemented at the Mattaceunk Project.

Our Analysis

GLHA has an existing plan that covers the operation and maintenance of the existing fishways for Atlantic salmon. GLHA proposes to continue to implement this plan. However, the plan does not address the operation of eel passage facilities at the project, nor does GLHA propose to develop such a plan, or modify the existing plan, for eel passage at the project.

Most fishways require operation and routine maintenance to ensure the fishways operate effectively. An operation and maintenance plan would ensure that routine

cleaning and maintenance, including debris removal, are performed so that the eel fishways operate as intended. In addition, the plan would ensure that any eel fishways constructed at the project would be operated during the appropriate times of the day and year, and with an appropriate conveyance flow.

Upstream Alosine Passage

Fish passage and associated restoration efforts for diadromous fishes in the Penobscot River Basin are guided by the Maine DMR and Maine DIFW (2008) strategic plan. This plan involves a two-phased approach to restoring runs of diadromous fishes, including alosines, on the Penobscot River. The first phase has been completed with the removal of Great Works and Veazie dams on the lower river in 2012 and 2013, respectively, and the installation of a fish lift at the Milford Project in 2014. These efforts have increased access to 56 miles of mainstem spawning habitat for alosines between the old Veazie Dam and the West Enfield Project. The second phase of the strategic plan (present day through year 2032) involves monitoring the population response of alosines to this increased spawning habitat and if needed, installing additional fishways or modifying existing passage facilities at dams located farther upstream, including Weldon Dam at the Mattaceunk Project (*see* Objective 2.2; Maine DMR and Maine DIFW, 2008).

The pool-and-weir fishway at the Mattaceunk Project is unable to effectively pass alosines upstream because the fishway was designed for salmon, not alosines. Specifically, the fishway has plunging flows created by the 14-inch head drop between pools and a steep gradient (approximately 45 degrees). Because they are weaker swimmers than salmon and not jumpers, alosines have difficulty ascending such fishways (Larinier and Travade, 2002). As a case in point, river herring were observed in the project fishway in May and June of 2016, but did not successfully pass upstream as they were not collected in the fish trap above the dam and appeared to have abandoned their migration attempt.¹²⁹

The applicant proposes to continue to operate and maintain the existing pool-and-weir fishway designed to pass Atlantic salmon and also proposes to install and operate an additional (second) upstream fishway that is suitable for passing alosines. The alosine fishway would be installed in year 15 of any new license issued for the project and would be operational in year 16. Accordingly, under this proposal, starting in year 16 of a new license, there would be two upstream fishways operating at the project: (1) the existing pool-and-weir fishway designed to pass salmon and (2) a fishway designed to pass alosines and secondary species, including sea lamprey. NMFS, Maine DMR, and Maine DEP recommend the installation of an alosine fishway in year 15 of any new license.

¹²⁹ See exhibit E of final license application; see letter filed by NMFS on May 23, 2017.

NMFS further requires the alosine fishway to be operational in year 16 of a license (Maine DMR and Maine DEP do not specify a recommended operational date for the fishway). In addition, NMFS requires, and Maine DMR recommends, that the alosine fishway be operational from May 1 through July 31 of each year.

Several participants, including the Penobscot Indian Nation, ASF, and Bruce Haines, recommend that the alosine fishway be installed sooner than 15 years after license issuance, because alosines are currently present in the project area. Specifically, the Penobscot Indian Nation recommends that the alosine fishway be installed immediately upon relicensing (in year two of any new license issued). Neither Bruce Haines nor ASF provided a specific timeline for installation of the alosine fishway.

Our Analysis

The middle portion of the Penobscot River, to which alosines now have increased access, can support a considerable number of spawning adults. Specifically, based on a production estimate of 111 American shad per acre (Maine DMR and Maine DIFW, 2008), the 53 miles of mainstem habitat between the Milford and Mattaceunk Projects could support 266,820 adult American shad.¹³⁰ Yet, current run sizes of adult shad are only on the order of a few thousand fish per year—between 1,806 and 7,862 American shad at Milford from 2015 to 2017 (table 13). These run sizes constitute less than three percent of the production potential of the mainstem spawning habitat between the Milford and Mattaceunk Projects. Therefore, the spawning habitat below Mattaceunk appears underutilized at this time and could support considerably more spawners.

Because of the low run sizes of alosines, particularly American shad, compared to the amount of currently accessible and available spawning habitat on the mainstem Penobscot, installing an additional fishway at the Mattaceunk Project at this time would provide minimal benefit to alosines. Furthermore, there are many unknowns that make it difficult to predict whether the number of fish seeking passage past the Mattaceunk Project 15 years post-license would warrant the installation of an additional fishway at that time; these include: (1) the response of alosine populations to the increased access to spawning habitats between the former Veazie dam location and West Enfield in terms of both population size and spawning distribution within the river, (2) unknown passage efficiency at downstream projects including West Enfield, and (3) potential changes in ocean mortality. Nevertheless, if any new license issued for the project required an

¹³⁰ We did not estimate the production potential of blueback herring because there are no production estimates available for that species. Nor did we estimate the production potential of alewives for this portion of the river because they primarily spawn in lake habitats, not in the mainstem.

upstream alosine fishway to be installed, the fishway would provide American shad and blueback herring access to an additional 30 miles (13 percent) of spawning habitat in the upper Penobscot River Basin (Maine DMR and DIFW, 2008), primarily consisting of the East Branch of the Penobscot River upstream to its confluence with Wassataquoik Stream.¹³¹ However, the installation of an alosine fishway would provide little to no benefit to alewives because less than 1 percent of their lake spawning habitat in the Penobscot Basin is located upstream of the Mattaceunk Project.

Table 13. Annual counts of adult alosines passed upstream of the Milford Project via the fish lift that became operational in April 2014.

Year	American shad	Blueback herring	Alewife	Combined River Herring (blueback + alewife)
2014	812	44,597	142,841	187,438
2015	1,806	207,237	382,503	589,740
2016	7,862	697,882	561,502	1,259,384
2017	3,868	N/A	N/A	1,256,061

(Sources: Maine DMR, 2017a; Maine DMR, 2017b).

Although the type of fishway that would be installed at the Mattaceunk Project has not been specified, the situation is similar to the Milford Project, where a second upstream fishway (fish lift) was added to a dam containing an existing fish ladder designed for salmon. The Milford fish lift took approximately 18 months to construct. Therefore, the requirement by NMFS that the new fishway at the Mattaceunk Project be operational within two years of commencing fishway construction appears feasible.

Upon its completion, Maine DMR recommends and NMFS requires that the alosine fishway operate from May 1 to July 31 of each year. This period encompasses the reported upstream migration period for alosines in this region (Loesch, 1987; Saunders *et al.*, 2006). Therefore, operating the alosine fishway for upstream passage from May 1 to July 31 would provide adequate opportunities for alosines, particularly American shad and blueback herring, to pass upstream of the project and access additional spawning habitat.

¹³¹ Although alosines are historically documented to occur in the West Branch of the Penobscot River, this branch is currently inaccessible and not targeted for diadromous fish restoration, as the first 15 miles of the West Branch contains five hydropower dams, only one of which, the lowermost at Medway, provides fish passage via an eel ramp, which alosines cannot ascend.

Downstream Alosine Passage

The existing downstream fish passage facility—surface bypasses integral with turbine units 3 and 4—is currently operated from April 1 to June 15 and October 17 to December 1 for salmon smolt and kelt passage. To accommodate downstream alosine passage upon completion of the alosine fishway (expected in year 16 of a license), GLHA proposes to extend the operation period of the existing downstream passage facility to include the period from June 1 through December 1, as needed based on the results of monitoring studies of downstream alosine passage. GLHA also proposes to open and provide flows of 225 cfs to 690 cfs down the log sluice from June 1 through December 1, as needed, to accommodate the downstream passage of alosines upon completion of the upstream fishway. As discussed in sections above, GLHA proposes to install, within two years of the effective date of a new license, full-depth trash rack overlays with 1-inch clear spacing that would extend to the bottom of the intakes. Although they do not specify dates, GLHA proposes to deploy the full-depth, 1-inch trash rack overlays during the ‘downstream fish passage season’.

NMFS and Maine DMR¹³² both recommend extending the operation season of the existing downstream passage facility to include the period from June 1 through December 1 and also open the log sluice during this timeframe to accommodate the downstream passage of alosines once the upstream alosine fishway would be operational. NMFS further states that the period of operation for downstream passage of alosines may be modified based on new information and agency consultation. In addition, NMFS and Maine DMR both recommend the installation of full-depth trash racks with 1-inch clear spacing. However, NMFS requires these full-depth trash racks be installed within 2 years of license issuance, while Maine DMR recommends the trash racks be installed during the first downstream passage season after license issuance.

The Penobscot Indian Nation states that the existing downstream passage facility does not protect out-migrating alosines or keep them out of the project turbines, but provides no specific recommendations for improvements to the existing downstream

¹³² Although Table 2 in Maine DMR’s 10(j) letter indicates that downstream passage for alosines would be provided from June 1-November 15, its 10(j) recommendation no. 3 states the downstream fishway should be operated from June 1 to November 30 for alosines; therefore, we assume throughout this EA that June 1 through November 30 is Maine DMR’s recommended operation period for providing downstream passage for alosines. Because the November 30 end date for the downstream operation period for alosine passage is just one day earlier than that proposed by the applicant and required by NMFS, we assume this difference is negligible and that the December 1 end date incorporates, and is consistent with, Maine DMR’s 10(j) recommendation.

passage facility.¹³³ ASF states that downstream fish passage measures for alosines should be implemented sooner than 15 years post-license issuance, because the current lack of dedicated downstream passage for river herring at the Mattaceunk Project will likely preclude stocking efforts above the project, which could start as soon as 2020 based on current population trajectories.¹³⁴

Our Analysis

Downstream Fishway Operations Schedule

In Maine, alosines migrate downstream from mid-summer through fall. Most adult alosines in this region are repeat spawners, and after spawning, migrate downstream during May and June (alewives) or June and July (American shad and blueback herring) (Saunders et. al, 2006). Meanwhile, juvenile alosines migrate downstream from mid-July through the end of October (Saunders *et al.*, 2006). Therefore, GLHA's proposal to extend the operation of the downstream fish passage facility and log sluice to include the period from June 1 through December 1 includes the reported downstream migration period of juvenile and adult alosines, and would therefore, accommodate downstream passage of these species. However, there would be no benefit to requiring these measures in any new license until an upstream fishway for alosines is operational.

Regarding the comment by the Penobscot Nation on the difficulty of providing downstream passage, this subject is discussed extensively below. ASF's comment is not considered further because alewives are the only alosine species currently targeted for stocking in the Penobscot River,¹³⁵ and waters above the Mattaceunk Project are not targeted for alewife stocking because they contain less than one percent of the historical spawning habitat in the Penobscot Basin for this species, as discussed above (in *Upstream Alosine Passage*).

Trash Racks

Most out-migrating juveniles would likely be entrained through the project turbines during their downstream migration. During the low-flow period in which out-migration occurs (mid-July through October), the project would only be spilling

¹³³ See letter filed by The Penobscot Indian Nations on May 23, 2017.

¹³⁴ See letter filed by ASF on May 23, 2017.

¹³⁵ See letter filed by Maine DMR on May 22, 2017.

approximately 7 to 18 percent of the time.¹³⁶ Therefore, the primary downstream passage routes during the juvenile out-migration period would be through the: (1) turbines, (2) surface bypasses, or (3) log sluice.

From July through October, flows into the surface bypasses of turbine units 3 and 4 would compose only 2.8 to 3.7 percent of the median monthly inflow into the impoundment. Proposed surface flows through the log sluice (225 cfs to 690 cfs) would compose a slightly higher fraction of the total inflow—4.5 to 18.2 percent. However, the bulk of the total inflow, 78 to 93 percent, would pass through the turbines during non-spill periods, mostly through units 3 and 4, which are the first units online and last units offline, and have a combined maximum hydraulic capacity of 3,672 cfs. Given their strong attraction to the bulk flow at hydropower projects (Kynard, 1993; Desroches *et al.*, 1993), reduced swimming abilities compared to adults (table 14), and small, narrow-bodies that would easily fit through the proposed trash racks having 1-inch bar spacing (table 15), most juvenile alosines would likely be entrained through the turbines at the Mattaceunk Project during their downstream migration. Nevertheless, entrainment survival is expected to be high for juvenile alosines. For the sizes of out-migrating juvenile alosines expected at the project (1.5-5.0 inches across species; Richkus, 1975; Pardue, 1983; O’Leary and Kynard, 1986; Weiss-Glanz *et al.*, 1985), the blade strike model of Franke *et al.* (1997) indicates that at least 95 percent of juveniles would survive passage through the turbines (GLHA, 2016a). In addition, Heisey *et al.* (1992) found that 97 to 98 percent of juvenile American shad survived passage through Kaplan units with characteristics similar to those at the Mattaceunk Project.¹³⁷ Therefore, even if juvenile alosines are found to predominantly pass through the turbines instead of the presumably safer downstream routes (surface bypasses, log sluice, or occasional spill), whole-station survival at the Mattaceunk Project should be high (greater than 95 percent) for out-migrating juvenile alosines, and adequate for the protection of the population.

Given their larger body sizes and greater swimming abilities, the entrainment potential of adult alosines is lower than that of juveniles. During their post-spawning migration in riverine habitats, adult alosines have been found to primarily travel in the bottom-third (American shad) or middle portion (blueback herring) of the water column

¹³⁶ Calculation of the percent of time the project would be spilling is based on monthly flow duration curves provided in the final license application for the 1996-2015 period of record and the assumption that spill occurs when reservoir inflows exceed 7,593 cfs, which is the sum of the project’s maximum hydraulic capacity (7,438 cfs) and existing conveyance flows for upstream (15 cfs) and downstream (140 cfs) fish passage.

¹³⁷ The Kaplan units in the Heisey *et al.* (1992) study also had 5 runner blades (same as Mattaceunk), but a larger runner diameter (18 feet vs. 9 feet) and lower rotational speed (109 rpm versus 189.5 rpm) than the units at Mattaceunk.

(Witherell, 1987; Witherell and Kynard, 1990). Spawning blueback herring and alewives are generally greater than 10 inches total length (Loesch and Lund, 1977) and spawning American shad are typically greater than 17 inches total length (Leggett and Carscadden, 1978; Limburg *et al.*, 2003). At the Mattaceunk Project, the bottom portions of the existing trash racks (where out-migrating adults would be expected to travel) have a clear spacing of 2.63 inches; therefore, the existing trash racks would not physically exclude blueback herring or alewives of any size, and would only exclude post-spawning American shad greater than 19.6 inches total length (table 15). However, GLHA’s proposal to install full-depth trash racks with 1-inch clear spacing to the bottom of the intakes would reduce entrainment of alosines at the project because trash racks with this spacing would physically exclude all post-spawning American shad and blueback herring and alewives larger than 11.4 and 11.6 inches, respectively (table 15). Assuming the installation of full-depth trash racks would not increase the approach velocities at the project, the installation of full-depth trash racks with 1-inch clear bar spacing would not be expected to result in impingement of adult alosines because their burst swimming speeds (4 to 21 fps; table 14) greatly exceed the existing approach velocities at the Mattaceunk Project (1.7 fps). Therefore, adults would be able to avoid impingement based on their swimming abilities.

Lastly, adult alosines have been noted to become more surface-oriented and initiate searching behavior upon reaching obstructions, such as dams, during their downstream migration (Desrorches *et al.*, 1993; Kynard, 2003). Therefore, given this exploratory behavior, which is afforded by their greater swimming abilities, adult alosines may be more adept than juveniles at locating surface outlets that would provide downstream passage past the Mattaceunk Project (i.e., through the surface bypasses, log sluice, or occasional spill). Still, monitoring the downstream passage of adult and juvenile alosines would be necessary to conclusively determine the routes used for passage and their associated survival rates.

Table 14. Reported burst swimming speeds in feet per second (fps) of juvenile and adult alosines (Source: Staff).

Species (total length, inches)	Burst swimming speed (fps)	Source
Juveniles		
American shad (1-3’')	1.8-2.5	Bell (1991)
Alewife (2.5-3.5’')	0.5-3.0	Bell (1991)
Adults		
American shad (12-14’')	8.0-14.0	Bell (1991)
American shad (17’')	11.0-21.0	Castro-Santos (2005)
Blueback herring (9.5’')	5.8-17.4	Castro-Santos (2005)
Alewife (10.6’')	4.0-14.0	Castro-Santos (2005)

Table 15. Minimum sizes of alosines (total length, inches) physically excluded from trash racks with 1-inch and 2.63-inch spacing, based on the body width scaling factors in Smith (1985).

Species	1-inch trash racks	2.63-inch trash racks
American shad	7.4 inches	19.6 inches
Blueback herring	11.4 inches	NE ^a
Alewife	11.6 inches	NE

^a NE indicates none excluded (i.e., all sizes of a given species could pass through the trash racks) because the minimum exclusion size exceeds the maximum reported sizes for these species: 16 inches for blueback herring and 15 inches for alewife (Bigelow and Schroeder, 1953). (Source: Staff).

Passage Effectiveness Studies for Alosines

Upon completion of an upstream alosine fishway, GLHA proposes to monitor its use for 2 years and also monitor, for 2 years, the use of the existing downstream passage structures by alosines. Two years of upstream and downstream monitoring of alosine passage is also recommended by Maine DMR and required by NMFS, upon completion of an upstream alosine fishway. Furthermore, NMFS requires that study plans for fish passage monitoring studies of all diadromous fishes (Atlantic salmon, eel, and alosines) be developed in consultation with the resource agencies and conducted using scientifically accepted practices, and that monitoring begin at the start of the second migratory season after each fishway facility is operational. NMFS also requires a provision that additional protective measures, including structural or operational modifications of fishways, be implemented, if necessary based on monitoring results, to meet any performance standards that are established for alosines by the time the alosine fishway is operational.

Our Analysis

Although GLHA proposes to monitor upstream and downstream passage of alosines for 2 years once the new upstream fishway is operational, they provide no details on the methodology that would be used. Therefore, developing study plans for passage monitoring studies, in consultation with the resource agencies, would help ensure the data collected is sufficient to determine if any operational or structural modifications are necessary to improve the effectiveness of the fishways and meet any passage performance standards established for alosines. Nevertheless, there would be no benefit to requiring monitoring studies in any new license until an upstream fishway for alosines is operational.

Fish Passage Operation and Maintenance Plan for New Alosine Fishway

Maine DMR, in its 10(j) letter, recommends that GLHA develop and maintain, in consultation with the resource agencies, written operating procedures for fishways at the Mattaceunk Project. Specifically, these operating procedures would include general schedules for routine maintenance, procedures for routine operation, procedures for monitoring and reporting on the operation of each fish passage facility or measure, schedules and procedures for annual start-up and shut-down, and procedures for emergencies and project outages significantly affecting fishway operations. Maine DMR recommends that copies of these written operating procedures, and any revisions made during the term of a license, be provided to the resource agencies.

Our Analysis

With regard to an operation and maintenance plan, GLHA has a plan that covers the operation and maintenance of the existing fishways for Atlantic salmon. GLHA proposes to continue to implement this plan. However, the plan does not cover alosines, nor does GLHA propose to develop such a plan, or modify the existing plan, for alosine passage at the project.

An operation and maintenance plan for the upstream alosine fishway, including the operation and maintenance aspects recommended above by Maine DMR, would ensure this new structure is operated during the appropriate times of the day/year and with adequate attraction flows. Such a plan would also ensure that routine cleaning and maintenance, including debris removal, are performed so that the new fishway operates as intended. Changes in the operation of the existing downstream passage structures (e.g., extending the operation season) would occur once the alosine fishway is operational. Therefore, revising the FPOMP for the existing downstream passage structures to reflect any such changes would be necessary to ensure that the downstream structures are operating during the appropriate times of the day and year with the appropriate conveyance flows, generally functioning as intended, and clear of debris to facilitate passage.

Upstream Passage for Sea Lamprey

Sea lamprey, like the alosines discussed above, are an anadromous species that spends most of its life at sea, but must migrate upstream to freshwater to spawn. As discussed in section 3.3.1.1, *Fish Community, Sea Lamprey*, sea lamprey occur in the Penobscot River, including habitats downstream of the Mattaceunk Project. NMFS recommends that the upstream alosine fishway proposed by GLHA (discussed above) be designed to ensure safe upstream passage for sea lamprey.

Our Analysis

As discussed in section 3.3.1.1, *Affected Environment*, sea lamprey have been observed passing upstream of West Enfield Dam (first dam immediately downstream of the project) as recently as 2016, and thus are potentially present immediately downstream from the Mattaceunk Project. Sea lamprey could attempt to use the existing pool and weir fishway, if they desired to migrate upstream of the project. However, sea lamprey are poor swimmers¹³⁸ and would likely have difficulty moving through the weirs and up successive pools of the existing upstream fishway, which was designed to create flows and turbulence suitable for strong swimmers like salmon. Thus, it is more likely that they would need an alternate upstream passage to successfully migrate upstream of the project.

NMFS recommends that GLHA provide an alternative to the existing pool and weir fishway to enable safe upstream passage for sea lamprey, but does not specify the benefits of providing upstream passage. Historical accounts indicate that sea lamprey were collected upstream of the project in 1832 and 1903 (Kendall, 1914), but the historical abundance of sea lamprey upstream of the project is not known. Further, the relative abundance and importance of upstream habitat to the historical and existing sea lamprey population is not known. Because the abundance and importance of upstream habitat is not known, the benefit to passing sea lamprey upstream of the project also is not known and cannot be determined based on available information.

Fish Passage Design, Operation, Maintenance, and Monitoring

GLHA proposes that any structural and/or operational modifications of existing upstream and downstream fishways be conducted in consultation with the resource agencies, and that the design of any new fishways would be reviewed with the resource agencies. GLHA also proposes to conduct upstream and downstream fishway effectiveness studies for passage of eel, alosines, and Atlantic salmon (*see* details discussed in section 3.3.2.2, *Eel Passage Effectiveness Studies* and *Alosine Passage Effectiveness Studies*, and section 3.3.4.2, *Environmental Effects, Atlantic Salmon*). In addition, GLHA proposes to implement the FPOMP, which defines the: (1) operational period of the existing upstream and downstream fishways; (2) annual start-up and shut-down procedures; (3) opening methods; (4) debris management; and (5) safety rules and procedures.

Regarding the design of fishways, NMFS's fishway prescription would require GLHA to: (1) submit design plans to the resource agencies for review and consultation

¹³⁸ Sea lamprey have burst swim speeds of about 6 to 7 fps (Bell, 1991), compared to 16.5 to 19.7 fps for Atlantic salmon (Wolter and Arlinghaus, 2003). Their burst speed is at the lower end of the range of that for alosines (see table 14).

during the conceptual, 30, 60 and 90 percent design stages; (2) provide conceptual designs to the resource agencies no later than 2 years before the anticipated operational date; (3) provide the resource agencies with conceptual designs for the proposed full-depth trash racks with 1-inch bar spacing at least 6 months prior to the first downstream passage season following issuance of any new license; (4) submit final design plans to the Commission for final approval after resource agency approval and prior to the commencement of fishway construction activities, with all unaddressed resource agency comments; and (5) file final as-built drawings with NMFS and FWS that accurately reflect the project as constructed after the fishway is completed.

Regarding evaluation of fish passage effectiveness studies, NMFS has a fishway prescription that includes provisions for GLHA to: (1) develop study design plans in consultation with NMFS and state and federal resource agencies; (2) seek resource agency approval of the study design prior to filing with the Commission for final approval; (3) complete all monitoring with scientifically accepted practices; (4) begin monitoring at the start of the second migratory season after each fishway facility (Atlantic salmon, alosines and eel) is operational, and continue monitoring for the time frames proposed, or as otherwise required; (5) conduct fishway “shakedowns” the first season after fishways are constructed; (6) provide reports of the monitoring studies to the resource agencies for a minimum 30-day review and consultation, prior to submittal to the Commission for final approval; and (7) include resource agencies’ comments in the annual reports submitted to the Commission for final review.

Interior’s fishway prescription would require that GLHA to provide information on fish passage operation, and project generating operation that may affect fish passage, upon written request from the FWS. Interior has a second, related fishway prescription that would require GLHA to provide FWS personnel and other FWS-designated representatives, timely access to the fishways at the project and to pertinent project operational records for the purpose of inspecting the fishways to determine compliance with the fishway prescription.

Maine DMR recommends five general provisions for fish passage operations and maintenance.

- The first provision is for GLHA to operate each fish passage facility for a one-season "shakedown" period to ensure that it is generally operating as designed and to make minor adjustment to the facilities and operation. At the end of the “shakedown” period, GLHA would have a licensed engineer certify that the facility is constructed and operating as designed in all material respects. Further, GLHA would provide the Maine DMR, FWS, and NMFS with a copy of the as-built fishway drawings as submitted to the Commission, along with the licensed engineer's letter of certification.

- The second provision is for GLHA to keep the fishways in proper working order and maintain fishway areas clear of trash, logs, and material that would hinder passage. GLHA would perform routine maintenance sufficiently before a migratory period such that fishways can be tested and inspected, and will be operational during the migratory periods.
- The third provision is for GLHA to draft, in consultation with Maine DMR, FWS, and NMFS, and maintain written fishway operating procedures (FOPs) for the Mattaceunk Project. These FOPs would include general schedules of routine maintenance, procedures for routine operation, procedures for monitoring and reporting on the operation of each fish passage facility or measure, schedules for procedures for annual start-up and shutdown, and procedures for emergencies and project outages significantly affecting fishway operations. Copies of these FOPs, and any revisions made during the term of the license, would be sent to the Maine DMR, FWS, and NMFS.
- The fourth provision is for GLHA to meet with Maine DMR, FWS, and NMFS in March annually to review fish passage operational data from the previous year, draft an annual report, and develop an operational plan for the upcoming year. The fish passage operational data should include the number of fish passed daily (by species), daily water and air temperature data, and other related fishway operational information.
- The fifth and final provision is for GLHA to maintain and operate permanent fish ways during the upstream and downstream migration periods for Atlantic salmon, American shad, blueback herring, alewife, and eel. Any of the operating schedules during these migration periods could be modified during the term of the license based on migration data, new information, and in consultation with the Maine DMR, FWS, and NMFS. Upon request from GLHA, the actual dates of operation could be varied somewhat in any given year in response to river conditions, maintenance requirements, or annual variability in fish migration patterns, with the approval of Maine DMR, FWS, and NMFS, as appropriate.

Our Analysis

As discussed in several sections above, as well as in section 3.3.4.2, *Environmental Effects, Atlantic Salmon*, below, GLHA is proposing to install fishways (for eel and alosines) or improve existing fishways (if necessary, for Atlantic salmon) to provide or enhance fish passage at the project. The installation of fishways, such as the proposed eel ladder and upstream alosine fishway, would require careful design considerations to ensure the fishways are able to pass fish in a safe, timely, and effective manner. The proposed eel ladder and alosine fishway would be new structures at the project that would require considerations such as proper placement along the dam and necessary attraction flows to provide adequate passage for the target species (eel and

alosines), without negatively affecting the efficiency of the existing fishways for Atlantic salmon. Fishway design would also require consideration of the intended performance standards, such as Interior’s fishway prescription that requires GLHA to pass 90 percent of eel that enter the eel ladder. Modifications of the existing upstream fishway and downstream surface bypass may also be necessary at some future date. Any modifications would require similar design considerations regarding potential effects on other fishways, as well as performance standards.¹³⁹ GLHA’s proposal to consult with the resource agencies on the design of new fishways, and NMFS’s fishway prescription that includes general provisions for the design of fishways, would help guide the design process and ensure fishways are constructed to operate effectively.

As-built drawings provide documentation that fishways are constructed as designed. NMFS’s fishway prescription would require GLHA to provide as-built drawings to the resource agencies, for any new fishways and Maine DMR recommends that GLHA also provide as-built drawings for modified fishways, along with a licensed engineer’s letter of certification. 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. Further, as-built drawings could be accessed by the agencies, through the Commission.

Maine DMR recommends operating each fishway for a one-season “shakedown” period to ensure that the fishways are generally operating as designed, and if not, to make adjustments. The existing upstream fishway and downstream surface bypass are currently operated and maintained using the FPOMP, and have been monitored several times for passage effectiveness (*see* section 3.3.4.1, *Affected Environment, Atlantic Salmon*). As discussed below and in section 3.3.4.2, *Downstream Passage Operations*, the operation and maintenance of the existing fishways would benefit from additional measures to the FPOMP. Through implementation of the FPOMP, with the additional measures, there is no reason to believe that the existing fishways would not perform as designed. Thus, there would be no benefit to operating the existing fishways for a one-season “shakedown” period.

In contrast to the existing fishways, newly proposed fishway(s) have not been constructed or installed (i.e., upstream eel ladder), and therefore there has never been an evaluation to ensure the new fishways are operating as designed. Thus, for any newly constructed or installed fishways, there would be a benefit to conducting a “shakedown” period during the first season after construction (or installation) as required by NMFS’s fishway prescription. NMFS’s fishway prescription would require “shakedowns” to

¹³⁹ After specific fishway modifications are identified, they can only be implemented upon additional Commission approval in a proceeding separate from this relicensing proceeding.

occur during the first season after fishways are constructed, which would allow the “shakedowns” to occur in a timely manner without substantial delay to the operation of the fishway. However, to prevent interference with the fish passage season or delay of the start of the fish passage effectiveness studies, the “shakedown” period and any necessary adjustments should be timed so that they are completed prior to the relevant fish passage season and pertinent effectiveness studies (see discussion below).

The benefits of fish passage effectiveness studies for eel is discussed above, and effectiveness studies for Atlantic salmon are discussed below in section 3.3.4.2, *Environmental Effects, Atlantic Salmon*. The general provisions for fish passage effectiveness studies that NMFS would require in its fishway prescription, would apply to any effectiveness studies conducted at the project. Implementing these provisions would help to guide the development of effectiveness studies so that the results provide reliable and accurate information regarding fishway effectiveness. Further, the provision to begin monitoring at the start of the second migratory season after each fishway facility is operational, would ensure that studies are conducted in a timely fashion, and so that any needed adjustments could occur quickly, and effectiveness standards could be met as soon as possible.

To maintain proper operation and effectiveness, the fishways need to be properly maintained. GLHA proposes to continue implementing the FPOMP to ensure proper operation and maintenance of fishways. The FPOMP includes maintenance and inspection procedures specifically for the existing upstream fishway and downstream bypass. Maine DMR has five general provisions for fish passage operations and maintenance, which would apply to the existing or new fishways, and would help to ensure proper operation and maintenance of fishways at the project. Some of the recommendations included within Maine DMR’s five general provisions are already in the FPOMP for the existing facilities, and thus adding them as conditions to a new license would not provide any additional benefit to upstream or downstream migration of diadromous species in the river. The Maine DMR recommendations that are already in the FPOMP include: (1) maintaining written FOPs for the existing facilities that would include: (a) general schedules for routine maintenance and inspection of the existing facilities; (b) procedures for routine operations of the existing facilities; and (c) procedures for monitoring the existing facilities; (2) maintaining fishway areas clear of debris that would hinder passage; and (3) operation schedules for Atlantic salmon.¹⁴⁰ However, the FPOMP for the existing facilities does not have the following procedures, which are recommended by Maine DMR: (1) perform routine maintenance sufficiently before a migratory period, such that the fishways can be fully operational during the

¹⁴⁰ The upstream and downstream fishway operations schedules and potential need for schedule modifications for Atlantic salmon are discussed in section 3.3.3.2, *Environmental Effects, Atlantic Salmon*.

migratory periods; (2) shutdown procedures for the existing facilities; (3) procedures for emergencies and project outages; (4) procedures for reporting annually on the operation of the existing facilities, including providing information upon written request from the resource agencies (as required in Interior's fishway prescription); and (5) a provision to provide copies of the plan to Maine DMR, FWS, and NMFS. Modifying the FPOMP to include items 1 through 4 would help to ensure proper operation and maintenance of the existing fishways. Regarding item 5, copies of plans would be filed publicly with the Commission, and because all public filings are accessible to the public, there would be no benefit to providing copies of the plan to the agencies.

Maine DMR also recommends in its general provisions that GLHA develop an operational plan for fishway operation prior to the beginning of each fish passage season. However, a modified FPOMP would be adequate to ensure proper operation of the existing fishways during each year. Further, new plans would need to be developed for any new fishways, and those plans would need to include, at a minimum, the procedures recommended by Maine DMR, in order to ensure proper maintenance and operation.

Maine DMR also recommends that GLHA meet with Maine DMR, FWS, and NMFS annually in March to review fish passage operational data from the previous year. However, Maine DMR does not identify a specific need or benefit of meeting annually or reviewing fish passage operational data. Further, as discussed above, GLHA would operate and maintain all fishways by following specific operation and maintenance plans that are developed (or modified) in consultation with the resource agencies, and approved by the Commission. With proper operation and maintenance, there is no reason to believe that the fishways would not perform as designed. Thus, there would be no benefit to meeting annually. For the same reasons, there would also be no benefit to Interior's fishway prescriptions that would require GLHA to provide information on fish passage operations and project generation to FWS upon written request, and to provide FWS personnel access to fishways.

Maine DMR has also indicated in its recommendation that the fish passage operational data should include the number of fish passed daily (by species), daily water temperature, and daily air temperature. GLHA currently counts the number of adult Atlantic salmon that pass through the existing upstream fishway, and they propose to continue to provide these counts under a new license (discussed in detail in section 3.3.3.2, *Environmental Effects, Atlantic Salmon*). Nevertheless, counting Atlantic salmon, or any other migratory species would not protect fishery resources from project effects, mitigate a project effect on fishery resources, or enhance the population. Further, Maine DMR does not provide any justification for counting fish species in the project fishways. Thus, we find no benefit to counting fish species that pass through fishways at the project.

Cumulative Effects

European colonization led to dams being built on tributaries of the Penobscot River for saw mill operations, with over 250 active saw mills in the Penobscot River Basin by 1837 (Atkins and Foster, 1869, as cited in Opperman *et al.*, 2011). Construction of dams along the mainstem of the river began in the 1820s, with the first dam built in the Old Town-Milford area, and the last dam (Weldon Dam) constructed in 1939 (Maine DMR and Maine DIFW, 2008). As recent as recent as 2012, there were five hydroelectric dams on the mainstem of the Penobscot River, including Veazie, Great Works, Milford, West Enfield, and Mattaceunk. The Great Works and Veazie dams, were removed in 2012 and 2013, respectively.

The construction of dams in the Penobscot River Basin during the last 200 years converted a once free-flowing system to a series of impoundments, resulting in decreased flow and increased water depth, which in turn likely led to some lowering of DO and increases in water temperature. Construction of dams also blocked passage to migratory fish spawning and rearing habitat, which along with commercial fishing likely contributed to declines in migratory fish populations (Opperman *et al.*, 2011). Upstream and downstream passage is now available along the entire mainstem of the Penobscot River, with fishways present at Milford, West Enfield, and Mattaceunk, and the removal of the Great Works and Veazie dams.

Today, the Mattaceunk Project, in combination with the other hydroelectric projects that still exist in the Penobscot River Basin (see figure 1), cumulatively affects water quality, downstream aquatic habitat, and migratory fish species (i.e., Atlantic salmon, American eel, American shad, alewife, and blueback herring).

Under existing project operations, water quality at the Mattaceunk Project is consistent with Maine DEP's state water quality standards for Class C aquatic life criteria, and demonstrates that the structure and function of the resident biological community is maintained. With no proposed changes in operation, the project would have minimal cumulative effects on water quality in the Penobscot River.

Under normal project operation, minimal impoundment fluctuations result in relatively stable impoundment and downstream flows, which would continue under any new license. In addition, continuing to provide a year-round continuous minimum base flow, as well as seasonal daily average minimum flows would maintain: (1) the existing, high-quality aquatic habitat in the project area; and (2) an adequate zone of passage for fish migration. Consequently, the project's contribution to cumulative effects on aquatic habitat in the Penobscot River would be minimal.

Cumulative effects occur from multiple hydroelectric developments within the river basin and include injuries and mortality from turbine passage, as well as interference with upstream and downstream fish migrations. GLHA's proposal to

provide upstream fish passage for migratory fish species, would: (1) improve upstream passage effectiveness of Atlantic salmon at the project (discussed in section 3.3.4.2, *Operation of the Upstream Fishway*); and (2) improve the passage effectiveness of eel at Weldon Dam and access to habitat upstream of the dam. In addition, GLHA's proposal to enhance downstream passage for Atlantic salmon at the project (discussed in section 3.3.4.2, *Downstream Passage Operations*), and to provide downstream passage measures for eel would limit entrainment and turbine-related mortality of fish moving downstream through the project. Therefore, the proposed protection and enhancement measures are likely to be cumulatively beneficial for diadromous fish in the Penobscot River.

3.3.3 Terrestrial Resources

3.3.3.1 Affected Environment

Botanical Resources

Two types of forested uplands surround the project boundary, a spruce-fir forest and a spruce-northern hardwood forest. The spruce - fir forest is composed primarily of red spruce, with Balsam fir dominating open gaps and younger stands. The ground layer is typically sparse. Shrubs are virtually absent, except for occasional lowbush blueberry, with a ground cover of scattered Canada mayflower, starflower, and bunchberry. The spruce - northern hardwood forest is characterized by red spruce, yellow birch, sugar maple, red maple, and American beech. There is a sapling/shrub layer, with red spruce, striped maple, balsam fir, and paper birch. The shrub species composition varies across sites. The ground layer ranges from vegetatively sparse to dense and is divided between forbs, ferns, and regenerating trees, with few shrubs. Nearly all forests of this type have been harvested in the past, during which the spruce were selectively removed. As a result, the canopy of the harvested forests are often composed of beech, birch, and maples, with spruce and fir appearing more commonly in the understory (Gawler and Cutko, 2010).

Current practices conducted by GLHA include vegetation maintenance around project facilities using mostly mechanical vegetation removal techniques (e.g., mowing). GLHA operations staff conduct periodic inspections for hazardous trees near facilities (e.g., power lines) and trim or clear trees when necessary. The designated recreation facilities are kept clear of vegetation through mechanical vegetation removal techniques.

The transmission line right-of-way (ROW) represents a different plant community, an open land or early successional plant community. This community is usually observed in upland areas where the forest has been cleared and dominates upland areas to maintain utility corridors and road edges, or for logging (Anderson *et al.*, 1976). Typically natural succession causes the herbaceous composition and structure to change gradually over time. However, because the ROW is subject to maintenance, the early successional composition is permanent. The maintenance schedule keeps the ROW in a state ranging

from herbaceous field to shrub dominated cover. The dominant vegetation within this cover type includes red raspberry, sweet fern, bracken fern, hay-scented fern sheep laurel wintergreen, and bunchberry.

Invasive vegetation

No invasive botanical species have been identified by GLHA within the Project Boundary during routine vegetation management efforts, and continued Project operations are not expected to contribute to the spread of non-native invasive species. As noted above, the botanical resources located within and adjacent to the Project Boundary generally are stable, mature, and well established. GLHA's vegetation management practices typically involve mechanical vegetation removal around Project facilities and the clearing of hazardous trees. GLHA is not proposing to conduct additional ground-disturbing activities such as road construction or land-clearing that would facilitate the spread of invasive botanical species within the Project Boundary. There were no comments or recommendations indicating that invasive plant species were problematic at the project. Therefore, we will not analyze invasive plants further in this document.

Wetland Vegetation

Based on satellite imagery, National Wetland Inventory (NWI) wetland data, and riparian and wetland habitat assessments conducted in 2014 and 2015, as part of project relicensing studies, wetland communities are common in and near the project boundary. Wetlands in the project area are generally represented as riverine,¹⁴¹ lacustrine,¹⁴²

¹⁴¹ "Riverine" includes all wetlands and deepwater habitats contained within a channel, excluding wetlands dominated by trees, shrubs, persistent emergent vegetation, emergent mosses, or lichens.

¹⁴² "Lacustrine" includes wetlands and deepwater habitats with all of the following characteristics : (1) situated in a topographic depression or a dammed river channel; (2) lacking trees, shrubs, persistent emergent vegetation, emergent mosses or lichens with greater than 30 percent areal coverage ; and (3) total area exceeds 8 hectares (20 acres).

palustrine-unconsolidated bottom,^{143.} ¹⁴⁴ palustrine forested, palustrine scrub-shrub, and palustrine emergent wetland types, as defined by Cowardin *et al.* (1979). Based on NWI maps, there are about 1,468 acres of wetlands within the project boundary, including about three acres of wetlands within the project's transmission ROW. The remaining 1,465 acres of wetlands are along the river and in the project boundary. The majority (about 1,426 acres) are classified as lacustrine (or riverine) wetland types. Plant species dominating these wetlands include water horsetail, royal fern, sensitive fern, broad-leaved cat-tail, bur-reed, three-way sedge, spike rush, bulrush, wool-grass, sedge, longhaired sedge, wild calla, skunk-cabbage, sweet flag, pickerelweed, soft rush, blue flag, willow, marsh-cinquefoil, and mountain-holly. True aquatic plants in the project area include pondweed, waterweed, duckweed, fragrant water-lily, water-hemlock, spatterdock, water parsnip, leatherleaf, and bladderwort.

Sensitive Botanical Species

In preparation of its license application, GLHA consulted with federal and state agencies to determine the location of any important natural communities in the vicinity of the project.¹⁴⁵ GLHA reviewed information on rare, threatened, and endangered botanical species, and botanical species of special concern known to occur or to potentially occur in the vicinity of the project. One plant (Orono sedge) was identified as state species of concern.

The Orono sedge is state-listed as rare/threatened and is endemic to Maine. It is found in Aroostook, Penobscot, Hancock, Piscataquis, and Somerset Counties and nowhere else in the world. This sedge is found mainly in fields, thickets, forest edges, open woods, and roadsides in the Penobscot and Upper Kennebec watersheds (Arsenault *et al.*, 2013). The Orono sedge flowers in June with fruiting occurring from July through

¹⁴³ "Palustrine" includes all non-tidal wetlands dominated by trees, shrubs, persistent emergent vegetation, and emergent mosses or lichens. It also includes wetlands lacking such vegetation, but with all of the following characteristics : (1) area less than 8 hectares (20 acres) ; (2) active wave-formed or bedrock shoreline features lacking ; and (3) water depth in the deepest part of basin less than 6 feet at low water.

¹⁴⁴ "Unconsolidated bottom" includes all wetland and deepwater habitats with at least 25 percent cover of particles smaller than stones, and a vegetative cover less than 30 percent.

¹⁴⁵ The Maine DACF maintains their Biological and Conservation Data system database (Maine BCD) of rare and unusual plant species and natural communities in the state, and tracks the state status (e.g., endangered or threatened) and rank based on a system shared by other state natural heritage programs.

August. This sedge grows in loose clumps, producing sharply angled stems up to 3-feet tall. The leaves are much shorter than the stem and are about 0.5-inches wide. The largest populations are found growing in open sun, while plants growing in the shadiest sites tend to be few, small, and with few reproductive stems. The Orono sedge tends to grow in highly disturbed sites, including roadsides. Often the largest populations are located in hayfields. Records in the Maine BCD database indicate that the project's transmission ROW intersects with several populations of Orono sedge.

Wildlife Resources

The project area supports various wildlife habitats, including those associated with wooded upland and riparian areas. There are over 130 resident and transient bird species, almost 50 species of mammals, and 25 herptile¹⁴⁶ species found in the habitats associated with the Penobscot River corridor.

Mammals common to the state of Maine that could be in the project area include masked shrew, water shrew, smoky shrew, long-tailed shrew, short-tailed shrew, pygmy shrew, hairy-tailed mole, star-nosed mole, little brown myotis, northern myotis, silver-haired bat, Keen's bat, big brown bat, red bat, hoary bat, snowshoe hare, eastern chipmunk, woodchuck, gray squirrel, red squirrel, northern flying squirrel, deer mouse, southern red-backed vole, meadow vole, southern bog lemming, northern bog lemming, Norway rat, house mouse, meadow jumping mouse, woodland jumping mouse, porcupine, coyote, red fox, black bear, raccoon, pine marten, fisher, ermine, long-tailed weasel, striped skunk, lynx, bobcat, white-tailed deer, and moose (DTA, 2002; DeGraaf and Yamasaki, 2001). During the scoping process, Interior recommended an analysis of the effects of project operation on aquatic furbearers such as mink, beaver, river otter, and muskrat.

Herpetiles occupying habitats like those in the project (in Maine) include blue-spotted salamander, spotted salamander, eastern/red-spotted newt, northern dusky salamander, northern redback salamander, four-toed salamander, northern two-lined salamander, eastern American toad, spring peeper, gray tree frog, bullfrog, green frog, mink frog, wood frog, northern leopard frog, pickerel frog, snapping turtle, wood turtle, eastern painted turtle, northern water snake, northern redbelly snake, eastern garter snake, northern ringneck snake, eastern smooth green snake, and eastern milk snake. (Tynning 1990).

There are over 130 species of birds that could possibly be found in the project area including 2 species of tern, 7 species of wading/marsh birds, 12 species of waterfowl, 13

¹⁴⁶ Herptile refers to amphibians and reptiles.

raptors, 6 ground birds, 5 owls, and 85 other assorted perching birds. (DTA, 2002; DeGraaf and Yamasaki, 2001; BNA, 2016.)

Sensitive Bird Species

Marsh Nesting Birds

GLHA conducted surveys for rare marsh nesting birds in the project wetlands. The rare marsh birds include three species listed by the state as endangered, the sedge wren, least bittern, and black tern. The common gallinule is listed as threatened, and two species are listed as of special concern, the common tern, and yellow rail. These birds, if present, could use the wetlands on the margin of the project impoundment as nesting habitat.

The survey used the Standardized North American Marsh Bird Monitoring Protocol, which is a conventional marsh bird survey technique (Conway, 2009). The protocol makes use of call-broadcast surveys, which try to elicit responses from otherwise hard-to-detect birds by increasing the probability of vocalization (Conway and Nadeau, 2006). The surveys collect data on bird response vocalizations, distance to the bird, and habitat occupied. A total of three field surveys were conducted (two surveys during early morning hours on June 11 and 17, 2014, and one survey during early evening hours June 30, 2014) during the marsh-nesting bird season.

During the impoundment field surveys, GLHA did not report detecting any of the target rare marsh-nesting birds listed above. A single American bittern (non-target species) was detected on June 17, 2014, in the wetland southwest of where Route 116 crosses the project boundary, when it responded to a call-broadcast sequence. In addition, during the final survey, a suspected American bittern was visually observed in flight as the biologists approached the survey point. Rare marsh nesting birds will not be discussed further as they were not present in the project area, and any project related effects that might occur to them would be more likely to affect the common loon discussed in the next section.

Common Loon

The common loon is a state threatened species. Common loons tend to occur on inland lakes larger than 59 acres, where there is little shoreline development, stable water levels, and clear water. Nests are constructed close to the water's edge in dense vegetation). Loons may be found in a wide variety of freshwater aquatic habitats; however, they generally prefer lakes with an abundance of small fish, numerous small islands, and an irregular shoreline that creates coves. Loons have great difficulty walking on land, and must nest right at the water's edge where their reproductive success is susceptible to water level changes. Loons also prefer protection from prevailing winds

and waves, overhead vegetation or lateral cover, and a wide viewing angle of their territory (Evers, 2004).

Loon nesting surveys conducted by GLHA in 2014 and 2015 indicate that loons use the project impoundment, but not in large numbers. During the survey, observers found one loon pair and no nests during 2014, and two loon pairs and one nest during 2015. The loon pair attempted to nest twice during 2015, but no eggs hatched. GLHA completed an analysis of the impoundment elevations during the 2014 and 2015 nesting period and found that the impoundment maintained elevations within a band of 0.75-feet with a maximum elevation during the nesting of 2015 of 240.40 feet (mean sea level). The loon nest was monitored for impacts from flooding, but there was no evidence that the impoundment elevations rose to a level high enough to reach the nest.

Bald Eagle

Bald eagles tend to locate in proximity to bodies of water where adequate food exists and human disturbance is limited (Wakeley and Wakeley, 1983). Nesting eagles can be sensitive to human intrusions or disturbances, and such activities can compel eagles to abandon a nest. Eagles prefer areas near large lakes and reservoirs, marshes and swamps, or stretches along rivers where they can find open water and their primary food, fish (DeGraaf and Yamasaki, 2001). Bald eagles require breeding habitat with an adequate supply of moderate-sized to large fish, nearby nesting sites, and a reasonable degree of freedom from disturbance during the nesting period (Johnsgard, 1990).

Though bald eagles eat primarily fish, they are highly opportunistic and will consume various items including birds, reptiles, amphibians, crustaceans, and small mammals. They will also consume carrion. While many bald eagles leave Maine in winter, some remain through the winter months. Because ice cover greatly limits food availability in winter, bald eagles that stay in Maine through the frozen months are most likely to occur where open water remains available (e.g., large flowing rivers and coastal areas), or where carrion is available (Maine, DIFW 2014). Several bald eagles were observed at or near the Mattaceunk Project during the 2014 and 2015 field survey seasons. Most of the eagles were observed in the eastern portion of the project impoundment, to the East of the end of Dickey Moore Road. Additionally, a mature bald eagle was observed landing in a known bald eagle nest located approximately one and a half miles southeast of the Interstate 95 Bridge crossing of the Penobscot River.

3.3.3.2 Environmental Effects

Wetlands and Riparian Habitat

GLHA proposes to continue to operate the project in a run-of-river mode, with the impoundment fluctuation limits and minimum flows discussed fully in section 3.3.2.2,

Aquatic Resources, Environmental Effects. Interior, NMFS, and Maine DMR recommend GLHA's proposal for impoundment fluctuation limits and minimum flows.

Our Analysis

GLHA's proposal would result in the project being operated in a manner that would minimize changes in impoundment elevations and provide consistency in downstream flows. As discussed in section 3.3.1.2, *Geology and Soils*, the proposed operational protocol should continue to minimize erosion by providing stable conditions along the project shoreline, which would protect wetlands in the impoundment and avoid project-related sedimentation of downstream riparian habitat.

As discussed in the section 3.3.1.2, *Impoundment Levels*, operation of the project, as outlined by the applicant, would also maintain stable riparian habitats downstream of the dam because of the continued release of relatively stable flows associated with run-of-river operation.

Temporary drawdowns resulting from flashboard failures could require drawdowns up to 5 feet below the normal pond elevation; however, these are typically limited to a period of less than three days. Further, based on recorded data of impoundment elevations from 2008 to 2015, these types of drawdowns occur on average, less than once per year (GLHA, 2016). Thus, the drawdowns required for flashboard repair are infrequent and short in duration, and are unlikely to cause any substantial affects to wetlands.

Terrestrial Habitats and Wildlife

Current practices used by GLHA for vegetation maintenance around project facilities and the ROW include using mostly mechanical vegetation removal techniques (e.g., mowing). GLHA operations staff periodically inspect project facilities for hazardous trees, which are trimmed or cleared periodically as necessary. Recreation facilities are kept clear of vegetation through mechanical vegetation removal techniques. GLHA proposes to continue these current vegetation management practices for the term of a new license.

Interior, on behalf of FWS, states that uplands, wetlands, and associated wildlife are not likely to be adversely affected by continued project operation. No recommendations have been filed regarding altering the vegetation management practices used by GLHA at the project.

Our Analysis

Orono sedge is considered an early successional species and GLHA's current maintenance activities in the ROW permanently keep the successional stage in this early

state. This management is likely conducive to the success of the Orono sedge in the ROW. Therefore, continued maintenance of the ROW, as proposed by GLHA, would provide a constant open habitat for the Orono sedge, and would support the continued existence of the present populations under a new license.

Wildlife Resources

Bald Eagles

The bald eagle was listed as federally-endangered on March 11, 1967, partially due to the significant population declines attributed to the use of DDT. On July 9, 2007, FWS issued a final rule (Final Delisting Rule effective on August 8, 2007) removing the bald eagle from the list of endangered and threatened wildlife.¹⁴⁷ The eagle however is still protected under the Bald and Golden Eagle Protection Act, as amended,¹⁴⁸ and the Migratory Bird Treaty Act, as amended¹⁴⁹.

Bald eagles have been documented at the Mattaceunk Project using foraging habitat that can be found within the project boundary. There are four historical locations for nests around the project, but none are currently active (FWS, 2012). No measures for bald eagle protection have been proposed or recommended.

Our Analysis

Given current population trends for the species, future use of the project area by bald eagles is likely, as suitable habitat is widespread throughout the Penobscot River Basin. Human activities that can disturb eagles, such as construction of roads, trails, canals, or power lines, or alteration of shoreline or wetlands, are not occurring or proposed for the relicensing of the project. Continued operation and maintenance of the Mattaceunk Project, as proposed, would not disturb bald eagles or associated habitats.

Common Loons

There were no comments or recommendations indicating that project operation would negatively affect loon habitat in in the project impoundment.

¹⁴⁷ Endangered and Threatened Wildlife and Plants; Removing the Bald Eagle in the Lower 48 States From the List of Endangered and Threatened Wildlife. Final Rule. 72 Fed. Reg. 37346 (July 9, 2007).

¹⁴⁸ 16 U.S.C. §§ 668-668d.

¹⁴⁹ 16 U.S.C. §§ 703-712.

Our Analysis

Fluctuating water levels that can occur in impoundments can cause Loon nest failure by flooding or stranding nests, reducing nest accessibility, and increasing vulnerability to predation. Continued operation of the project in a run-of-river mode with minimal fluctuation in impoundment surface elevation for the installation and operation of the project flashboards, would maintain the reservoir elevation within 1.0 foot of the normal full pond elevation of 240.0 feet.

Impoundment drawdowns would only occur when flashboard repairs are needed, generally early in the year, and repairs completed in less than three days. The short timing of flashboard loss and repair would minimize impacts to the loon nesting season by returning the reservoir to normal operational levels quickly and deterring loons from building nests in normally submerged areas. Therefore, loons nesting success is unlikely to be affected by continued project operation under a new license.

Aquatic Furbearers

During the scoping process, Interior recommended an analysis of the effects of project operation on aquatic furbearers.

Our Analysis

Although dens are constructed to allow for changes in water levels, a consistent water levels during prime birthing periods is preferred during this critical life stage. By not fluctuating impoundment levels more than 1-foot between late May and mid-July, GLHL would limit negative impacts on loon breeding and/or brooding activities along the shoreline.

During winter months, entrances to beaver dens must be inundated to maintain an open den entrance below the ice. When water levels fall below the entrance, ice can form a barrier to the den. Because of the project's relatively stable reservoir operation, furbearers are unlikely to be affected by project operations under a new license.

3.3.4 Threatened and Endangered Species

3.3.4.1 Affected Environment

The federally endangered Gulf of Maine Distinct Population Segment (GOM DPS) of anadromous Atlantic salmon (*Salmo salar*) currently occupies the Penobscot River. In addition, two federally listed threatened species, the Canada lynx (*Lynx canadensis*) and northern long-eared bat (*Myotis septentrionalis*), could occur in Somerset County, Maine.

Atlantic Salmon

Listing Status

The initial listing (issued in 2000) for anadromous Atlantic salmon defined the Gulf of Maine Distinct Population Segment (GOM DPS) as including tributaries of the lower Kennebec River to, but not including, the mouth of the St. Croix River at the U.S.-Canada border, but excluded fish that inhabit the mainstem and tributaries of the Penobscot River upstream of the former Bangor Dam, near Bangor, Maine.¹⁵⁰ In 2009, a final rule was issued for the GOM DPS, which expanded the listing to encompass the freshwater range of salmon associated with the Penobscot River (figure 12).¹⁵¹ The GOM DPS range for Atlantic salmon on the Penobscot River extends from Penobscot Bay to impassible falls including Big Niagara Falls on Nesowadnehunk Stream in the West Branch Penobscot Basin, Grand Pitch on Webster Brook in the East Branch Penobscot Basin, and Grand Falls on the Passadumkeag River.¹⁵² Critical habitat within the main stem of the Penobscot River was designated for the GOM DPS and extends from the estuarine habitat of Penobscot Bay up into the East and West Branches. The Mattaceunk Project falls within the designated critical habitat, which is located in the Penobscot Bay salmon habitat recovery unit (SHRU)¹⁵³ for Atlantic salmon (figures 13 and 14).

¹⁵⁰ 74 Fed. Reg. 29344 (June 19, 2009).

¹⁵¹ *Id.*

¹⁵² *Id.*

¹⁵³ SHRUs are separate geographic units within the GOM DPS. The GOM DPS is separated into three SHRUs to ensure that Atlantic salmon are well distributed across the GOM 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 GOM DPS.

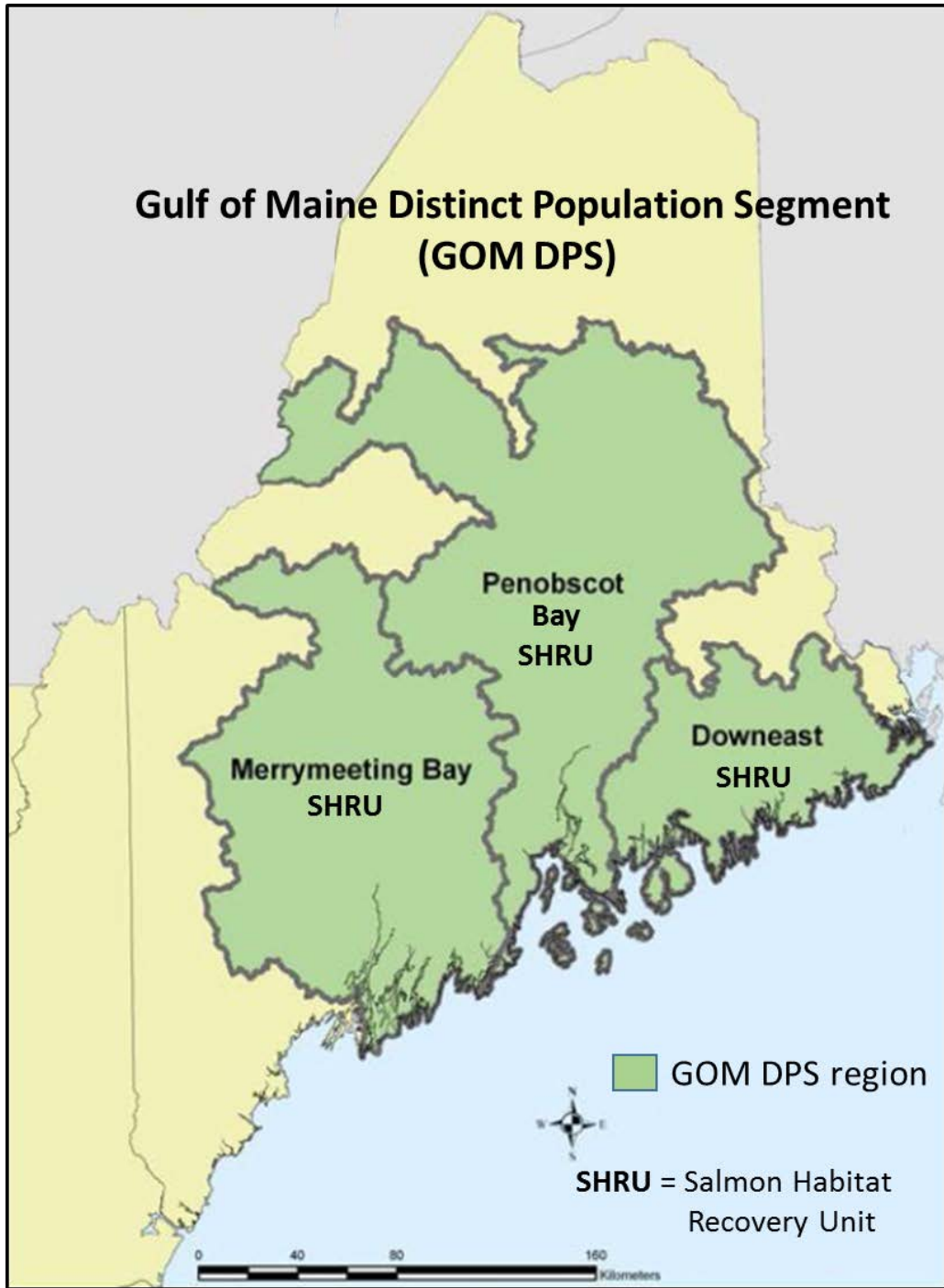


Figure 12. The freshwater population range of the Gulf of Maine Distinct Population Segment (GOM DPS) of endangered Atlantic salmon. (Source: NMFS, 2016a, as modified by staff).

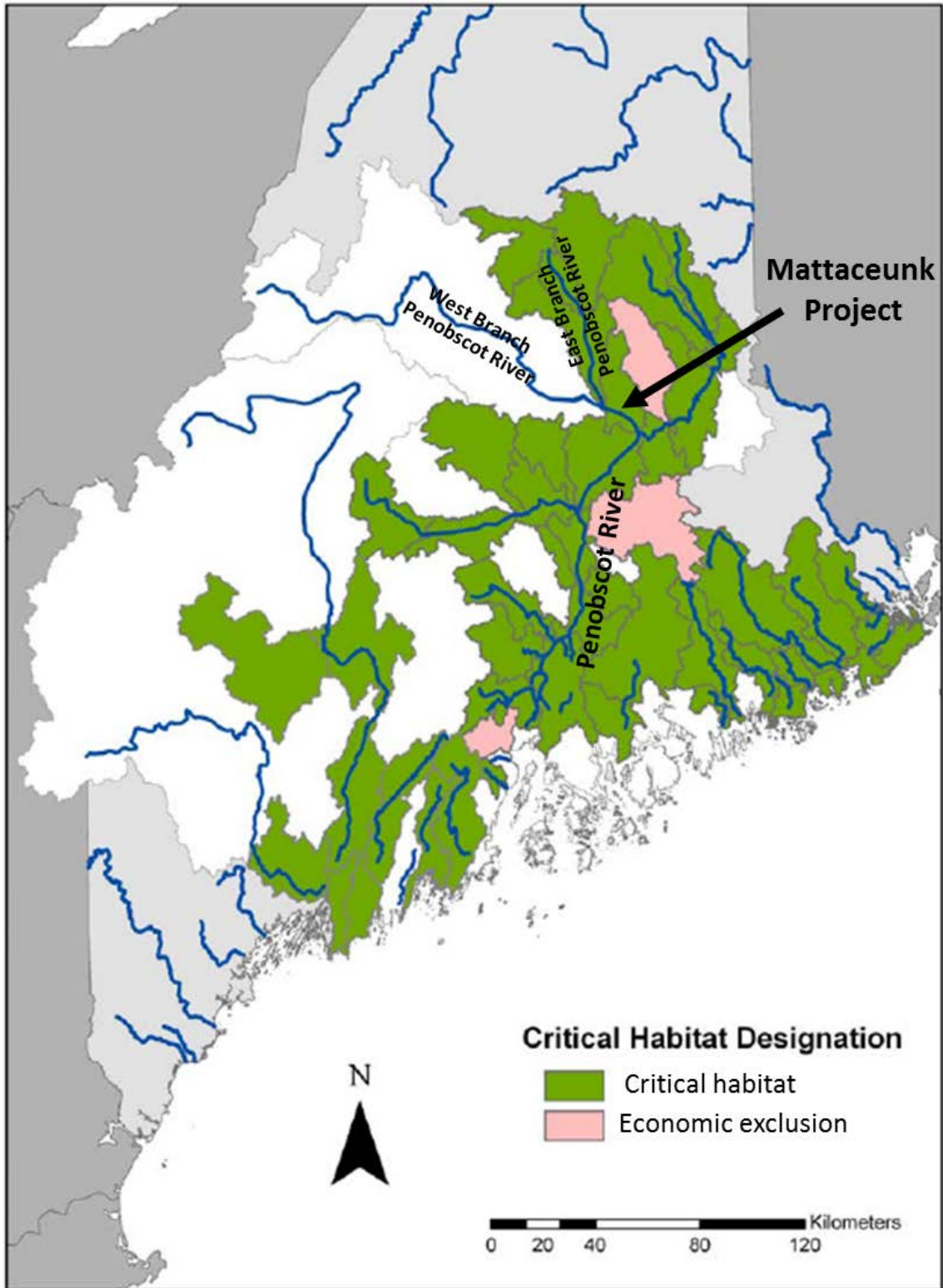


Figure 13. Atlantic salmon critical habitat in Maine.
 (Source: NASCO, 2009, as modified by staff).

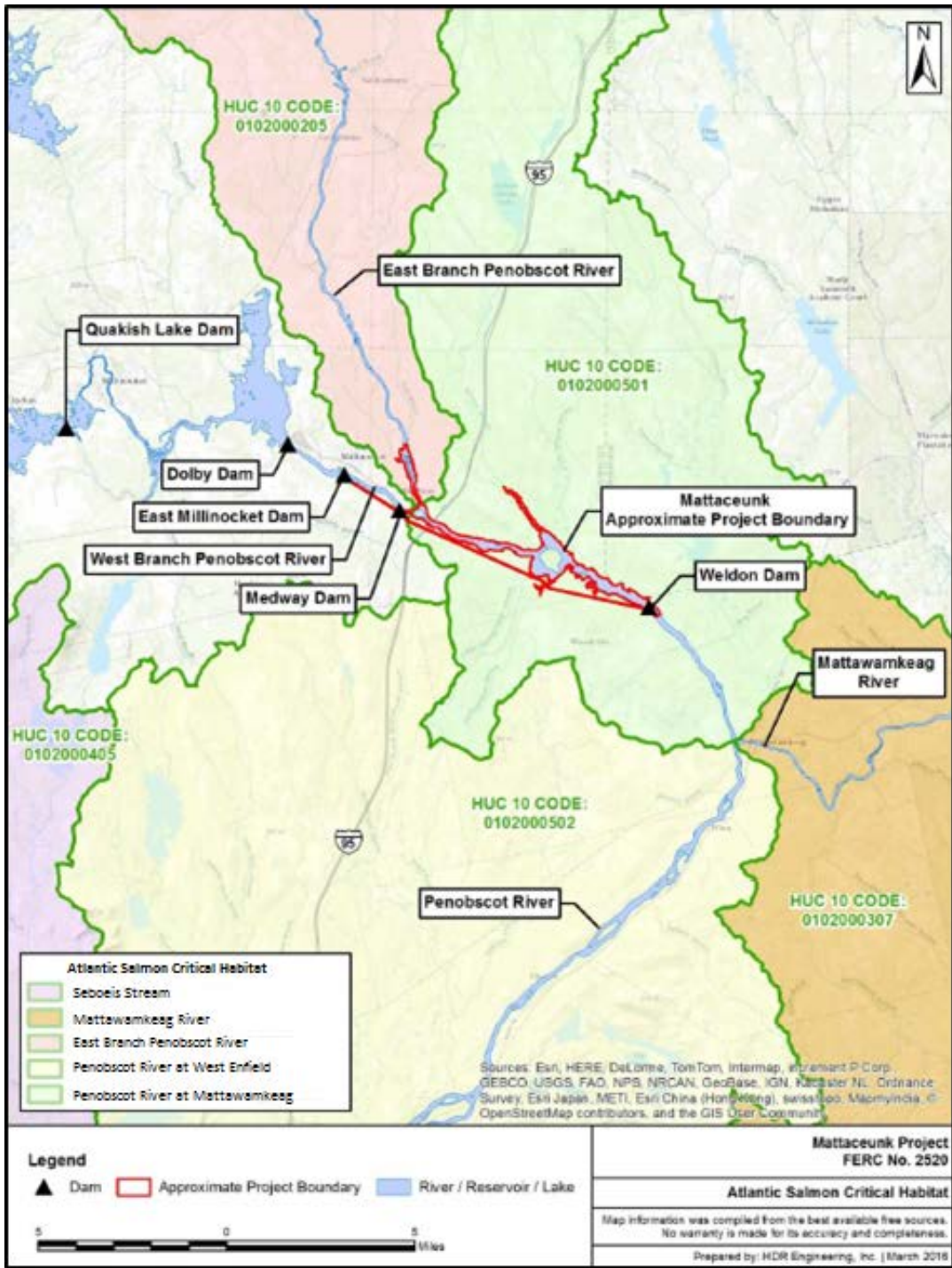


Figure 14. Atlantic salmon critical habitat near the Mattaceunk Project. (Source: GLHA, 2016a, as modified by staff).

Life History

Anadromous Atlantic salmon typically spend 2 to 3 years in the ocean before returning to their natal rivers to spawn. Approximately 86 percent of adults return after 2

years, about 10 percent (primarily males) return after 1 year, and the remaining 4 percent are repeat spawners, or spend 3 years at sea (NMFS, 2009). 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). In the Penobscot River, upstream migrating adult Atlantic salmon are most common in June (Maine DMR 2007 and 2008; NMFS, 2009). Daily monitoring at the Mattaceunk Project, from 1983 to 2012, indicates that upstream migration past the project peaks during July and in late September, with limited movement occurring in early June, August, and mid-late October (figure15).

Upstream migrating adult Atlantic salmon will return (or home) to their natal river or stream (i.e., habitat where they reared as young salmon) where they will 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.*, 1998). 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 suitable well-oxygenated, clean water. Anadromous Atlantic salmon spawn in October and November (Fay *et al.*, 2006). After spawning, some adults, known as kelts during the downstream migration, survive, journey back to the ocean, and return again to spawn after at least one year in the ocean. From 1967 to 2003, approximately 3 percent of the wild and naturally reared adult anadromous Atlantic salmon returning to U.S. rivers were repeat spawners (USASAC, 2004).

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 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.

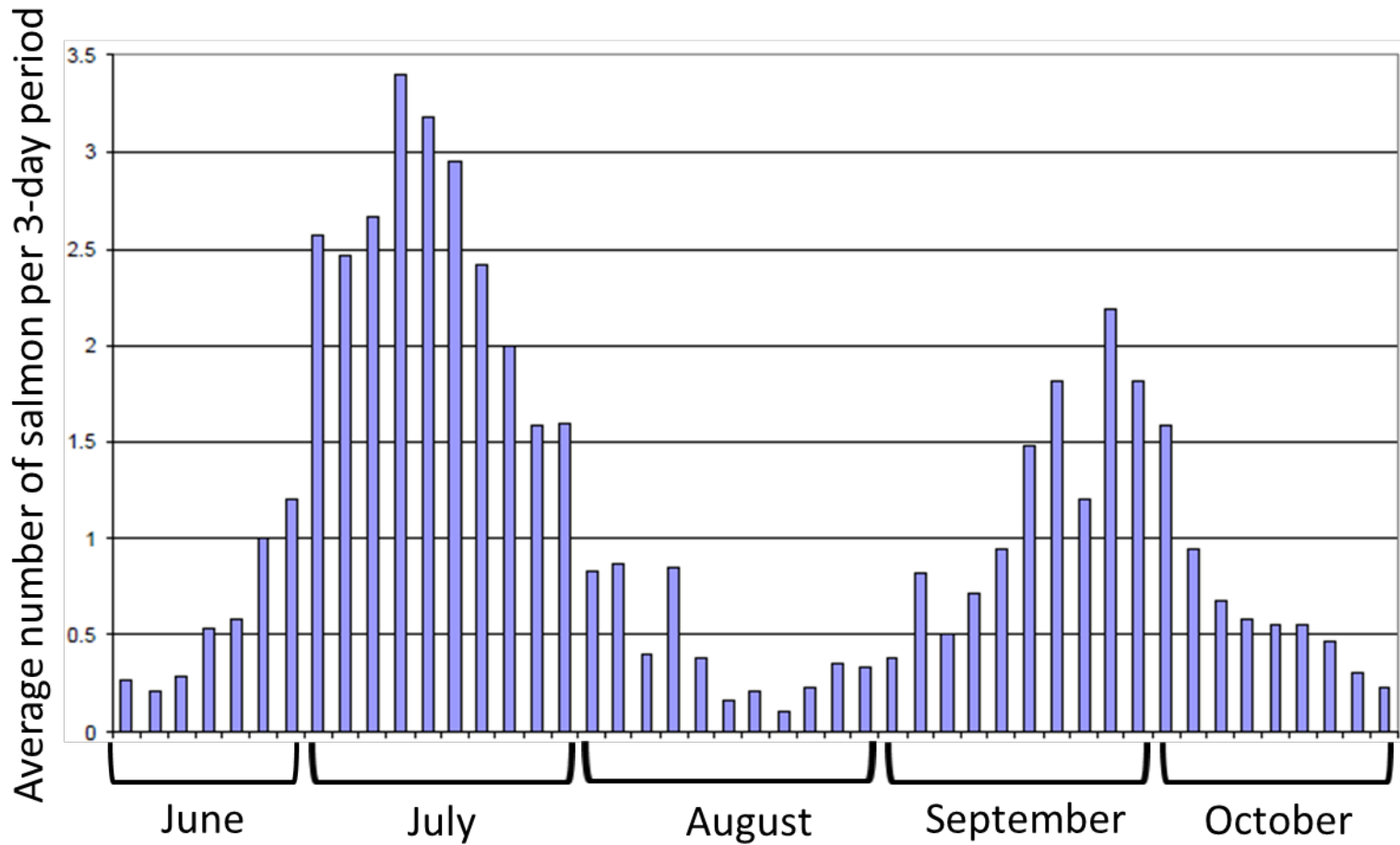


Figure 15. Average number of salmon per 3-day period (i.e., each bar is a 3-day period) counted in the upstream fishway at the Mattaceunk Project from 1983 to 2012. (Source: GLHA, 2016a, as modified by staff).

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 emerge from the gravel in mid-May. Juvenile salmon (parr) remain in rivers 1 to 3 years (until approximately 5 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).

Smolt population surveys conducted from 2000 to 2005, demonstrate that smolts migrate from the Penobscot River 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 migrate 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. 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 1 meter per second for prolonged periods (Vanderpool, 1992; Shepard, 1993) and can include directed movement through very large lakes and reservoirs in the absence of rheotactic¹⁵⁴ 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).

Habitat

Atlantic salmon habitat is quantified in the GOM DPS by mapping habitat within hydrologic units.¹⁵⁵ The Penobscot River consists of 314,314 historic habitat units, with 207,955 units currently characterized as accessible to returning adults, which indicates that 66 percent of the historic habitat units are currently accessible to Atlantic salmon (NASCO, 2009). Atlantic salmon habitat quality also is measured in the same hydrologic units based on the suitability of several parameters, which include temperature, biological

¹⁵⁴ For fish, rheotaxis generally refers to the tendency to orient swimming movement in the direction of oncoming current.

¹⁵⁵ Specifically, the GOM DPS is mapped for habitat quantity and quality at the hydrologic unit code 10 (HUC 10; ten representing the number of digits in the code that represents the hydrologic unit) 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.

communities, water quality, substrate, and cover. Medium-low and medium quality habitat scores have been assigned throughout most of the Penobscot River, with scores increasing from the mouth to the headwaters (figure 16; NASCO, 2009). Most of the Mattaceunk Project boundary is located in a hydrologic unit that has medium habitat quality, but the portion of the project boundary located in the East Branch Penobscot River occurs in a habitat unit classified as high quality (figure 16).

Fine scale mapping data within the hydrologic units nearest the project indicate the presence of both spawning and juvenile rearing habitat upstream and downstream of the project (FWS, 2016a). The nearest mapped spawning and rearing habitat upstream of the project is located in Wassataquoik Stream, a tributary of the East Branch of the Penobscot River, the confluence of which is located approximately 31 miles upstream of Weldon Dam (figure 17) and approximately 22 miles upstream of the project boundary. Mapped spawning and rearing habitat in the mainstem of the East Branch occurs approximately 29 miles upstream of the project boundary. The nearest downstream mapped spawning and rearing habitat is in the Mattawamkeag River, a tributary that flows into the Penobscot River approximately 4.3 miles downstream from Weldon Dam (FWS, 2016a). As indicated by NMFS,¹⁵⁶ and as discussed in section 3.3.2.1, *Aquatic Habitat*, habitat mapping conducted in the project tailrace indicates that the tailrace is suitable for spawning and rearing of Atlantic salmon given the presence of run, riffle, and gravel bar habitat.

Because the project operates in run-of-river mode, flows upstream and downstream of the project are similar, and thus outflow generally mimics inflow. Average flows during the peak upstream migration of adults and peak downstream migration of smolts is 5,366 cfs and 9,664 cfs, respectively (table 16). Flows at the project rarely fall below 2,943 cfs and 3,409 cfs during the peak upstream migration of adults and peak downstream migration of smolts, respectively (i.e., 90 percent exceedance; table 16).

Table 16. Flows in cfs at the project during the peak upstream and downstream migration of Atlantic salmon.

Life stage	Migratory period	Average flow	Minimum flow	90 percent exceedance	10 percent exceedance	Maximum flow
Adult (upstream)	early June to late October	5,366	1,726	2,943	8,714	45,108
smolt (downstream)	May	9,664	1,673	3,409	18,807	69,936

(Source: GLHA, 2016a, as modified by staff).

¹⁵⁶ See letter filed by NMFS on May 23, 2017.

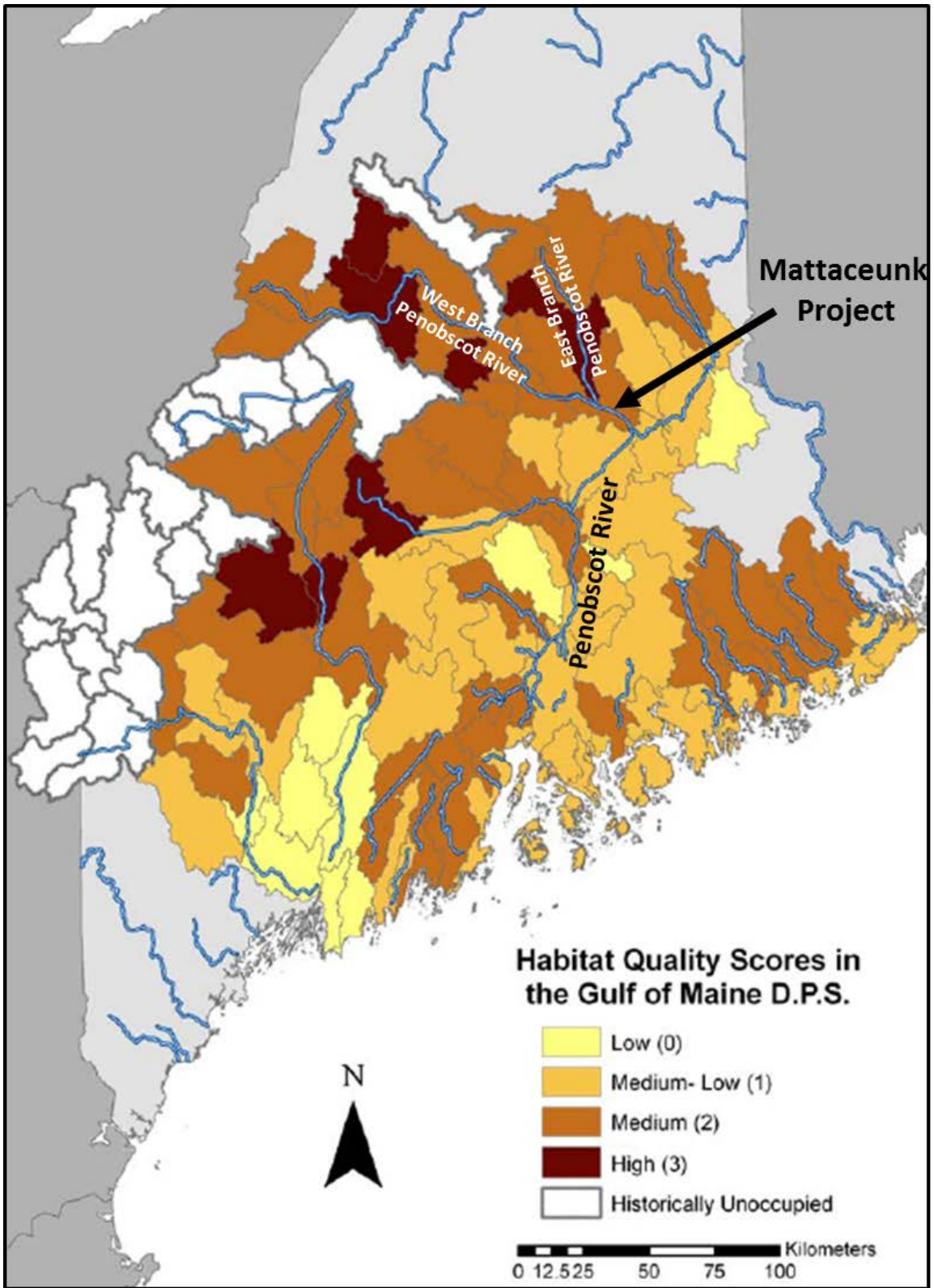


Figure 16. Atlantic salmon habitat quality.
 (Source: NASCO, 2009).

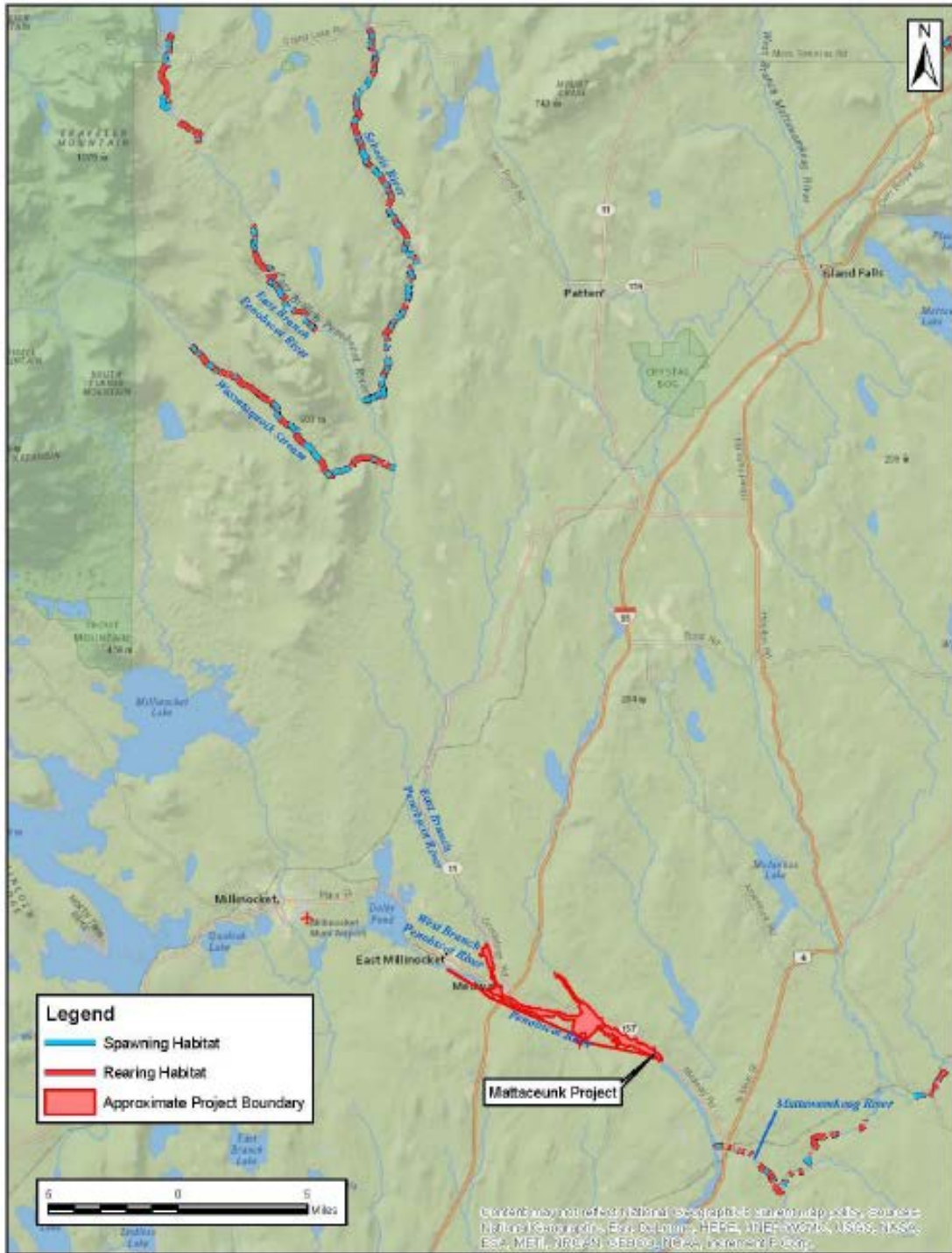


Figure 17. Atlantic salmon habitat.
(Source: FWS, 2016a).

Abundance

Historically, high abundances of Atlantic salmon were reportedly present in the Penobscot River, but adult returns and native stocks of Atlantic salmon have decreased

dramatically in the Penobscot River watershed (NMFS, 2009). Atkins and Foster (1867) estimated that the Penobscot alone had 100,000 returning adults annually (as cited in Fay *et al.*, 2006). Currently, adult Atlantic salmon returning to the Penobscot River each year are recorded at the Milford Dam fish lift, which began operation in 2014 following its construction and the removal of the Great Works (2012) and Veazie (2013) dams. Adult Atlantic salmon were previously recorded at the Veazie Dam fishway, until it was removed in 2013. Numbers of returning adult Atlantic salmon to the Penobscot River are substantially higher than all other GOM DPS salmon rivers (USASAC, 2015). Over the past decade, adult Atlantic salmon returns have ranged from a low of 261 in 2014 to 3,125 in 2011 (figure 18). The 2011 Atlantic salmon returns were the highest since 1991 (USASAC, 2015).

Upstream migrating adult Atlantic salmon are also counted at the Mattaceunk Project. The number of adults counted at the Mattaceunk Project is lower than at Milford Dam or Veazie Dam, because many of the fish counted at Milford Dam or Veazie Dam would have migrated to tributaries and spawning habitat located downstream of Mattaceunk, and because some adults were used for broodstock and other research activities and were not released upstream of Milford or Veazie (figure 18). Nevertheless, the abundance patterns are similar to those at Milford and Veazie and show a declining trend since 1983.

To increase the number of returning adult Atlantic salmon in the Penobscot River, Maine DMR stocks approximately 1 million fry annually in the Penobscot River Basin, with about 50 percent stocked upstream of the project in the East Branch Penobscot River. In addition to stocking 1 million fry, Maine DMR also stocks smolts in the lower Penobscot River, to reduce cumulative mortality during the downstream migration, and thereby maximize the number of smolts that enter the ocean.

The smolt population in the Penobscot River mostly consists of individuals that were stocked in the river as fry. On the Penobscot River, out of a total of 1,614 smolts captured during a survey in 2004, 1.7 percent were naturally reared smolts and the remainder were hatchery-origin smolts (Fay *et al.*, 2006). More recently, the smolt population in a tributary located downstream from the project (i.e., upper Piscataquis River¹⁵⁷) was estimated at 4,576 individuals \pm 1,307, 9,304 individuals \pm 1,213, 5,209 individuals \pm 1,312, and 4,278 individuals \pm 272 in 2009, 2010, 2011, and 2015, respectively (Dube *et al.*, 2012; USASAC, 2015). However, from 2009 to 2011, the majority of smolts produced in the Piscataquis River were stocked in the river as fry and not produced from returning adults (Dube *et al.*, 2012).

¹⁵⁷ The Piscataquis River is a large tributary that enters the Penobscot River downstream from the Mattaceunk Project near the town of Howland.

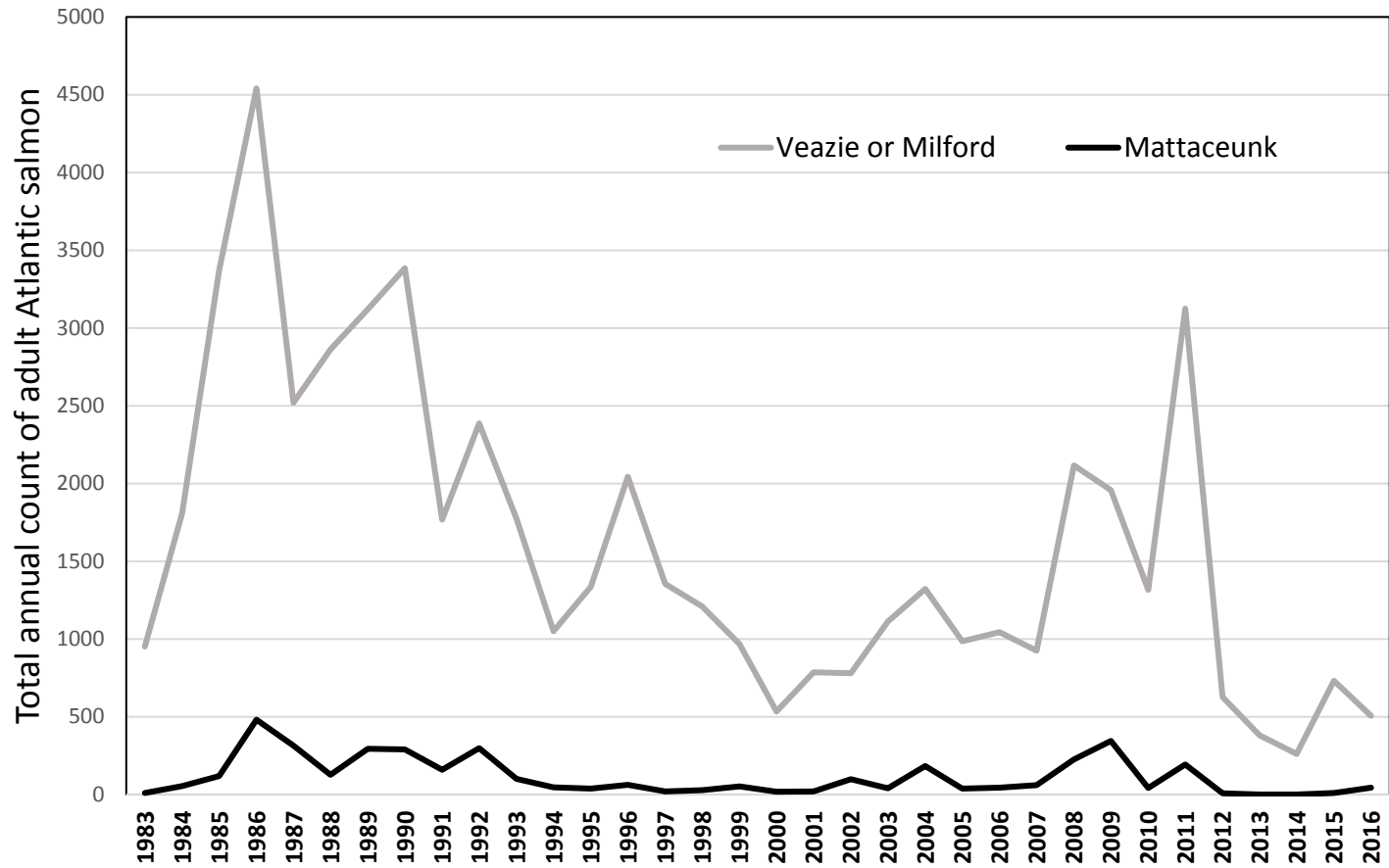


Figure 18. Adult Atlantic salmon counts at the Mattaceunk Project and at Veazie dam (1983-2013) or Milford dam (2014-2016).

(Source: Maine DMR (2016), as modified by staff).

Upstream Passage

From 1983 to 2016, 3,859 adult Atlantic salmon have passed the upstream fishway at the Mattaceunk Project. Since the 1980s, a few upstream Atlantic salmon passage efficiency studies have been conducted at the Mattaceunk Project. In 1986, upstream passage efficiency of the existing upstream fishway was evaluated using radio telemetry,¹⁵⁸ following a series of fishway modifications that were made in support of relicensing (GNP, 1986). During the study, adult salmon that were stocked in the East Branch of the Penobscot River as smolts, were captured at the Veazie Dam fish trap and radio-tagged (or untagged as controls), and released 1.5 miles downstream from the Mattaceunk Project. The study indicated that 71 percent¹⁵⁹ of radio-tagged salmon, and 89 percent¹⁶⁰ of control salmon (externally tagged without a radio), successfully passed upstream of the project using the upstream fishway.¹⁶¹

More recently, GLHA has been cooperating with USGS and the University of Maine on an upstream Atlantic salmon monitoring study involving the use of PIT

¹⁵⁸ Radio telemetry is a method used to track fish by inserting a radio-tag which transmits a high frequency radio signal that can be detected when a radio-tagged fish swims near an instrument capable of receiving the signal (i.e., receiver).

¹⁵⁹ Fourteen radio-tagged Atlantic salmon that reached the tailwaters immediately downstream from the Mattaceunk Project were included in the analysis. Ten of the 14, or 71 percent, successfully passed upstream using the upstream fishway. The remaining four salmon that did not successfully pass upstream of the fishway, but rather moved downstream after reaching the project tailwaters.

¹⁶⁰ Sixteen of 18 (89 percent) control salmon released downstream from the project were observed to successfully pass upstream using the upstream fishway. However, because the control salmon were not tagged, it is not known whether the two salmon that did not pass upstream ever migrated to the project tailwaters.

¹⁶¹ The Atlantic Sea Run Salmon Commission also conducted a study that included 10 unmarked Atlantic salmon released about 24 miles downstream from the project (near South Lincoln, Maine). The results were reported in the GNP (1986) report, which indicated that 9 of 10 (90 percent) unmarked salmon were observed to have passed through the upstream fishway. However, distinguishing unmarked study salmon from wild salmon that were not part of the study would have been difficult. Because the GNP (1986) report does not provide details on how the unmarked salmon were identified as study fish, we do not include this study in any further discussion or analysis.

(passive integrated transponder) tag¹⁶² detection arrays at nine dams in the Penobscot River, including the Mattaceunk Project (Maine CFWRU and University of Maine, 2011). In 2012, eight PIT-tagged Atlantic salmon that reached the Mattaceunk Project all successfully passed upstream using the existing fishway. No tagging occurred in 2013 because of the Veazie Dam removal construction activities, and in 2014 and 2015 due to the low numbers of Atlantic salmon available downstream of Weldon Dam resulting from low returns and hatchery broodstock collection.

Downstream Passage

Smolt Passage Past the Dam

As discussed in section 2.1.1, *Existing Project Facilities*, the downstream bypass facility includes single surface inlets at intakes 3 and 4. The bypass has been tested a number of times using smolts since 1993, when it was installed. From 1993 to 1999 (excluding 1996 when no studies were conducted), the collection efficiency¹⁶³ of the existing bypass was evaluated using radio-tagged smolts released upstream of the project. During the studies, bypass testing conditions varied using different combinations of strobe light depth in forebay #1 and #2 (i.e., forebays without surface bypasses) and turbine flow through forebays #3 and #4 (i.e., where the surface bypasses are located). Based on these studies, collection efficiency ranged between 17 and 59 percent.¹⁶⁴ In 2004, the downstream bypass was tested with no strobe lights and under typical turbine flow conditions, resulting in a passage efficiency of 41 percent.¹⁶⁵ Given the irregular success of the strobe light system in directing smolts to the bypass, it is no longer used. None of these studies evaluated passage survival.

¹⁶² The PIT tag is an electronic tag measuring 0.5 inches long and less than 1/8 inches in diameter. Fish injected with this tag can be automatically recognized by detecting/recording devices located within collection facilities at hydroelectric dams.

¹⁶³ Collection efficiency represents the proportion of study smolts that successfully pass the dam using the bypass system relative to the total number of smolts that pass the dam successfully.

¹⁶⁴ Collection efficiencies were 59 percent (1993), 45 percent (1994), 52 percent (1995), 41 percent (1997), 22 percent (1998), and 17 percent (1999). No studies were conducted in 1996. See GLHA's Biological Assessment filed with the final license application on August 31, 2016.

¹⁶⁵ See GLHA's Biological Assessment filed with the final license application on August 31, 2016.

In 2014 and 2015, GLHA conducted studies to evaluate passage route selection, collection efficiency, and survival past the dam for downstream migrating smolts that were radio-tagged and released upstream of the project.¹⁶⁶ In 2015, GLHA also studied passage survival in the project impoundment. In both years, the most common route of passage for smolts was through the turbines (2014: 70.1 percent; 2015: 78.5 percent). In 2014, the bypass and spillway were used equally (14.9 percent) by downstream migrating smolts. In 2014, the log sluice was not open for passage. In 2015, when the log sluice was open for passage, the bypass was used by 8.1 percent of smolts, and the spillway and log sluice were each used by 6.7 percent of smolts.

Bypass collection efficiency was 17.5 percent in 2014 and 9.4 percent in 2015. In 2015, following completion of the study, GLHA observed that the bypass was blocked with debris during maintenance activities, which might have affected the bypass collection efficiency.

Using the same study of smolts described above, GLHA estimated minimum survival rates of smolts through each passage route in 2014 and 2015.¹⁶⁷ Minimum survival estimates are shown in table 17 and indicate that smolt survival through the downstream bypass and log sluice was 100 percent, while survival through the turbines and other spill routes (where the majority of smolts passed downstream) was between about 85 and 93 percent.

¹⁶⁶ In 2014, GLHA radio-tagged and released 151 smolts; GLHA released 102 (treatment) fish upstream of Weldon Dam and 49 (control) fish downstream from the dam to account for natural mortality not associated with the project (i.e., paired-release study design). GLHA did not use the paired-release model in 2015, but instead released 100 tagged test smolts about 1,300 feet upstream of the project, and 49 tagged test smolts at the upper end of the impoundment to evaluate impoundment mortality and delay. GLHA evaluated natural mortality by smolts that were detected between two arrays downstream from the project.

¹⁶⁷ Minimum survival rates were estimated without accounting for and removing background mortality that naturally occurs in the river and false mortalities that could occur when a surviving smolt passes a downstream receiver, but is not detected by the receiver.

Table 17. Study results of downstream smolt passage studies.

Year	Passage route	Number of smolts using route	Percent of smolts using route	Percent of smolts surviving route
2014	Spillway	10	14.9	90
	Bypass	10	14.9	100
	Powerhouse	47	70.1	85.1
	Total	67	100	
2015	Spillway	9	6.7	88.9
	Bypass	11	8.1	100
	Powerhouse	106	78.5	92.5
	Log sluice	9	6.7	100
	Total	135	100	

(Source: GLHA, 2016a, as modified by staff).

Stich *et al.*, (2015b) estimated survival past the project dam from 2010 to 2014 for wild and hatchery smolts. Mean survival was estimated to be 84 percent and 91 percent for wild and hatchery smolts, respectively.¹⁶⁸ Total survival past the dam (i.e., combined survival through all passage routes) was also estimated by GLHA in 2014 and 2015. In 2014, GLHA used a paired-release study design, which allowed GLHA to include a control group released downstream from the dam for estimating background mortality.¹⁶⁹ In 2014, the total survival past the dam was estimated to be 95.8 percent (point estimate) with a 95 percent confidence interval between 83 and 100 percent.¹⁷⁰ In an effort to

¹⁶⁸ Stich *et al.* (2015b) estimated mean survival per kilometer in a 2.4 kilometer reach that included the project dam to be 93 percent and 96 percent for wild and hatchery smolts, respectively. Based on the per kilometer estimates, total survival in the 2.4 kilometer reach including the dam would be 84 percent and 91 percent, respectively.

¹⁶⁹ Background mortality is the mortality that occurs in a natural free-flowing section of river, and is unrelated to the dam.

¹⁷⁰ Point estimates are single value estimates for survival. However, because there are inherent uncertainties (e.g., some surviving fish may not be detected by arrays) when calculating survival using telemetry, there is some uncertainty or error with a point estimate. Therefore, true survival may be larger or smaller than the point estimate. To capture the range of potential true values of survival, GLHA estimated a 95 percent confidence interval for the 2014 and 2015 survival estimates. The 95 percent confidence

increase the number of smolts released upstream of the project for estimating impoundment mortality, GLHA did not use a paired-release design in 2015, but, instead released all smolts upstream of the project.¹⁷¹ In 2015, total survival past the dam was estimated to be 95.9 percent (point estimate) with a 95 percent confidence interval between 89.3 and 100 percent.

The downstream smolt passage studies also evaluated migration timing and delay. Based on the timing of tag detections, once smolts approached the project dam (within 656 feet), they typically moved through quickly. The median migration time was 0.24 hours (range between 0.01 and 29.03 hours) in 2014, and 0.3 hours (range between 0.01 and 297.5 hours) in 2015. In both years, movement rates increased from early May to late May.

In response to a request from NMFS, GLHA also determined the proportion of smolts that did not pass the dam within 24 hours of reaching a location 1,300 feet upstream of the dam (i.e., enter the forebay).¹⁷² In 2014, two of the 69 smolts (2.9 percent) took slightly longer than 24 hours (27.3 and 29.0 hours) to pass the project after being detected in the forebay. In 2015, 12 of 137 (8.8 percent) of smolts detected in the forebay took longer than 24 hours to pass the project.

In addition to the onsite studies above, GLHA also included an analysis of whole station survival of smolts past the dam in its desktop entrainment and impingement study conducted during the pre-filing period of this relicensing proceeding. The results of the desktop study estimated that 97.4 percent, 96.6 percent, and 96.6 percent of smolts would survive passage past the dam at 25 percent, 50 percent, and 75 percent exceedance flows, respectively.

interval represents a range of survival values, within which there is a 95 percent probability of including the true survival estimate.

¹⁷¹ In 2015, background mortality was estimated from smolts released upstream of the project and detected at monitoring stations located at 4.7 and 6.7 miles downstream from the dam.

¹⁷² In a letter filed on March 10, 2015, NMFS requested that GLHA calculate survival past the dam by assuming that only smolts that pass the project within 24 hours of approaching the trash racks can be counted as possible survivors. This 24-hour performance standard is currently a condition of other FERC-licensed projects on the Penobscot River (i.e., West Enfield, Milford, Stillwater, Orono).

Smolt Survival Through the Impoundment

In 2015, GLHA also estimated smolt survival through the project impoundment by releasing 49 radio-tagged smolts about 7.8 miles upstream of the project dam. All 49 reached the first monitoring station about 984 feet downstream from the release site. A total of 42 smolts reached the dam, yielding an impoundment survival rate of 85.7 percent, or a mortality rate of 1.8 percent per mile (the distance from the release location to the dam is about 7.8 miles). In 2015, a mortality rate representative of background mortality unrelated to dam passage was estimated using tag detections from receivers located about 2.9 miles and 4.2 miles downstream from the dam, which equated to 4.8 percent mortality between the receivers, or about 3.8 percent mortality per mile based on the distance between the two stations.

In a separate study, Stich *et al.* (2015b) estimated mortality rates in the project impoundment, and in free-flowing reaches of the Penobscot River. The data from Stich *et al.* (2015b) indicate that for hatchery smolts, the average mortality per mile was higher in the project impoundment (2.7 percent per mile)¹⁷³ than in free-flowing sections (0.80 percent per mile) of the Penobscot River. Based on these rates of mortality per mile for hatchery smolts, cumulative survival would be lower through the entire length the project impoundment (i.e., 8.5 miles) compared to a free-flowing reach of the same length (table 18). The data from Stich *et al.* (2015b) also indicate that for wild smolts, the average mortality per mile was slightly lower in the project impoundment (1.6 percent per mile) than in free-flowing sections (1.7 percent per mile) of the Penobscot River (table 18). Based on these rates of mortality per mile for wild smolts, cumulative survival would be very similar through the entire length of the project impoundment compared to a free-flowing reach of the same length (table 18).

¹⁷³ Stich *et al.* (2015b) provide estimates of smolt mortality in table S2 of the supplementary material provided with the article (<http://nrcresearchpress.com/doi/suppl/10.1139/cjfas-2014-0573>). We estimated the average mortality rates in the project impoundment based on the reaches labeled, “Weldon Head Pond” in table S2. Table S2 provides three estimates of mortality in the impoundment for hatchery and three estimates for wild smolts. Our estimate of average mortality in the impoundment is based on those three estimates, respectively, for hatchery and wild smolts. We estimated the average mortality rates in free-flowing reaches based on the reaches in table S2 that are in the Penobscot River and not labelled. Table S2 provides three estimates of mortality in free flowing reaches for hatchery and six estimates for wild smolts. Our estimate of average mortality in free-flowing reaches is based on those three estimates, respectively, for hatchery and wild smolts (see table 18).

Downstream Passage of Kelts

Studies have been conducted at the project to evaluate passage of kelts and the collection efficiency of the existing downstream bypass. During the fall of 1992, a radio telemetry study indicated that among eight radio-tagged kelts, six survived passage downstream (five used the bypass, one passed through the turbines), one died or regurgitated its tag upstream of the dam, and one died downstream from the dam (GNP, 1993). In the spring of 1993, a larger-scale study involving 71 post-spawn broodstock kelts from the Craig Brook National Fish Hatchery was conducted under spill conditions, in which 30 kelts were radio-tagged and 41 served as controls. Among the radio-tagged kelts, three did not pass the dam (10 percent), three (10 percent) used the bypass, one passed through the turbines (3.3 percent), and 20 (66.7 percent) passed downstream via spill (GNP, 1993). The kelt that passed through the turbines died; however, the

Table 18. Smolt survival and mortality estimates in the project impoundment and free-flowing sections of the Penobscot River (Source: NMFS; Stich *et al.* (2015b); as modified by staff).

Source	Section of river ^a	Survival per km ^b (percent)	Mortality per km	Mortality per mile ^c	Cumulative survival ^d
Column ID					
		A	B	C	D
Column Equations					
			100 - A	B/0.621371	$((100-C)/100)^{8.5} \times 100$
Hatchery	Mattaceunk Impoundment	98.9	1.1	1.8	85.9
		99.0	1.0	1.6	87.1
		97.0	3.0	4.8	65.7
		<i>Average</i>	<i>98.3</i>	<i>1.7</i>	<i>2.7</i>
Hatchery	Free-flowing	99.5	0.5	0.8	93.4
		99.2	0.8	1.3	89.6
		99.9	0.1	0.2	98.6
		<i>Average</i>	<i>99.5</i>	<i>0.5</i>	<i>0.8</i>
Wild	Mattaceunk Impoundment	99.3	0.7	1.1	90.8
		99.1	0.9	1.4	88.3
		98.6	1.4	2.3	82.4
		<i>Average</i>	<i>99.0</i>	<i>1.0</i>	<i>1.6</i>
Wild	Free-flowing	99.1	0.9	1.4	88.3
		98.1	1.9	3.1	76.8
		99.7	0.3	0.5	96.0
		<i>Average</i>	<i>98.9</i>	<i>1.0</i>	<i>1.7</i>

table 18 footnotes on next page

Table 18 footnotes:

^a The free-flowing description is analogous to the "open river" description used by NMFS to describe the same data in their comment letter filed on April 27, 2018.

^b Per km (kilometer) survival rates are from Stich *et al.* (2015b) and were also provided in the letter filed by NMFS on April 27, 2018.

^c Mortality per mile was calculated by dividing mortality per km by 0.621371, where 0.621371 mile equals 1 km.

^d Cumulative survival through the Mattaceunk Project impoundment based on per mile estimates of mortality and an impoundment reach length of 8.5 miles.

remaining 26 kelts survived, indicating that passage survival was 96.3 percent when flows exceed the hydraulic capacity and the project is spilling. Among the control kelts, 13 (31.7 percent) used the bypass. The passage route of the remaining control kelts was unknown, but based on the radio-tagged kelts, they likely passed via spill. Passage survival, bypass efficiency, and passage route selection are not known for kelts when the project is not spilling.¹⁷⁴

Bypass collection efficiency for kelts was also analyzed using the data collected during the 1992 and spring 1993 studies above, as well as a fall 1993 study that provided limited information on survival.¹⁷⁵ Data collected during these studies indicated that 11 radio-tagged kelts migrated downstream of the project dam using non-spillage routes during project operation. Nine of the kelts were collected in the downstream bypass, resulting in a collection efficiency of 82 percent (GNP, 1994).

In addition to the onsite studies above, GLHA also included an analysis of whole station survival of kelts past the dam in its desktop entrainment and impingement study. The results of the desktop study estimated that 96.6 percent, 94.2 percent, and 93.9 percent of kelts would survive passage past the dam at 25 percent, 50 percent, and 75 percent exceedance flows, respectively.

¹⁷⁴ Non-spill events (i.e., flows less than hydraulic capacity) can occur 40 percent of the time during the spring downstream migration period for kelts.

¹⁷⁵ During 1993, 13 radio-tagged adult salmon were radio-tagged and released after successfully passing upstream via the upstream fishway. In the fall of 1993, only one of these kelts returned to the project after spawning, and it used the downstream bypass.

Recovery Plans

The 2005 Final Recovery Plan for the Gulf of Maine Distinct Population Segment of Atlantic Salmon for the originally-listed GOM DPS (NMFS and FWS, 2005) presented a strategy for recovering Atlantic salmon listed as endangered under ESA in 2000. An updated draft recovery plan was recently published for public comment, which addresses recovery within the expanded range of the GOM DPS of Atlantic salmon described in the 2009 listing rule (NMFS and FWS, 2016a).

The 2016 Draft Recovery Plan for the Gulf of Maine Distinct Population Segment of Atlantic Salmon plan reflects a new recovery planning approach (termed the Recovery Enhancement Vision, or REV) 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 draft recovery plan is based on two premises: first, that recovery must focus on rivers and estuaries located in the GOM DPS until threats in the marine environment are better understood; and second, that survival of Atlantic salmon in the GOM DPS depends on conservation hatcheries through much of the recovery process (NMFS and FWS, 2016a). The main objective of the draft 2016 recovery plan is to maintain self-sustaining, wild populations with access to sufficient suitable habitat in each 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 DPS (NMFS and FWS, 2016a).

This 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 (NMFS and FWS, 2016b). 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 seven categories of recovery actions include:

- Habitat Connectivity, intended to enhance connectivity between the ocean and freshwater habitats important for salmon recovery;
- Genetic Diversity, intended to maintain the genetic diversity of Atlantic salmon populations over time;
- Conservation Hatchery, intended to increase adult spawners through the conservation hatchery program;
- 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;

- Federal/Tribal Coordination, intended to facilitate consultation with all involved Tribes on a government-to-government basis; and
- Outreach, Education, and Engagement, intended to collaborate with partners and engage interested parties in recovery efforts for the GOM DPS (NMFS and FWS, 2016a).

Recovery actions are also outlined in the workplan (NMFS and FWS, 2016b) to address these threats. Those actions potentially relevant to the Mattaceunk Project include:

- Complete an SPP at Weldon Dam to establish upstream and downstream fish passage efficiency standards required to ensure the survival and recovery of Atlantic salmon.
- Evaluate and modify operation of the Weldon Project¹⁷⁶ as needed until operations meet or exceed the specified standards. Standards must be met within ten years of the completion of any final SPP.
- Assess whether artificial lighting increases opportunities for predation at dams, particularly by cormorants, and implement measures to minimize these impacts.
- Identify and document sources of cool water that could serve as refuge for adult and juvenile salmon and ensure that all areas of cool water along the mainstem Penobscot are protected from activities that degrade water quality and limit accessibility for both adults and juveniles.
- Assess the feasibility of conducting a large wood/boulder project in the East Branch of the Penobscot River, develop a study design, and if deemed feasible and appropriate, implement according to the study design.
- Improve conductivity within the watershed through the modification of culverts within the project vicinity.

Atlantic Salmon Critical Habitat

Critical habitat was designated for Atlantic salmon on June 19, 2009.¹⁷⁷ The critical habitat designation includes 45 specific areas occupied by the GOM 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 GOM DPS, Atlantic salmon PCEs include sites for spawning, incubation, and juvenile rearing,

¹⁷⁶ The Weldon Project is the Mattaceunk Project.

¹⁷⁷ 74 Fed. Reg. 29300-29341 (June 19, 2009).

(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:

- 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 sea water adaptation of smolts.

Atlantic Salmon Critical Habitat in the Project Area

Critical habitat within the main stem Penobscot River extends from the estuarine habitat of Penobscot Bay up into the East and West Branches. Therefore, the Mattaceunk Project falls within the designated critical habitat of the Penobscot Bay SHRU for Atlantic salmon. Section 3.3.2.1, *Aquatic Resources, Affected Environment* contains a description of aquatic habitat conditions upstream of and downstream from the project, which are within designated critical habitat.

Essential Fish Habitat

Essential fish habitat (EFH) refers to those waters and substrate necessary to fish for spawning, breeding, feeding, or growth to maturity and covers a species' full life cycle.¹⁷⁸ 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 (NEFMC, 1998) as follows:

- Eggs: Bottom habitats with a gravel or cobble riffle above or below a pool in 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 in 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 freshwater, water temperatures below 77°F, water depths between 10 cm and 61 cm (3.9 to 24.0 inches), and water velocities between 30 and 92 cm per second (1 to 3 feet per second). 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.

¹⁷⁸ 50 CFR 600.10.

- **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 5 parts per million (ppm). Oceanic adult Atlantic salmon are primarily pelagic and range from the waters of E-5-65 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 30 cm and 61 cm (11.8 to 24 inches), water velocities around 61 cm per second (2 feet per second), and clean, well-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 upstream of and downstream from the project boundary. Further, NMFS has indicated that the habitat mapping conducted in the project tailrace by GLHA indicates that the tailrace is suitable for spawning and rearing of Atlantic salmon given the presence of run, riffle, and gravel bar habitat.¹⁷⁹

Canada Lynx

Canada lynx are medium-sized cats that inhabit boreal forests and feed almost exclusively on snowshoe hare. In the United States, they are found primarily in the Northeast, western Great Lakes, northern and southern Rockies, and northern Cascades, in the southern-most extent of its range. The Canada lynx was listed as threatened under the ESA on March 24, 2000 (FWS, 2000). Canada lynx are a state species of special concern in Maine (Maine DIFW, 2013).

Canada lynx habitat is widespread throughout northern Maine and includes large areas of young, dense stands of spruce and fir, approximately 12 to 30 years old, which have dense understory vegetation that support high densities of snowshoe hares. Areas of prime habitat shift with time as stands mature and new stands are cut. Populations of

¹⁷⁹ See letter filed by NMFS on May 23, 2017.

snowshoe hare have a direct effect on local lynx populations, which fluctuate in response to its prey.

The FWS designated five units of critical habitat for the Canada lynx in November 2005. In Maine 10,123 square miles of forestland in western and northern Maine (FWS, 2014) was proposed for critical habitat (Unit 1). Unit 1 includes portions of Aroostook, Franklin, Penobscot, Piscataquis, and Somerset Counties. According to the FWS, this area is important for lynx conservation, because it is the only area in the northeastern region of the lynx's range that is within the contiguous United States, and that currently supports a resident breeding population. Thus, Unit 1 likely acts as a source or provides connectivity with Canada for more peripheral portions of the lynx's range in the Northeast.

The Mattaceunk Project exists outside of Unit 1 and thus there is no designated critical habitat within the project boundary. No agency recommendations were received regarding the Canada lynx.

Northern Long-eared Bat

The northern long-eared bat (NLEB) was listed as a federally threatened species under the ESA on May 4, 2015 and is also listed as an endangered species by the state of Maine. 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 syndrome¹⁸⁰ and effects of tree removal on roosting bats or maternity colonies (FWS, 2017b). As part of the 4(d) rule, FWS proposes that take incidental to certain activities conducted in accordance with three specific habitat conservation measures, as applicable, would not be prohibited. Those habitat conservation measures are that the activity: (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-rearing season (June 1 – July 31);¹⁸¹ and (3) avoids clearcuts within 0.25 mile of known, occupied maternity roost trees during the pup season (June 1 - July 31). 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. On January 5, 2016, FWS developed an optional streamlined consultation framework that allows federal agencies to

¹⁸⁰ Hibernacula are locations where bats hibernate over the winter, such as caves. 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. (FWS, 2014b)

¹⁸¹ Pup season refers to the period when bats birth their young.

rely on a programmatic biological opinion on FWS's final 4(d) rule to fulfill section 7(a)(2) consultation requirements for northern long-eared bat (FWS, 2016b).¹⁸²

NLEB emerge at dusk and use upland and lowland forested habitats and tree-lined corridors to feed on insects while in flight and using echolocation. In summer, natural roosts are under loose tree bark and in other tree cracks, crevices, and cavities (ESI, 2002). Non-reproductive females and males also sometimes roost in cooler places, such as caves or mines. NLEB will roost in a variety of natural habitats. The species also uses man-made structures such as abandoned buildings, dilapidated barns, park pavilions, sheds, window shutters, utility poles, and bat houses (FWS, 2017b). NLEB spend the winter hibernating in hibernacula, which generally include caves or mines of varying sizes, with constant temperatures, high humidity, and no air current. Pregnant females roost in small colonies (generally 30 to 60 females and young) and give birth in the summer (FWS, 2015). No critical habitat is designated for this species; however, the project is located within the white-nose syndrome buffer zone for the northern long-eared bat.¹⁸³

3.3.4.2 Environmental Effects

Atlantic Salmon

Operational Effects on Atlantic Salmon Habitat

As discussed previously, GLHA proposes to continue to operate the project in a run-of-river mode, with the impoundment fluctuation limits and minimum flows discussed fully in section 3.3.2.2, *Aquatic Resources, Environmental Effects*. Interior,

¹⁸² FWS developed a key to help federal agencies determine if they can rely on the streamlined section 7 consultation in the 4(d) rule, or if their actions may cause prohibited incidental take that requires separate section 7 consultation (FWS, 2016b). FWS's key considers whether the federal action: (1) may affect the northern long-eared bat; (2) involves the purposeful take of northern long-eared bats; (3) is located inside the white-nose syndrome zone; (4) will occur within a hibernaculum or alter the entrance/environment of a hibernaculum; (5) involves tree removal; (6) involves the removal of hazardous trees; and (7) includes (a) the removal of an occupied maternity roost trees or any trees within 150 feet of a known occupied roost tree from June 1 through July 31, or (b) the removal of any trees within 0.25 mile of a hibernaculum at any time of year.

¹⁸³ 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.

NMFS, and Maine DMR recommend GLHA's proposal for impoundment fluctuation limits and minimum flows.

In addition to the operational recommendations, Maine DEP recommends that GLHA develop an operation and monitoring plan that specifies the methods that would be used to monitor the project and maintain minimum flows and impoundment water levels. NMFS recommends that GLHA conduct a study, within 1 year of any new license issued, to verify the accuracy of the existing flow monitoring system and develop a minimum flow monitoring plan. This plan would include making near-real time and historic flow data electronically accessible to the public via the internet within one year of any new license issued. NMFS also recommends that GLHA develop a plan to monitor impoundment water levels, with specific provisions discussed in section 3.3.2.2, *Aquatic Resources, Environmental Effects*. These recommendations also are discussed in more detail in section 3.3.2.2, *Aquatic Resources, Environmental Effects*.

Our Analysis

Atlantic Salmon Critical Habitat

As discussed in section 2.1.3, *Existing Project Operation*, GLHA operates the project in run-of-river mode, with impoundment fluctuations that are minimal and maintained within 1 foot or less of the top of the flashboards, except when repairs are needed, in which case drawdowns are maintained within 2 feet of the flashboards, or within 1 foot of the crest of the dam when the flashboards are being repaired or installed. Thus, other than when drawdowns are needed, the project is operated as a run-of-river facility with inflow equal to outflow. This mode of operation, which GLHA proposes to continue under a new license, prevents rapid fluctuations in the impoundment, and thus prevents migrating salmon from being stranded along the shore. Run-of-river conditions with minimal fluctuation of the impoundment also helps to maintain submerged aquatic vegetation along shallow water areas of the impoundment, which can serve as temporary holding and resting areas during the upstream migration of adult salmon (i.e., PCE 9 discussed above). The continuation of these project operations would maintain the existing conditions, and as discussed in section 3.3.2.2, *Environmental Effects* and below, an operation compliance monitoring plan would ensure that GLHA consistently maintains the impoundment elevation and downstream minimum flows at levels that are protective of Atlantic salmon.

As discussed in section 3.3.2.2, *Water Quality*, the water quality study conducted by GLHA demonstrates that water quality in the project impoundment is very good and consistent with Maine's water quality levels specified for Class C waters. The study also indicates that the impoundment does not stratify and that water temperature and DO are relatively uniform throughout the water column. Further, operating the project in run-of-river mode, which would provide nearly natural flows and maintain cool water temperatures, would help provide the diurnal cues to stimulate smolt migration (i.e., PCE

12), and support the migration of other native diadromous species (i.e., eel, alosines, and sea lamprey), which serve as protective buffers against predation (i.e., PCE 10). All of the conditions discussed above would be maintained under proposed operations, and are generally consistent with the recommendations from NMFS, Interior, and Maine DMR. Further, as discussed in section 3.3.2.2, *Operations Compliance Monitoring*, the development and subsequent implementation of an operations compliance monitoring plan to monitor impoundment water levels, as recommended by Maine DEP and NMFS, would ensure that the good habitat conditions under existing conditions would be maintained under a new license.

Project operation also maintains good water quality downstream from the project (water temperature of 69° F and DO of 8.6 mg/L in mid-August), as discussed in section 3.3.2.1, *Water Quality*, and run-of-river flows allow the physical habitat to be maintained and biological productivity to be sustained. This habitat consists of runs, riffles, and pools, with bottom substrates consisting mostly of gravel, cobble, and boulders (see section 3.3.2.1, *Downstream Habitat*). These water quality, flow, and bottom substrate conditions (particularly gravel in runs and riffles) create habitat that is potentially suitable for spawning and rearing of Atlantic salmon (i.e., PCE 1 through PCE 7 as discussed above).¹⁸⁴

Existing run-of-river operation prevents rapidly fluctuating water levels from occurring downstream of the project, which prevents stranding of Atlantic salmon that migrate upstream or downstream, or dewatering of spawning habitat that may be present downstream of the project. Run-of-river operation also allows flows that average 5,366 cfs and 9,664 cfs to move through habitats downstream of the project during the upstream migration of adults and the downstream migration of smolts, respectively (GLHA, 2016a). However, as discussed above, if minimum flow releases are needed during impoundment drawdowns, the minimum flow study conducted by GLHA indicates that the proposed minimum flow of 1,674 cfs would maintain suitable aquatic habitat and provide connectivity of habitats with water depths that exceed the 4 inches to 10 inches of water needed for passage of adult Atlantic salmon to reach the project (Maine DOT, 2004), and thus the downstream habitat would not be a barrier to upstream or downstream migration (i.e., PCE 8 as discussed above). Further, water velocities along the shoreline passage zones were less than the burst swim speeds of smolts (6 fps) and adults (16.5 to 19.7 fps), and therefore would not be a barrier to passage.

¹⁸⁴ Habitat downstream of the project has not been documented (i.e., mapped or formally described) as spawning and rearing habitat for Atlantic salmon. The habitat conditions in the project tailrace, however, are suitable for spawning and rearing (see letter filed by NMFS on May 23, 2017).

As discussed in detail below, GLHA is proposing to maintain upstream and downstream fishways for Atlantic salmon and ensure the fishways meet performance standards of 95 percent effectiveness for upstream migrating adults and 96 percent survival for downstream migrating smolts and kelts. Maintaining a rate of passage at the level of the proposed performance standards would provide necessary passage requirements for the GOM DPS, and improve migration habitat for Atlantic salmon migrating through the project area, and reduce passage delay (i.e., PCE 11 as discussed above).

Atlantic Salmon Essential Fish Habitat

Essential fish habitat for Atlantic salmon is present both upstream of and downstream from the Mattaceunk Project, and Atlantic salmon use habitat in the immediate vicinity of the project for migration and potentially for spawning and rearing downstream from the dam. As the discussion above on critical habitat indicates, proposed project operation would maintain the good quality habitat in the project vicinity, which currently allows passage of all life stages of Atlantic salmon, and the water quality, flow, and habitat conditions capable of supporting spawning and rearing downstream from the project. Further, as discussed in detail below, GLHA is proposing to maintain upstream and downstream fishways for Atlantic salmon, and to ensure the fishways meet performance standards of 95 percent effectiveness for upstream migrating adults and 96 percent survival for downstream migrating smolts and kelts. As discussed below, maintaining passage at the proposed performance standards would provide necessary passage requirements for the GOM DPS to migrate to EFH located upstream of the project 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 5.1, *Comprehensive Development and Recommended Alternative*, which are supported in section 3.3.2.2, *Aquatic Resources*, and in sections below, would further support EFH.

Operation of the Upstream Fishway

To improve upstream passage of Atlantic salmon at the Mattaceunk Project, an upstream pool and weir fishway was constructed in the late 1930s, and the current configuration has been used since the spring of 1986, when it was improved after agency consultation. The current upstream fishway has 36 pools with a drop of approximately 14 inches between pools, which is described fully in section 2.1.1, *Existing Project Facilities*.

To provide the necessary upstream passage for Atlantic salmon, GLHA proposes to continue to maintain and operate¹⁸⁵ the existing upstream fishway annually from May 1 to November 10, including continuing to use a 7 cfs attraction flow at the fishway entrance. In addition, GLHA proposes to implement the FPOMP, which defines the: (1) operational period of the existing upstream and downstream fishways; (2) annual start-up and shut-down procedures; (3) opening methods; (4) debris management; and (5) safety rules and procedures.

NMFS's fishway prescription would require, and Maine DMR recommends, GLHA's proposal to maintain and operate the upstream fishway. NMFS's fishway prescription would also require GLHA to open the upstream fishway prior to May 1 if the fish lift at Milford Dam begins capturing adult Atlantic salmon earlier than May 1. Maine DMR recommends including a provision in any new license to allow modification of the upstream fishway operating schedule during the term of the license, and in consultation with Maine DMR, Interior, and NMFS, based on new information or migration data. Maine DMR also recommends that, with approval from Maine DMR, Interior, and NMFS, GLHA have the ability to request changes in the upstream fishway operating schedule in any given year in response to river conditions, maintenance requirements, and annual variability in migration patterns.

NMFS also recommends that GLHA determine the minimum impoundment elevation necessary to operate the upstream fishway.

Our Analysis

Existing Upstream Passage Facility Effectiveness

GLHA's proposal to operate the existing fishway, which is supported by NMFS and Maine DMR, would allow upstream migrating adult Atlantic salmon that reach the project to continue ascending the river to access spawning habitat upstream of the project. As discussed above, studies conducted in 1986 and 2012 indicate that the passage efficiency of the existing upstream fishway is capable of passing adult Atlantic salmon, but the effectiveness is variable. Among three separate groups of tagged adult salmon, the percent that successfully passed upstream through the fishway was 71 percent (1986, radio-tagged), 89 percent (1986, externally tagged control), and 100 percent (2012, PIT tagged).

Although the existing upstream fishway is capable of passing adult Atlantic salmon, improvements may be needed. As discussed above, passage effectiveness is

¹⁸⁵ In operating the upstream fishway, GLHA is required to provide flows through the fishway that consist of 6 to 8 cfs transport flow, with an additional attraction flow of 7 cfs.

estimated to be between 71 percent and 100 percent. The effectiveness of the existing upstream fishway has never consistently met the performance standard of 95 percent that is proposed by GLHA, recommended by Bruce Haines and the Atlantic Salmon Federation, and currently supported by NMFS (see additional discussion of the performance standard below in section titled, *Upstream Passage Performance Standard and Effectiveness Testing*).

Upstream Passage Operation Schedule

As discussed in section 3.3.4.1, *Affected Environment*, daily monitoring at the Mattaceunk Project from 1983 to 2012 indicates that the peaks in upstream migration past the project occur during July and in early September, with limited movement occurring in early June, August, and mid-late October (see figure 15). Thus, GLHA's proposal, Maine DMR's recommendation, and NMFS's fishway prescription to maintain and operate the existing upstream fishway from May 1 to November 10, represents an appropriate operational window that would afford all adult Atlantic salmon that reach the Mattaceunk Project an opportunity to migrate to upstream habitats. However, since 2012, there are now two fewer impediments to upstream passage (i.e., the removal of Great Works and Veazie dams), and there is improved upstream passage at the Milford Project (i.e., new fish lift began operations in 2014). With fewer potential causes of upstream passage delay in habitats downstream of the Mattaceunk Project, adult Atlantic salmon may reach the project sooner than historical records indicate. Thus, it may be necessary to begin operating the upstream fishway earlier than May 1, if monitoring data at the Milford Project, or other sources of information indicate that adult Atlantic salmon are migrating to the Mattaceunk Project earlier than historical observations. It is also possible that upstream migratory delays could occur as a result of environmental factors. As discussed above, river flow and extremes in temperature can cause adult Atlantic salmon to delay their upstream migration.

With respect to modifying the fishway operations schedule, Maine DMR recommends that the Commission allow (a) the operating schedule for the upstream fishway to be modified during the term of the license, and (b) GLHA to request changes to the operating schedule, if data (i.e., migration timing, river flow, river temperature) and consultation with resource agencies, support the need to modify the operating schedule. In addition, NMFS's fishway prescription would require GLHA to open the upstream fishway prior to May 1 if the Milford fishway begins capturing fish earlier. Both Maine DMR and NMFS indicate that there should be flexibility in the operating schedule for the upstream fishway to allow the fishway to operate beyond the window of May 1 to November 10. However, neither Maine DMR's recommendation, nor NMFS's prescription includes limits regarding the number of days earlier or later that the fishway should operate outside the May 1 to November 10 schedule. In the absence of such limits to the operational window, we have no information to determine whether a particular schedule modification would or would not provide benefits to the GOM DPS of Atlantic

salmon. Therefore, we are unable to identify any benefits to implementing unspecified modifications to the upstream fishway operating schedule.

Effects of Impoundment Elevation on Upstream Passage Operation

The upstream fishway is operational when the flashboards are in place, and under normal operating conditions, which allow fluctuations of up to 2 feet from the top of the flashboards (impoundment elevation with the flashboards in place is 240.0 feet, thus 2 feet below flashboards is 238.0 feet), although fluctuations are typically less than 1 foot below the flashboards. Under these conditions, water from the impoundment flows into the fishway and serves as a source of water and attraction flow at the fishway entrance. When high flows or other events cause flashboard failure, resulting in a need for replacement or repair, the impoundment is drawn down up to 1 foot below the permanent crest (impoundment elevation is 236.0 feet) of the dam and the fishway is not operational, because no flows from the impoundment can pass into the fishway.

The upstream fishway is operational under normal operating conditions, which could include impoundment fluctuations down to an impoundment elevation of 238.0 feet. The upstream fishway is not operational at an impoundment elevation of 236.0 feet. However, there is an unknown impoundment elevation between 236.0 feet and 238.0 feet at which the upstream fishway becomes non-operational. NMFS recommends that GLHA determine this elevation for future fishway operation, and any new fishway construction.

Knowing the elevation at which the upstream fishway becomes non-operational is irrelevant to the operation of the upstream fishway, because under existing and proposed project operations, the impoundment elevations are always at or above 238.0 feet when the flashboards are in place (i.e., normal operations), or between 235.0 feet and 236.0 feet, when the flashboards are down for repair or because of flashboard failure. An impoundment elevation between 236.0 feet and 238.0 feet would never occur under normal operations. Thus, the existing upstream fishway would be operational under the proposed normal operating conditions, which are the same as existing operations, and therefore it is not necessary to identify the impoundment elevation at which the existing fishway can no longer operate.

Upstream Passage Performance Standard and Effectiveness Testing

Despite the presence of an upstream fishway, existing studies indicate that its effectiveness varies, ranging between 71 percent and 100 percent. GLHA is proposing to meet a performance standard of 95 percent passage effectiveness for upstream migrating adults. Thus, upstream fishway improvements may be needed. To evaluate the need for upstream passage improvements, GLHA proposes in the SPP for Atlantic salmon to conduct up to 3 years of upstream fishway effectiveness studies for Atlantic salmon using

the methods in the existing approved study plan.¹⁸⁶ GLHA’s proposed study would include coordination with resource agencies to stock uniquely marked Atlantic salmon smolts upstream of the Mattaceunk Project in the first 3 years after relicensing to serve as a source of imprinted adult fish that can be used for studying upstream passage of adults.¹⁸⁷ GLHA also proposes, as part of the SPP for Atlantic salmon, to implement an adaptive management approach, in consultation with the resource agencies that would include additional operational, structural, and/or habitat enhancement measures, if necessary, to improve passage and/or address performance criteria for upstream and downstream migrating Atlantic salmon. Specifically, if the upstream fishway is able to meet GLHA’s proposed performance standard of 95 percent effectiveness during one year of study, GLHA would evaluate upstream passage at the project once every 10 years to verify continued achievement of the performance standard. If the project does not achieve the proposed 95 percent performance standard for upstream passage during one year of study, GLHA would begin an adaptive management approach to meeting the performance standard that would include consulting with the resource agencies and Penobscot Indian Nation to make any modifications to the upstream fishway deemed appropriate, followed by additional study.

Bruce Haines and the Atlantic Salmon Federation also recommend upstream passage effectiveness that meets a 95 percent performance standard for adult Atlantic salmon migrating to spawning habitats upstream of Weldon Dam.

NMFS’s fishway prescription would require, and Maine DMR recommends, GLHA’s proposal to conduct up to 3 years of upstream fishway effectiveness studies. In addition, NMFS’s fishway prescription would require, and Maine DMR recommends, GLHA’s proposal to implement additional operational and structural modifications, and/or habitat enhancement measures, if necessary, to address performance standard deficiencies for upstream migrating Atlantic salmon adults. If modifications to the upstream fishway are needed, Maine DMR recommends that GLHA operate the fishway for a one season “shakedown” period (i.e., evaluation period), as discussed in section 3.3.2.2, *Aquatic Resources, Environmental Effects*, to ensure it is generally operating as designed and to make minor adjustments to the facilities and operation. Further, Maine

¹⁸⁶ GLHA’s existing study plan (Upstream Salmon Passage – Interim Species Protection Plan) was filed on December 11, 2013 as part of GLHA’s revised study plan for relicensing the Mattaceunk Project.

¹⁸⁷ Stocked smolts would migrate downstream, through the project area, and out to sea. They would then spend about 2 years at sea before returning to the Penobscot River, where they would be collected at the Milford Project fishlift, inserted with a telemetry tag, and released to be part of the upstream passage effectiveness study.

DMR recommends that at the end of the “shakedown” period, GLHA have a licensed engineer certify that the facility is constructed and operating as designed. NMFS’s fishway prescription would require GLHA to operate the upstream fishway in a way that complies with any incidental take statement.¹⁸⁸ NMFS also recommends, as proposed in the SPP for Atlantic salmon, that GLHA’s adaptive management for upstream and downstream passage be developed in consultation with the resource agencies.

Our Analysis

Under existing conditions, passage effectiveness of the upstream fishway has never consistently exceeded GLHA’s proposed performance standard of 95 percent (*see* section 3.3.4.1, *Upstream Passage*), and has been more than 20 percent lower (i.e., 71 percent in 1986) than the proposed performance standard. A performance standard of 95 percent effectiveness for upstream passage is already a requirement at the West Enfield and Milford Projects,¹⁸⁹ which are the only two dams downstream from the Mattaceunk Project on the mainstem of the Penobscot River. Thus, increasing passage effectiveness at the Mattaceunk Project to 95 percent would increase the cumulative passage through the river from what could be as low as 64 percent under existing conditions to about 86 percent.¹⁹⁰ The increase in upstream passage effectiveness at the project would benefit the GOM DPS of Atlantic salmon by allowing more individuals to locate suitable spawning habitat upstream of the project, and thereby improve the reproductive potential of the population.

Additional monitoring would be needed to verify whether the 95 percent performance standard is currently being met. Conducting up to 3 years of upstream fishway effectiveness testing, as proposed by GLHA, recommended by Maine DMR, and required by NMFS’s fishway prescription, would ensure that the existing fishway is either meeting the 95 percent performance standard, or if it is not meeting the standard, the study results would provide documentation of a need for additional measures to

¹⁸⁸ In a letter filed on May 23, 2017, NMFS indicated that a performance standard of 95 percent effectiveness, as proposed by GLHA, is consistent with other performance standards in the Penobscot River, but that standard could be modified in the incidental take statement of its future biological opinion.

¹⁸⁹ 146 FERC ¶ 62,224 (2014).

¹⁹⁰ The cumulative passage through the mainstem of the Penobscot River under existing conditions would be the product of passage effectiveness at the Milford Project (95 percent), the West Enfield Project (95 percent), and the Mattaceunk Project (71 percent, assuming the lowest reported effectiveness for the upstream fishway), which is 64 percent. If passage effectiveness at Mattaceunk were increased to 95 percent, the product of effectiveness at all three dams would increase to 86 percent.

improve passage effectiveness. Further, GLHA's proposed use of the existing study plan, which was previously developed in consultation with the resource agencies and Penobscot Indian Nation, and approved by the Commission, includes scientifically acceptable methods, such as the use of telemetry tagged adult Atlantic salmon. However, because some aspects of the methodology, such as the choice of telemetry tag (e.g., radio-tag, acoustic tag), have not been finalized in the existing study plan, GLHA would need to consult with the resource agencies and Penobscot Indian Nation before filing any final study plans on upstream passage effectiveness.

For the proposed upstream passage study to accurately determine the effectiveness of the upstream fishway, telemetry tagged adult Atlantic salmon must be motivated to migrate to spawning habitat upstream of the project (i.e., imprinted to habitat upstream of the project), otherwise failure to pass upstream could be caused by lack of motivation and not an ineffective fishway. To increase the chances that adults would be motivated to migrate upstream of the dam, GLHA proposes, Maine DMR recommends, and NMFS would require in its fishway prescription, stocking uniquely marked Atlantic salmon smolts upstream of the project,¹⁹¹ to serve as a source of imprinted adult fish that would be used to study upstream passage of adults.¹⁹²

The use of adult fish imprinted to spawning habitat upstream of the project is necessary to ensure that the fish used in the study are motivated to migrate upstream of the project. If non-imprinted adults are used, they may not migrate upstream of the project simply because there are no cues motivating them to migrate to upstream spawning habitat (Shepard, 1995). Any unsuccessful passage caused by the absence of motivation would reduce the percent of successfully passing adults, even though the cause of unsuccessful passage may not be caused by the upstream fishway. Using imprinted adults would remove motivation as a factor that could cause unsuccessful upstream passage, and would allow the study to more accurately evaluate passage success as a function of operational or structural upstream fishway conditions.

¹⁹¹ Stocking of smolts upstream of the project is required, because natural reproduction upstream of the project is currently very low. Thus, there are very limited numbers of adult Atlantic salmon that are both imprinted to habitats upstream of the dam and that are returning to the project. For numbers of recent returning adults Atlantic salmon, see section 3.3.4.1, *Affected Environment, Atlantic Salmon*.

¹⁹² The marked smolts would migrate downstream, and most would spend 2 years at sea before returning to the Penobscot River. Any marked adults captured at the Milford Project fish lift would be identified as being stocked upstream of the Mattaceunk Project, and included in the upstream fish passage study.

NMFS's fishway prescription would require that the effectiveness studies begin at the start of the second migratory season after fishways are operational. The existing upstream fishway is currently operational, thus NMFS's fishway prescription would require effectiveness studies for upstream migrating adult Atlantic salmon to begin in the second year after any new license is issued. However, if smolts are stocked in the first year after any new license is issued, then upstream migrating adult Atlantic salmon would not be available for study until at least the third year after any new license is issued, because the stocked smolts would spend at least 2 years at sea (as post-smolts). Thus, NMFS's requirement would not be feasible for the Atlantic salmon upstream passage effectiveness studies.

NMFS has indicated,¹⁹³ with respect to the upstream passage effectiveness studies, that its incidental take statement may include a condition stating that the performance standard of 95 percent effectiveness would be considered achieved if 75 percent of adult study fish pass the project area within 48 hours of approaching the dam (i.e., 656 feet downstream), and the remaining 20 percent of study fish pass the project within 96 hours. Thus, any adults that exhibit migratory delays beyond the 48- or 96-hour thresholds, would be considered as failed passage attempts in evaluating whether the performance standard is achieved. Delays in migration are a concern because they can result in prolonged exposure to disease and parasites, cause delay in reproduction which may negatively affect egg and sperm quality, or cause depletion in overall energy reserves – all of which could negatively affect reproduction and survival (Geist *et al.*, 2000; Hari *et al.*, 2006; Hinch *et al.*, 2012; Fenkes *et al.*, 2016).

Although dams are known to delay upstream passage of salmonids (Caudill *et al.*, 2007), a 48-hour and 96-hour passage requirement implicitly assumes that delay is exclusively caused by the dam or ineffective upstream passage. However, other factors, including extreme high or low water temperatures (Alabaster, 1990; Shepherd 1995) and river flow (Jensen *et al.*, 1986; Trepanier *et al.*, 1996) can also delay migration. Further, we have been unable to identify any studies that would indicate that delays beyond 48 hours, 96 hours, or any time period would negatively affect reproduction or survival. Thus, NMFS's potential requirement for adult salmon to pass upstream of the project within a specific 48-hour or 96-hour threshold is without scientific justification.

The upstream effectiveness studies may show that the existing upstream fishway does meet the 95-percent performance standard for upstream passage after 1 year of study. Under this scenario, GLHA proposes to operate the existing fishway without structural or operational changes and evaluate upstream passage once every 10 years to verify continued achievement of the performance standard. The ability to meet the 95-percent performance standard after 1 year of study would indicate that the upstream

¹⁹³ See letter from NMFS filed on May 23, 2017.

fishway is effective at passing adults upstream, and if the upstream fishway is maintained in accordance with the FPOMP (discussed in section 3.3.2.2, *Fish Passage Design, Operation, Maintenance, and Monitoring*) it should continue to meet the 95 percent standard. However, because GLHA is proposing to stock uniquely tagged smolts during the first 3 years after relicensing, GLHA could conduct an additional 1 or 2 years of upstream passage effectiveness studies to provide additional verification of effectiveness. The need for an additional 1 or 2 years of study could be determined in consultation with the resource agencies, with final approval from the Commission.

Once the upstream fishway meets the 95 percent effectiveness standard, GLHA proposes to reevaluate of the upstream fishway effectiveness every 10 years to provide additional assurance that upstream passage effectiveness is maintained at a high level throughout the duration of any license issued. However, if the upstream fishway meets the 95 percent performance standard and is properly operated and maintained, as discussed in section 3.3.2.2, *Fish Passage Design, Operation, Maintenance, and Monitoring*, there would be no benefit to conducting additional effectiveness monitoring every 10 years.

Evaluating the upstream fishway effectiveness may show that the upstream fishway does not meet the 95 percent performance standard. Under this scenario, GLHA proposes, Maine DMR recommends, and NMFS's would require GLHA to consult with the resource agencies and Penobscot Indian Nation, and make any structural or operational modifications that are deemed appropriate, followed by additional study. Although additional measures may be needed to meet a 95 percent performance standard, specific structural and/or operational modifications have not been proposed, because a need for such measures cannot be determined at this time. Without specific structural and/or operational modifications to analyze, we are unable to determine whether such measures would benefit the Atlantic salmon GOM DPS. Nevertheless, if specific structural and/or operational modifications are identified as necessary at a future date, implementation could occur, but would require final Commission approval.

GLHA is only proposing to stock smolts for 3 years, which would allow them to conduct up to 3 years of upstream effectiveness monitoring. A fourth year of study would not be feasible under GLHA's proposal, and stocking additional smolts for the purposes of additional study may not be consistent with the restoration objectives for Atlantic salmon.¹⁹⁴ Therefore, 3 years of monitoring could end without meeting the 95

¹⁹⁴ For the study to succeed, GLHA would need to stock tens of thousands of smolts each year of the upstream passage study, in order to get at least 20 adult salmon returning to the Penobscot River and Milford Project fishlift, where they would be collected, telemetry tagged, and released as study fish. Kocik and Sheehan (2006) indicate that adult return rates of hatchery smolts released in the Penobscot River in 2005

percent performance standard and without an ability to conduct additional monitoring. Under this scenario, GLHA could develop additional adaptive management provisions, but implementation of any future provisions would require final Commission approval. This would provide GLHA a mechanism to continue efforts to meet the 95 percent performance standard, which would benefit the GOM DPS.

Counting Atlantic Salmon in the Upstream Fish Trap

Atlantic salmon that pass through fishways can be counted, with the data being used to determine current population status and historical trends, which can inform management decisions. Since 1983, the licensee of the Mattaceunk Project has voluntarily operated a fish trap located at the upstream exit of the fishway, where fish enter the trap through a funnel-like opening after negotiating the fishway. The trap is tended daily during the migration season by GLHA, and any Atlantic salmon captured are counted and classified by size and allowed to passively swim out of the trap by opening a hinged door. GLHA proposes to monitor the upstream fishway and count the number of adult Atlantic salmon passing upstream of the project, using a methodology developed in consultation with the resource agencies (e.g., PIT tagging, or video). GLHA indicated, in its letter filed July 7, 2017, that the counts may or may not involve using the existing fish trap. NMFS's fishway prescription would require GLHA to maintain the existing fish trap for counting adult Atlantic salmon. Maine DMR recommends that GLHA provide counts of adult Atlantic salmon that exit the upstream fishway to resource agencies, but does not specify a need to continue using the existing fish trap.

Our Analysis

For over three decades, adult Atlantic salmon have been counted in the fish trap at the Mattaceunk Project. The count data provide resource managers with information on the number of spawning capable salmon that successfully pass the project, and are within access to spawning grounds in the East Branch of the Penobscot River. The abundance estimates derived from the counts can help determine whether the population is increasing or decreasing. Nevertheless, there is no benefit to counting Atlantic salmon (in the fish trap or by other means), as it relates to project effects on the GOM DPS.

was 0.17 percent. Based on a 0.17 percent return rate alone, GLHA would need to stock a minimum 11,765 smolts to have the possibility of 20 adult returns. However, GLHA may need to stock thousands more smolts to improve the chances of collecting and tagging 20 adult salmon each year. Stocking smolts upstream of the project for the purposes of the study could impede restoration efforts, which are currently focused on stocking smolts downstream of all Penobscot River hydropower projects in order to maximize the number of smolts that reach the ocean (*see* GLHA's Updated Study Report Meeting Summary filed on February 5, 2016 for discussion on current stocking efforts in the Penobscot River).

More specifically, counting Atlantic salmon does not protect adult salmon from project effects, mitigate a project effect on adult salmon, or provide information that would allow GLHA to enhance the GOM DPS through changes in its operations.

Downstream Passage Operations

GLHA proposes to continue to maintain and operate the existing downstream fish passage facility at its maximum flow capability (140 cfs) to provide downstream passage for Atlantic salmon smolts and kelts from April 1 to June 15 and only kelts from October 17 to December 1. Continued operation also includes operating the project such that turbines 3 and 4 are the first units on and the last units off whenever the downstream fishway is operational. GLHA also proposes a new measure to open the project's log sluice between 3 percent and 9 percent of the station's hydraulic capacity, or between approximately 225 cfs and 690 cfs. This measure would start during the first passage season following license issuance, in order to support downstream Atlantic salmon smolt out-migration for a 3 week period during the spring. The dates of the three-week period would be determined in consultation with resource agencies (measure in SPP for Atlantic salmon).¹⁹⁵ In addition, GLHA proposes to full-depth trash racks with 1-inch clear bar spacing. The trash racks would be installed within two years after license issuance, and thereafter would be deployed annually during the fish passage season, from April 1 to June 15 [smolts and kelts] and October 17 to December 1 [kelts] (measure in SPP for Atlantic salmon).¹⁹⁶ Finally, as discussed previously, GLHA proposes to implement adaptive management that would include additional operational, structural, and/or habitat enhancement measures, if necessary, to improve passage and/or address performance criteria for upstream and downstream migrating Atlantic salmon (measure in SPP for Atlantic salmon).

NMFS filed six fishway prescriptions relevant to downstream passage structures and operation, exclusive of effectiveness testing and maintenance (the latter issues are detailed in sections below). These prescriptions state that:

¹⁹⁵ As discussed in section 3.3.1.2, *Environmental Effects*, GLHA is proposing to extend the seasonal operation of the log sluice beyond the 3 week period once the new upstream fishway for alosines is operational.

¹⁹⁶ As discussed in section 3.3.1.2, *Environmental Effects, Downstream Eel Passage*, GLHA also proposes to provide downstream passage for eel during downstream eel migrations, which GLHA expects to occur from September to October, but would be determined in consultation with the resource agencies and based on a predictive model for eel movement.

- (1) downstream passage structures shall be operational within 2 years after issuance of a new license, and consist of a protective barrier leading to a bypass system,¹⁹⁷ with the bypass system consisting of (a) a surface entrance leading to a pipe or sluice to convey fish around the project and discharge to flowing water below the project, such as the tailrace with sufficient depth (at least 4 feet) to avoid injury, and (b) increased spill through an opening (e.g., log sluice) adjacent to the powerhouse discharging to flowing water below the project with sufficient depth (at least 4 feet) to avoid injury;
- (2) the downstream fishway shall be operational for Atlantic salmon smolts and kelts from April 1 to June 15 and Atlantic salmon kelts from October 17 to December 1;
- (3) the log sluice shall be open (between 3 percent and 9 percent of station hydraulic capacity, or between approximately 225 cfs and 690 cfs) starting the first passage season following relicensing in support of downstream Atlantic salmon smolt out-migration for a 3 week period during the spring that would be determined in consultation with resource agencies;
- (4) within 2 years of license issuance, GLHA shall deploy during the fish passage season, trash racks having 1-inch clear spacing to the full depth of all turbine intakes;
- (5) measure approach velocities after installation of 1-inch full depth trash racks using point measurements, and ensure approach velocities do not exceed 2.0 fps; and
- (6) develop and implement an adaptive management plan that would include additional operational, structural, and/or habitat enhancement measures, if necessary, to improve passage and/or address performance criteria for upstream and downstream migrating Atlantic salmon.¹⁹⁸

¹⁹⁷ We assume that a protective barrier is analogous to the proposed trash rack overlays having 1-inch clear spacing to the full depth of the turbine intakes.

¹⁹⁸ GLHA's proposed SPP includes two adaptive management measures to: (1) implement an adaptive management plan to address performance criteria for downstream passage, should the proposed measures be inadequate; and (2) implement additional operational and structural modifications and/or habitat enhancement measures, if necessary, to address outmigrating Atlantic salmon smolts and kelts and upstream migrating Atlantic salmon adults. Because of the similarity in these two measures, we

To ensure safe and effective operation for downstream migrating fish, NMFS also recommends real-time monitoring of the downstream fishway using pressure transducers to identify debris blockages to shutdown the bypass and clean the bypass when a blockage is identified.

Maine DMR recommends GLHA's proposals, as discussed above, to maintain and operate the existing downstream fish passage facility from April 1 to June 15 and Atlantic salmon kelts from October 17 to December 1, open the project's log sluice, and develop and implement an adaptive management plan. Maine DMR also recommends GLHA's proposal to install full-depth trash racks with 1-inch clear bar spacing. Unlike GLHA's proposal, however, Maine DMR recommends that the trash racks be installed within the first fish passage season following license issuance, and thereafter deploy the trash racks during the downstream fish passage season (i.e., April 1 to June 15, and August 1 to December 31).¹⁹⁹

Penobscot Indian Nation recommends that downstream passage meet the FWS (2017a) design criteria, and as specified for the Mattaceunk Project by Sojkowski (2017). In reference to the Mattaceunk Project, Sojkowski (2017) indicates that four design criteria are particularly important: (1) bypass flows of at least 5 percent of the station's hydraulic capacity; (2) normal velocity not greater than 2 fps in front of the trash racks;²⁰⁰ (3) a ratio of sweeping velocity to normal velocity equal to or greater than 1;²⁰¹ and (4) trash rack clear bar spacing less than or equal to 1 inch to the full depth of the turbine intake for Atlantic salmon smolts.

combined them into this single adaptive management measure that captures the intent of the two measures proposed by GLHA.

¹⁹⁹ The downstream fish passage season was defined by Maine DMR in its May 22, 2017, filing with the Commission. Maine DMR's recommended downstream fish passage season incorporates the downstream migration periods defined by Maine DMR for Atlantic salmon smolts and kelts (i.e., April 1 to June 15 [smolts and kelts], October 15 to December 31 [kelts]), and August 1 to October 31 [eel]).

²⁰⁰ Normal velocity is the component of velocity in front of the trash racks that is perpendicular to the trash rack bars.

²⁰¹ Sweeping velocity is the component of velocity in front of the trash racks this is parallel to the trash rack bars.

Bruce Haines recommends that the downstream bypass include attraction flows of 5 percent of the station's hydraulic capacity, and that the attraction flows should be provided 24 hours per day, 365 days per year.

Our Analysis

Downstream Passage Survival Under Existing Bypass Operation

The existing downstream passage structures (i.e., surface bypass inlets with a designed maximum flow capability of 140 cfs [2 percent of station hydraulic capacity] and trash racks) at the project are designed to reduce entrainment and provide the only source of safe downstream passage when no water is spilling over the dam, and to reduce entrainment and enhance downstream passage when the project is spilling water over the dam. As discussed in section 3.3.4.1, *Affected Environment, Atlantic Salmon*, the downstream bypass facilities do function to reduce entrainment through the turbines and enhance passage past the project. In fact, studies conducted in 2014 and 2015 resulted in point estimates of 95.8 percent and 95.9 percent survival past the dam, respectively, with a 95 percent probability that survival was between 83 percent and 100 percent in 2014, and 89.3 percent and 100 percent in 2015.²⁰² These results are consistent with the estimates of smolt survival (96.6 percent [at 50 and 75 percent exceedance flows], 97.4 percent [at 25 percent exceedance flow]), calculated in GLHA's desktop entrainment and impingement analysis. Slightly lower rates of smolt survival (84 percent and 91 percent for wild and hatchery smolts, respectively) past the project dam were estimated by Stich *et al.* (2015b) between 2010 and 2014. Nevertheless, a large majority of smolts that approach the project survive passage past the project, and in 2014 and 2015, all smolts that used the surface bypass system survived passage to 8.3 and 4.2 miles downstream, respectively.

²⁰² Point estimates are single value estimates for survival. However, because there are inherent uncertainties (e.g., some surviving fish may not be detected by arrays) when calculating survival using telemetry, there is some uncertainty or error with a point estimate. Therefore, true survival may be larger or smaller than the point estimate. To capture the range of potential true values of survival, GLHA estimated a 95 percent confidence interval for the 2014 and 2015 survival estimates. The 95 percent confidence interval represents a range of survival values, within which there is a 95 percent probability of including the true survival estimate.

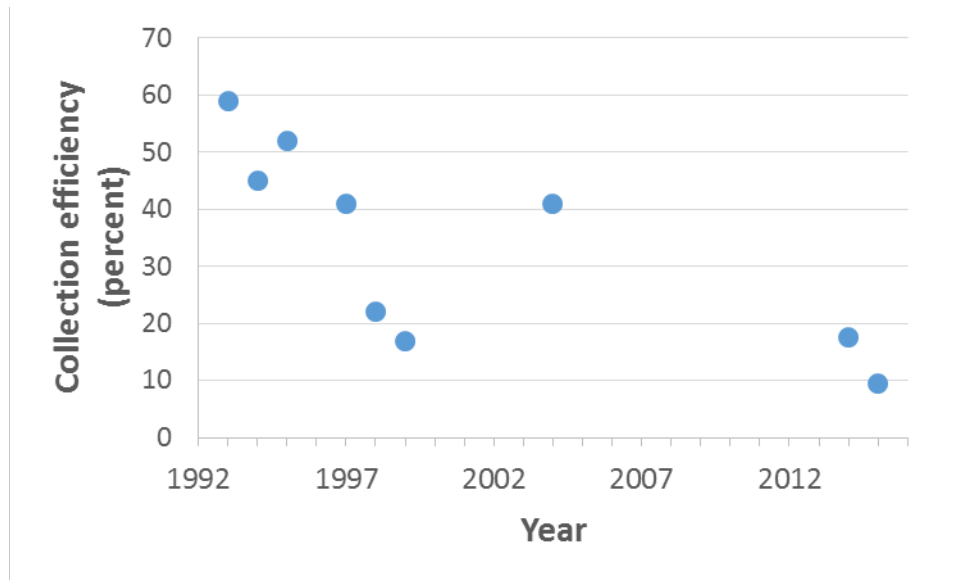


Figure 19. Smolt collection efficiency of the existing bypass at the Mattaceunk Project.

(Source: staff).

Although downstream survival of smolts using the bypass is good, the collection efficiency²⁰³ of the surface bypass system is low. Among nine studies conducted between 1993 and 2015, the average collection efficiency of the bypass system was 33.8 percent, with the minimum of 9.4 percent occurring most recently (2015)²⁰⁴ and the maximum of 59 percent occurring just after the permanent bypass system was installed (October 1992). Although study conditions varied from 1993 to 2015, the general trend in study results was a decline in bypass collection efficiency over time (figure 19). The studies occurring between 1993 and 1999 were conducted during low flow conditions, when the only two passage routes were the bypass system and the turbine intakes. Under such conditions, spill and the log sluice were not an option for downstream passage, and thus the majority of smolts were entrained through the turbine intake. Even when spill and/or the log sluice is an option for downstream passage, as in 2014 and 2015, 70.1 percent and 78.5 percent of smolts, respectively, were entrained through the turbines. Further, those smolts that are entrained through the turbines exhibit lower rates of

²⁰³ Collection efficiency represents the proportion of study smolts that successfully pass the dam using the bypass system relative to the total number of smolts that pass the dam successfully. Collection efficiency provides an estimate of the proportion of smolts that pass downstream that are using the bypass system, which is considered the safest route downstream.

²⁰⁴ As discussed in section 3.3.3.1, *Affected Environment*, GLHA discovered after completing the 2015 study that the bypass was blocked with debris, and might have affected the collection efficiency.

survival (2014: 85.1 percent, 2015: 92.5 percent) compared to smolts that use the bypass (2014: 100 percent, 2015: 100 percent) or the log sluice (2015: 100 percent) for downstream passage.

The information above indicates that smolts can pass the project under existing conditions with survival rates that range between 84 percent and 96 percent survival. As discussed above, the existing condition includes a bypass system that is generally ineffective at attracting smolts to a safe passage route and a turbine intake that is highly effective at entraining smolts through a less safe route. The ineffectiveness of the bypass compared to the turbine intakes is most likely a result of the relative location of the bypass and the limited flow capability of the bypass. Specifically, the bypass openings are positioned directly above the turbine intakes, and have a maximum flow capacity of 140 cfs, which is only 2 percent of the station's hydraulic capacity (i.e., 7,438 cfs).

To be effective, safe passage routes, like the bypass, must create hydraulic signals that are capable of attracting fish to the safe route. If flows coming from the bypass are not discernable from competing flows coming from the turbine intakes, fish will be attracted toward the turbine intakes. Thus, the greater passage of smolts through the turbines could be the result of a greater hydraulic signal coming from the turbine intake, compared to the signal coming from the bypass that is positioned in the same path as the turbine intakes. Additional improvements to smolt survival at the project could be possible by providing more discernable flows through a safe passage route (*see below, Opening the Log-sluice for Smolt Passage*). Such improvements could allow GLHA to consistently meet and/or exceed a 96 percent performance standard, allowing more smolts to survive passage past the project, which would benefit the GOM DPS.²⁰⁵ The specific improvements supported by the analysis above, which are proposed by GLHA, recommended by Maine DMR and Bruce Haines, and would be required by NMFS, are discussed in sections below.

Available information on downstream passage of kelts is based on studies conducted in the early 1990s, and the desktop entrainment study discussed in section 3.3.4.1, *Affected Environment, Atlantic Salmon*. In the spring of 1993, a large-scale study involving 71 post-spawn broodstock kelts from the Craig Brook National Fish Hatchery

²⁰⁵ A performance standard of 96 percent smolt survival is currently a requirement at the Orono, Stillwater, Milford, and West Enfield Projects, and is based on NMFS's recommendations for those projects (*see* 142 FERC ¶ 62,118 (2013)). All projects are located downstream of the Mattaceunk Project. West Enfield and Milford are located on the Penobscot River and Orono and Stillwater are located on the Stillwater River, which is a tributary of the Penobscot River. Thus, passing smolts downstream from the Mattaceunk Project with 96 percent survival meets the survival standard determined by NMFS to be protective of smolts migrating downstream in the Penobscot River.

was conducted under spill conditions, in which 30 kelts were radio-tagged and 41 served as controls. Among the radio-tagged kelts, three did not pass the dam (10 percent), three (10 percent) used the bypass, one was entrained through the turbines (3.3 percent), and 20 (66.7 percent) passed downstream via spill (GNP, 1993). The kelt that was entrained through the turbines died. The remaining 26 kelts survived, indicating that passage survival was 96.3 percent, which is relatively consistent with the results from the desktop entrainment analysis (i.e., 93.9 percent to 96.6 percent survival depending on inflow). Among the control kelts, 13 (31.7 percent) used the bypass. The passage route of the remaining control kelts was unknown, but based on the radio-tagged kelts, they likely passed via spill. These results indicate that under existing conditions when the project is spilling, entrainment of kelts is relatively low and survival past the dam meets the 96 percent survival performance standard proposed by GLHA. Like smolts, a performance standard of 96 percent for kelt survival is currently a requirement at the Orono, Stillwater, Milford, and West Enfield Projects, and is based on NMFS's recommendations for those projects.²⁰⁶ Thus, under existing conditions when the project is spilling, kelts are able to pass downstream of the Mattaceunk Project with 96 percent survival, which meets the survival standard determined by NMFS to be protective of kelts migrating downstream past other projects on the Penobscot River.

Bypass Operations Schedule

As discussed in section 3.3.4.1, *Affected Environment, Atlantic Salmon*, smolt population surveys conducted from 2000 to 2005, demonstrate that smolts migrate from the Penobscot River between late April and early June with a peak in early May (Fay *et al.*, 2006). In addition, 5 years of data collected on downstream migrating kelts at the Mattaceunk Project demonstrate a spring migration period between April 25 and June 25, and fall migration in October and November (GNP, 1993, 1994).

The downstream bypass was historically operated from October 17 to December 1 for Atlantic salmon kelts, as well as from April 25 to June 25 for smolts and kelts. To enhance passage, the spring operational period for the downstream bypass was modified in 2013 to begin on April 1 and end on June 15 each year. Operating the bypass earlier in the spring provides improved passage for kelts, which have been shown to occasionally migrate soon after ice-out occurs; and NMFS²⁰⁷ indicates that operation of the bypass after June 15 for smolts and kelts during the spring migration is unnecessary. Thus, based on the aforementioned information, GLHA's proposal to operate the downstream bypass from April 1 to June 15 for smolts and kelts, and from October 17 to December 1

²⁰⁶ See 142 FERC ¶ 62,118 (2013).

²⁰⁷ See letter filed by NMFS on June 28, 2015.

for kelts would allow smolts and kelts to use the downstream bypass when they are most likely to be migrating downstream of the project.

Bruce Haines recommends operating the downstream bypass 365 days per year. As shown by the existing data above, smolts and kelts migrate downstream during specific periods of the year. Thus, there is no additional benefit to operating the bypass all year long, and beyond the period proposed by GLHA.

Trash Racks

At the Mattaceunk Project, there are currently two intake openings per generating unit, and each opening is covered by a trash rack with 1-inch clear bar spacing that covers the top 16 feet of the water column (at normal impoundment elevation of 240 feet) and 2.63-inch clear bar spacing covering the lower 36 feet of the water column. Approach velocities in front of the trash racks are estimated to be 1.7 fps. Under these conditions, smolts could volitionally pass (i.e., by choice) through either the 1-inch or 2.63-inch trash racks and become entrained because of their small size (table 19), but because they have burst swim speeds of about 6.0 fps, smolts have the potential to avoid entrainment (table 20). Thus, for smolts there is a risk of entrainment, but little to no risk of impingement. Kelts are larger than smolts, and all kelts are too wide to be entrained through the existing 1-inch clear bar spacing (table 19). Most kelts are also too wide to be entrained through the existing 2.63-inch clear bar spacing. Although their large size makes them more susceptible to impingement than entrainment, kelts have burst swim speeds high enough to overcome impingement and entrainment (table 20).

GLHA proposes to begin using seasonally installed (i.e., during the fish passage season for smolts, kelts, and eel [April 1 to June 15 and September 1 to December 1]) full-depth trash racks with 1-inch clear bar spacing (i.e., from surface to about 36 feet below normal impoundment elevation) within 2 years after license issuance, with the intention of reducing entrainment of smolts and kelts. Maine DMR and Penobscot Indian Nation recommend, and NMFS's and Interior's fishway prescriptions would require, GLHA's proposed measures.

The information immediately above, as well as the downstream passage studies discussed earlier in this section, indicate that among salmon life-stages, smolts are most likely to be entrained under existing conditions, which include trash rack bar spacing of 1 and 2.63 inches. However, as indicated above, reducing the existing 2.63-inch bar spacing in the lower water column, to 1-inch bar spacing, would not reduce entrainment, because smolts could still pass through either the 1-inch or 2.63-inch bar spacing. Further, smolts are surface oriented swimmers that primarily use the upper 33 percent of the water column (Wagner and Ingram, 1973; Dunn, 1978, Eicher, 1988). The existing trash racks with 1-inch bar spacing already covers the top 24 percent of the water

column,²⁰⁸ which is 73 percent of the water column generally used by smolts. Thus, for the purposes of protecting smolts from entrainment, there is no apparent benefit to installing full-depth trash racks with 1-inch clear bar spacing.

Narrowly spaced trash rack bars do have the potential to deter fish from passing between the bars (Coutant and Whitney, 2000). However, the difference in deterrence between trash racks with 1-inch spacing compared to 2.63-inch spacing is not known. Nevertheless, GLHA could explore the potential deterrence effect of adding of 1-inch bar spacing to the full depth of the turbine intakes during the downstream passage season for smolts, if the downstream effectiveness studies indicate that the project is unable to meet the performance standard of 96 percent survival without the 1-inch bar spacing to the full depth of the turbine intakes. Thus, adding trash racks with 1-inch bar spacing could be a component of GLHA’s adaptive management strategy (discussed in more detail below), if necessary, to protect downstream passage of smolts. There would be no benefit of adding the 1-inch bar spacing for the protection of kelts, because most kelts are already protected by the existing trash rack configuration. However, as discussed in section 3.3.2.2, *Downstream Eel Passage*, installing full-depth trash racks with 1-inch clear bar spacing during the downstream eel passage season would be protective of larger eel, which swim in deeper water.

Table 19. Minimum length of Atlantic salmon excluded by trash racks with 1.0-inch and 2.63-inch bar spacing.

Species	Life-stage	Scaling factor for body width	Length range (inches)	Minimum length (inches) excluded	
				1.0 inch bar spacing	2.63 inch bar spacing
Atlantic salmon	juvenile (smolt)	0.104	5 – 8	Not excluded	Not excluded
	adult (kelt)	0.104	25-32	10	25

(Source: GLHA, 2016a, as modified by staff).

²⁰⁸ The estimated depth of the dam forebay is 66 feet at normal impoundment elevation, based on exhibit F-2 drawings included in the final license application. The existing 1-inch bar spacing extends down to 16 feet below normal impoundment elevation.

Table 20. Burst swim speeds of Atlantic salmon.

Species	Life-stage	Length range (inches)	Burst swim speed
Atlantic salmon	juvenile (smolt)	5 – 8	6.0 ^a
	adult (kelt)	25 - 32	16.5 - 19.7 ^b

^a Wolter and Arlinghaus, 2003

^b Peake *et al.*, 1997

(Source: GLHA, 2016a, as modified by staff).

Approach Velocity

The approach velocities at powerhouse intakes are generally defined as the average water velocity measured a few inches in front of the trash racks taken in the same direction as inflow (EPRI, 2000). This definition of approach velocity describes the velocity experienced by the fish as it swims freely near the front of the trash racks (EPRI, 2000). Approach velocities can be estimated by dividing the maximum hydraulic capacity by the total intake area of the powerhouse (EPRI, 2000). Using this approach, GLHA estimated the average approach velocity at the project to be 1.7 fps. As discussed above, an approach velocity of 1.7 fps is lower than the burst swim speeds of smolts and kelts (table 20), and therefore reduces entrainment and impingement risk during the downstream migration.

NMFS’s fishway prescription would require GLHA to take point measurements of approach velocities immediately upstream of the project trash racks (i.e., 6 to 12 inches) after installation of full-depth trash racks with 1-inch clear bar spacing, and ensure that point measurements do not exceed 2.0 fps within a 2-foot-square grid. However, the benefit of measuring approach velocities, as required by NMFS’s prescription, is not clear, as approach velocities would not deviate substantially from the estimated 1.7 fps (which is less than the prescribed 2.0 fps), because there are no proposed changes to the size of the turbine intake or the maximum hydraulic capacity.

In contrast to approach velocities, through-screen velocities²⁰⁹ could increase with debris accumulation on the trash racks. GLHA proposes to continue implementing the

²⁰⁹ Through-screen velocity represents the velocity of the water as it passes between the bars of a trash rack (EPRI, 2000).

FPOMP, which includes provisions for utilizing a trash rake²¹⁰ to clear debris from the intakes of units 3 and 4. GLHA has indicated that the intakes are cleared prior to opening the downstream fishway at the beginning of the season. However, the frequency of debris removal is not identified in the plan.²¹¹ Further, there is no indication that the intakes of units 1 and 2 are also cleared of debris. To maintain through-screen velocities, GLHA could use the trash rake to routinely clear debris from the trash racks in front of all four intakes during the downstream migration season. Debris loads in a river can vary seasonally (e.g., leaf drop) and with weather events (e.g., rain and thawing events that can transport debris to a river and increase flow causing suspension and transport of settled debris on the riverbed). Consequently, the frequency of debris clearing would be best determined in consultation with the resource agencies most familiar with the nature of debris loads in the Penobscot River, with final approval from the Commission. Implementation of these additional debris clearing measures would ensure that the through-screen velocities do not increase.

Through-screen velocities could also change if there are structural changes that could modify the trash rack configuration. GLHA is proposing to install full-depth trash racks with 1-inch clear bar spacing within 2 years of license issuance, which as discussed above, is not needed to protect Atlantic salmon, but as discussed in section 3.3.2.2, *Downstream Eel Passage*, would help protect eel during their downstream migration. The addition of these full depth trash racks could increase the through-screen velocity, because the 1-inch bar spacing would decrease the amount of open space at depths greater than 16 feet where trash bar spacing is currently 2.63 inches. However, the through-screen velocity would be experienced only when a fish is right at the face of the trash rack, or passing through the trash rack, and is not likely to be as important a factor in whether a fish becomes impinged or entrained as is the approach velocity (EPRI, 2000). More importantly, and to the merits of NMFS's prescription, there would be no change to the approach velocities as a result of adding full-depth trash racks with 1-inch clear bar spacing.²¹² Therefore, there would be no benefit to taking point measurements of approach velocities immediately upstream of the project trash racks for the purpose of ensuring that point measurements do not exceed 2.0 fps.

²¹⁰ GLHA operates a trash rake that is operated by an electrical hoist on a trolley beam.

²¹¹ See letter filed by GLHA on July 7, 2017.

²¹² Approach velocity is the velocity in front of the trash racks, which is estimated as the intake flow divided by the intake cross-sectional area (EPRI, 2000).

Opening the Log-sluice for Smolt Passage

GLHA proposes, Maine DMR recommends, and NMFS's fishway prescription would require, opening the project's log sluice (at between 3 percent and 9 percent of station's hydraulic capacity, or between approximately 225 cfs and 690 cfs)²¹³ starting the first passage season following license issuance to facilitate downstream Atlantic salmon smolt out-migration for a 3-week period during the spring that would be determined in consultation with resource agencies.

Sluiceways are typically used to bypass ice and debris at hydropower projects, but they can also provide an adequate and generally successful means of downstream passage if fish are able to locate them. This type of passage may work well for surface or near-surface oriented fish (i.e., alosines, salmon, and some resident riverine species), but may not work as well for fish distributed elsewhere in the water column (OTA, 1995). Currently, the log sluice is used for debris management, and since 2013, has been used as the first opened and last closed gate for passing excess flows²¹⁴ during the downstream migration seasons for Atlantic salmon. Thus, the log sluice is currently operated to pass smolts when the project is spilling. GLHA's proposal would expand the operating window of the log sluice to occur during a 3-week window of peak smolt migration, even if the project is not spilling. The proposed change would also increase downstream passage flows from 140 cfs (2 percent of the station's hydraulic capacity) through the bypass system, to between 365 cfs (5 percent) and 830 cfs (11 percent), with the addition of passage flows through the log sluice.

Sojkowski (2017) indicated that the project's log sluice is too far from the bulk flow through the turbine intakes to be an effective route for passage, and cites the few existing studies conducted at the Mattaceunk Project to support its conclusion.²¹⁵ The first studies to evaluate the effectiveness of the log sluice were conducted in 1991 and 1992 before the downstream bypass system was installed. During the studies, 140 cfs (2 percent of the station's hydraulic capacity) was passed through the log sluice, and among 26 tagged smolts, 16 passed through the turbines, and none passed through the log sluice (GNP, 1992). GLHA is proposing to pass flows of between 225 cfs and 690 cfs through the log sluice. Thus, the 1991 and 1992 studies may not be representative of the capacity of the log sluice to effectively pass smolts when flows through the log sluice are greater

²¹³ The log sluice has a gated capacity of 690 cfs.

²¹⁴ The roller gate is used to pass excess flows once the inflows exceed the hydraulic capacity of the turbines, fishways, and log sluice.

²¹⁵ In comments filed on May 23, 2017, the Atlantic Salmon Federation and Penobscot Indian Nation agreed with FWS's conclusion.

than 2 percent of the station's hydraulic capacity.²¹⁶ Further, a more recent telemetry study conducted in 2015 indicated that 9 of 135 radio-tagged smolts used the log sluice, and all of them survived passage to 4.2 miles downstream. The 2015 results indicate that the log sluice is a safe passage route and has the potential to be effective at reducing entrainment. Also, NMFS states that the log sluice is a safe route of passage given its smooth hydraulic transition into the tailrace.²¹⁷

Smolt population surveys, conducted from 2000 to 2005, demonstrate that smolts migrate from the Penobscot River between late April and early June with a peak in early May, and that the majority of the smolt migration takes place over a 2- to 3-week period after water temperatures rise to 50°F (Fay *et al.*, 2006). Thus, GLHA's proposal to open the log sluice continuously during the peak 3-week smolt migration period (determined in consultation with resource agencies), would ensure that the log sluice is able to pass smolts during the most opportune time of the migration season. GLHA has indicated that the log sluice opening would likely be based on water temperatures or other environmental factors, but the timing would ultimately be determined in consultation with the resource agencies,²¹⁸ and could be altered to coincide with the stocking of hatchery reared smolts upstream of the project. GLHA's approach to timing the opening of the log sluice would be based on evidence and consultation with resource experts, and would help ensure maximum downstream passage of smolts.

Existing information at the project indicates that the log sluice is a safe passage route, and its use during the peak downstream migration could improve the passage of smolts. Existing information also indicates the potential for the log sluice to be effective when used in combination with the existing bypass system. However, the proposed operation of the log sluice and installation of full-depth trash racks with 1-inch clear bar spacing would change the flow dynamics that currently occur in the project forebay, and these changes could affect how smolts and kelts move downstream through different passage routes (i.e., bypass, log sluice, spillway). Changing the flow characteristics (i.e., more water flowing toward and through the log sluice) and potentially the passage route could alter downstream passage survival of smolts and kelts, relative to the survival that

²¹⁶ The flow passing through the log sluice during the 2015 study has not been reported. Thus, staff do not know whether the flow is within the 225 cfs to 690 cfs proposed. However, even if the flow passing through the log sluice was the same as in the 1991 and 1992 studies, the 2015 results still indicate that the log sluice is a safe route, and that it has the potential to be effective.

²¹⁷ See the letter filed by NMFS on May 23, 2017.

²¹⁸ See letter filed by GLHA on January 25, 2017 in response to our October 27, 2016 additional information request.

occurs under existing conditions. Post-licensing downstream passage effective studies for smolts and kelts would help to determine whether the proposed operation of the log sluice and trash rack installation are able to maintain or improve downstream passage survival, or whether additional measures may be necessary.

Ratio of Sweeping Velocity to Normal Velocity

To improve downstream passage for eel and Atlantic salmon, GLHA proposes to: (1) open the project's log sluice (at between 3 percent and 9 percent of station's hydraulic capacity, or between approximately 225 cfs and 690 cfs) starting the first passage season following license issuance to facilitate downstream Atlantic salmon smolt out-migration for a 3-week period; (2) install full-depth trash racks with 1-inch clear bar spacing; and (3) implement adaptive management that would include additional operational, structural, and/or habitat enhancement measures, if necessary, to improve passage and/or address performance criteria for downstream migrating Atlantic salmon (measure in SPP for Atlantic salmon). In addition to the measures proposed by GLHA, Penobscot Indian Nation recommends that the trash racks at the project meet the FWS (2017a) design criteria for downstream passage, which includes maintaining a normal velocity not greater than 2 fps, and maintaining a ratio of sweeping velocity to normal velocity equal to or greater than 1.²¹⁹

GLHA's existing and proposed trash rack designs would result in a normal velocity of 1.6 fps, which meets the FWS (2017a) criteria (Sojkowski, 2017). However, under existing and proposed conditions, the sweeping velocity is 0.4 fps, which results in a ratio of sweeping velocity to normal velocity of 0.25 (i.e., 0.4:1.6), which is less than 1 (Sojkowski, 2017). To achieve a ratio of sweeping velocity to normal velocity equal to or greater than 1, Sojkowski (2017) indicates that GLHA would have to increase the angle of the trash racks relative to the face of the powerhouse or increase the incline of the trash racks relative to streambed. Increasing the angle or incline of the trash racks would also require extending the walls between 24 to 41 feet along the intake bays of all four turbine units (Sojkowski, 2017). Trash racks designed with a ratio of sweeping velocity to normal velocity equal to or greater than 1 are supposed to improve

²¹⁹ Penobscot Indian Nation did not disagree with GLHA's proposed operational changes for improving downstream passage for eel and Atlantic salmon (i.e., opening the project's log sluice [at between 3 percent and 9 percent of station's hydraulic capacity, or between approximately 225 cfs and 690 cfs] starting the first passage season following license issuance to facilitate downstream Atlantic salmon smolt out-migration for a 3-week period; implementing annual night-time turbine shutdowns and open the roller gate for downstream passage of eel; and installing full depth trash racks having 1-inch clear bar spacing), thus we assume Penobscot Indian Nation is recommending that the design changes be implemented in addition to the proposed operational changes.

downstream passage by reducing entrainment and improving guidance toward a bypass (Sojkowski, 2017). However, installing trash racks with a ratio of sweeping velocity to normal velocity equal to or greater than 1 is not guaranteed to improve passage, because they are general design criteria that have not been tested or modeled at the project. Further, modifying the trash racks to meet these design criteria would require structural changes to the project.

As discussed in sections above, GLHA could provide safe and effective downstream passage of smolts and kelts by using the existing trash racks (which include 1-inch bar spacing covering the top 16 feet of the water column) and bypass system, and opening the log sluice for 3 weeks during the smolt migration season. Penobscot Indian Nation, is instead recommending that GLHA replace the existing trash racks with trash racks that meet FWS design criteria for Atlantic salmon (i.e., full-depth trash racks with 1-inch clear bar spacing and a ratio of sweeping velocity to normal velocity equal to or greater than 1). Like the existing trash racks, Penobscot Indian Nation's recommendation to meet the FWS design criteria for Atlantic salmon has the potential to also provide safe and effective passage for smolts and kelts. Nevertheless, the added benefit of replacing the existing trash racks with trash racks that meet FWS design criteria has not been demonstrated. Further, GLHA is proposing to conduct downstream passage effectiveness studies for smolts and kelts, and to implement an adaptive management strategy (as discussed above) if after implementing its proposed measures, downstream passage survival of smolts does not meet a 96 percent survival performance standard. If the downstream effectiveness studies for smolts and kelts indicate that the project is unable to meet the performance standard of 96 percent survival, at that time it may be appropriate to explore structural changes such as those recommended by Penobscot Indian Nation. However, for the protection of smolts and kelts, there is no identifiable benefit to installing trash racks that have 1-inch bar spacing to the full depth of the turbine intakes and have a ratio of sweeping velocity to normal velocity equal to or greater than 1.

Attraction Flows

Successfully passing fish downstream of hydroelectric projects is dependent upon attracting the fish to the appropriate bypasses or sluiceways (Castro-Santos and Haro, 2010). Salmon smolts are surface oriented swimmers (Giorgi and Stephenson, 1995) and generally follow higher flow patterns as they approach dams (Coutant and Whitney, 2000). Thus, surface oriented bypasses and log sluices, such as those at the Mattaceunk Project, can effectively draw smolts to these routes if there is sufficient attraction.

GLHA proposes to continue operating the downstream bypass at its maximum flow capability of 140 cfs (2 percent of station hydraulic capacity) to safely pass smolts downstream. However, as described above (*Downstream Passage Survival Under Existing Bypass Operation*), the downstream bypass may not be effective based on low

bypass collection efficiencies (i.e., between 17 and 59 percent). As a result, smolt survival downstream of the project may not be able to meet the proposed performance standard of 96 percent survival without additional enhancements for downstream passage. Because GLHA operates the bypass at its maximum flow capability, it is unable to enhance downstream passage through the bypass by increasing attraction flows. However, GLHA proposes to operate the log sluice, as described above, to provide between 225 cfs and 690 cfs of safe passage flows downstream of the project. The log sluice flows by themselves would provide between 3 percent and 9 percent of the station's hydraulic capacity, which is near or greater than the 5 percent design criteria recommended for each fishway by FWS (2017a). Further, when the two fishways (i.e., log sluice and bypass) are combined, there would be between 5 percent and 11 percent of safe passage flows provided for smolts. Thus, operating the log sluice would increase the volume of safe passage flows during the peak smolt migration. These enhancements, should reduce entrainment and increase downstream passage survival for smolts, but if studies (discussed below) indicate they do not allow downstream passage to meet the performance standard, additional enhancements and studies could be conducted, as discussed below, until the performance standard is met.

Penobscot Indian Nation and Bruce Haines recommends that GLHA redesign the existing bypass to meet the 5 percent design criteria recommended by FWS (2017a). FWS (2017a) indicates that the attraction flows per fishway should be equal to 5 percent of the total station hydraulic capacity, or a flow of 50 cfs, whichever is greater. Based on these general design criteria, which are not specific to the Mattaceunk Project, attraction flows to the bypass would need to be 372 cfs to be effective.²²⁰ However, the 5 percent design criteria is a general engineering recommendation for downstream passage, in general, and is not specific to the Mattaceunk Project. As discussed above, the maximum flow capability of the existing bypass is 2 percent of the station's hydraulic capacity, and thus the 5 percent criteria has never been tested and is not known to be effective at the Mattaceunk Project. Like all other potential passage enhancement options, meeting the 5 percent design criteria would not guarantee improved passage downstream. In addition, redesigning the existing bypass would require structural changes to the project.

²²⁰ The Sojkowski (2017) memorandum included the 5 percent design criteria in a list of three recommended downstream passage alternatives for GLHA and FWS to consider for the Mattaceunk Project. The Sojkowski (2017) memorandum was included in the Interior's administrative record that was filed on May 23, 2017 with its fishway prescriptions. However, Interior did not include the 5 percent criteria as a recommendation or fishway prescription in its May 23, 2017 or June 27, 2018 filings. NMFS also did not include the 5 percent criteria as a recommendation or fishway prescription in its May 23, 2017 or June 28, 2018 filings.

GLHA's proposed opening of the log sluice, installation of full-depth trash racks with 1-inch clear bar spacing, and continued operation of the bypass, would occur in the first passage season following license issuance. Like Bruce Haines recommended design changes, there is no certainty that the GLHA's proposed log sluice operations and trash-rack installation would provide the necessary enhancements to existing operation to increase smolt survival past the project. However, the effectiveness of the proposed log sluice operations and trash-rack installation could be studied in the second passage season, which would allow a determination of whether additional enhancements are needed. As discussed below, GLHA proposes to study the effectiveness of downstream passage and improve passage as necessary using an adaptive management strategy, if survival past the project does not meet the performance standard. An adaptive management strategy may eventually lead to design changes similar to those recommended by Bruce Haines; however, GLHA should explore operational changes (e.g., operation of the log sluice), which can occur quickly, before exploring structural changes, which are more timing consuming, could be more costly, and cannot be easily reversed if they are not successful.

Real-time Monitoring of the Downstream Fishway

The existing downstream bypass is capable of minimizing entrainment and safely passing smolts and kelts downstream, and the proposed continued operation of the bypass would offer the same benefits if the bypass is maintained and fully functional during the migration season. However, as indicated by FWS,²²¹ the downstream bypass pipe is a closed system and therefore is difficult to clean or know when clogging occurs. GLHA does conduct daily visual inspections of the outflow from the bypass pipe, which should help determine whether blockage is preventing 140 cfs from flowing through and out of the bypass pipe. However, a blockage incident in 2015 indicates that visual inspection is not adequate for detecting debris blockages, which could cause decreased bypass outflow.

To ensure safe and effective operation of the bypass, NMFS recommends that GLHA conduct real-time monitoring of the downstream bypass using pressure transducers to identify debris blockages. The use of real-time flow monitoring using pressure transducers would allow GLHA to quickly identify decreases in flow through the bypass, as well as the need for additional inspection and possible debris removal.

²²¹ See the internal FWS memorandum with the subject title, "Downstream Passage Design Alternatives for the Mattaceunk Hydroelectric Project (FERC No. 2520)" Bryan Sojkowski (Regional Fish Passage Engineer, FWS), which was included in the Interior's administrative record filed on May 23, 2017 with its fishway prescriptions.

The daily visual inspections of the bypass outflow pipe that occur at the project in accordance with the FPOMP were not sufficient to identify the debris blockage that occurred in 2015. One possible reason is that the FPOMP does not provide details on how outflows from the bypass would be verified, when during each day data would be collected, or how data on outflows would be collected and made available to the Commission and resource agencies. To prevent future debris blockages and ensure the effectiveness of the bypass in passing smolts and kelts safely downstream, GLHA could modify the FPOMP, in consultation with the resource agencies, to at a minimum, establish a detailed approach, that is approved by the Commission, to monitor outflows from the bypass. If well designed, monitoring methods that are less intensive than the real-time monitoring recommended by NMFS, may suffice to ensure optimal bypass function. During modification of the plan, and through consultation, it may be determined that real-time monitoring using pressure transducers is necessary. In either case, it is important that the final FPOMP include a viable strategy to ensure proper function of the downstream bypass. That strategy would also include procedures to shutdown and clean the bypass when a blockage is identified to prevent mortality during passage through the bypass.

Downstream Smolt Passage Performance Standard and Effectiveness Testing with Adaptive Management

As discussed above, existing project facilities and operations during the downstream migration have the potential to safely pass smolts, but the overall effectiveness of the existing bypass as a passage route for smolts can be very low (i.e., 9.4 percent) and the survival rates past the dam can be less than 96 percent (i.e., the performance standard currently required at other projects on the Penobscot River). Because of the low effectiveness of the bypass in passing smolts, and to improve downstream passage of smolts and kelts, GLHA is proposing to open the log sluice for 3 weeks during the migration season and install full-depth trash racks with 1-inch clear bar spacing. To determine whether these additional downstream passage measures allow smolts to pass downstream of the project with at least 96 percent survival, GLHA proposes to conduct a minimum of 3 years of Atlantic salmon smolt downstream passage studies in the SPP to determine if the existing and proposed downstream passage operations and facilities meet a performance standard of 96 percent survival for smolts.²²² The studies would begin during the first spring out-migration season after installing the trash racks with 1-inch bar spacing (trash racks are proposed to be installed within 2

²²² In the SPP, GLHA indicates that it would conduct up to 3 years of downstream passage studies for smolts. However, in a letter filed on July 7, 2017, GLHA states that it would conduct a minimum of 3 years of downstream passage studies for smolts, until a total of 3 years meet the proposed performance standard of 96 percent survival.

years after license issuance). GLHA proposes to follow the existing study plan,²²³ along with any additional modifications deemed appropriate during consultation with the resource agencies and Penobscot Indian Nation. Maine DMR recommends and NMFS prescribes GLHA's proposed effectiveness monitoring.²²⁴

NMFS's fishway prescription does not specify a performance standard of 96 percent survival for smolts. However, NMFS's prescription does state that the fishways must operate in a way that complies with any incidental take statement issued as part of the biological opinion, and NMFS indicates that a performance standard of 96 percent for downstream passage is consistent with other performance standards in the Penobscot River. NMFS also states in its fishway prescription that during the downstream passage studies, smolts must pass the project forebay area²²⁵ within 24 hours to be considered a successful passage attempt that can be applied toward calculation of downstream passage survival.

There is uncertainty as to whether the existing upstream fishway, or the existing downstream bypass with the additional measures would be capable of meeting the proposed performance standard of 96 survival for smolts. Consequently, GLHA proposes, Maine DMR recommends, and NMFS prescribes,²²⁶ the development and

²²³ GLHA's existing study plan (Downstream Salmon Passage – Interim Species Protection Plan) was originally filed on December 11, 2013 as part of GLHA's revised study plan for relicensing the Mattaceunk Project. However, modifications to the study plan were made in 2015 to accommodate a request from NMFS to study smolt mortality in the project impoundment. The methods of the revised plan are included in the 2015 Atlantic Salmon Passage Study Report, filed on March 31, 2016.

²²⁴ In letters filed on May 23, 2017 and May 22, 2017, NMFS prescribed and Maine DMR recommended, respectively, GLHA's original proposal in the final license application to conduct up to 3 years of effectiveness studies for downstream passage of smolts. However, because GLHA's current proposal to conduct a minimum of 3 years of study ensures that more years of study would be completed, we assume that NMFS and Maine DMR would support GLHA's most recent proposal.

²²⁵ NMFS defines the project forebay as the area within 200 meters upstream of the dam.

²²⁶ In addition to requiring GLHA's proposed adaptive management plan, NMFS has an additional section 18 preliminary prescription requiring additional protective measures or alternative actions (e.g., additional fishway entrances, increased attraction flow) that may be necessary based on monitoring, to address performance standard deficiencies for upstream migrating salmon. However, because this preliminary

implementation adaptive management that would include additional operational, structural, and/or habitat enhancement measures determined in consultation with the resource agencies, to improve passage and/or address performance criteria for upstream and downstream migrating Atlantic salmon, if it is needed.²²⁷

GLHA describes its adaptive management approach in the SPP for Atlantic salmon. Specifically, if the downstream bypass, together with the proposed structural and operational enhancements (i.e., full-depth trash racks with 1-inch clear bar spacing, opening the log sluice for 3 weeks), meet smolt performance criteria during 3 years of study, GLHA proposes to evaluate downstream passage for smolts at the project once every 10 years, thereafter to verify continued achievement of the performance standard of 96 percent survival. However, if the project does not achieve the 96 percent performance standard for downstream passage of smolts, GLHA proposes to consult with the resource agencies and Penobscot Indian Nation to determine appropriate modifications, make any modifications that are deemed appropriate, and then reevaluate the downstream fish passage structures until the performance standard is met. If modifications are not feasible, GLHA proposes to initiate phased spill measures. The first phase would involve increasing spill to between 20 percent and 50 percent of river flow from 8 pm to 4 am for 3 weeks during the smolt out-migration period, and evaluate the ability of this measure to meet the performance standard during a minimum of 3 years of study. If the 20 percent to 50 percent spill phase meets the performance standard during 3 years of study, then GLHA would operate the project using that spill measure. If the 20 percent to 50 percent spill phase does not allow the project to meet the performance standard, GLHA would increase spill to between 50 percent and 75 percent of river flow, and evaluate the ability of this measure to meet the performance standard during a minimum of 3 years of study. If the 50 percent to 75 percent spill phase meets the performance standard during 3 years of study, then GLHA would operate the project using that spill measure. If the 50 percent to 75 percent spill phase does not allow the project to meet the performance standard, GLHA would increase spill to 100 percent of river flow, and evaluate the ability of this

prescription includes the types of measures that could be included in an adaptive management plan and because it fully overlaps with GLHA's proposal, we treat these two items as one preliminary prescription for adaptive management.

²²⁷ In the final license application, GLHA specifically proposes to: (1) implement an adaptive management plan to address performance criteria for downstream passage, should the proposed measures be inadequate; and (2) implement additional operational and structural modifications and/or habitat enhancement measures, if necessary, to address outmigrating Atlantic salmon smolts and kelts and upstream migrating Atlantic salmon adults. However, because both proposals are analogous and include an adaptive approach to addressing passage for Atlantic salmon, staff have combined the two proposals into one proposal for adaptive management.

measure to meet the performance standard during 1 year of study. If the final spill measure does not achieve the performance standard, GLHA proposes that the Commission reinstate formal consultation with NMFS.

Our Analysis

Passage Effectiveness Studies

To successfully reach the ocean, Atlantic salmon smolts spawned upstream of the project must survive a variety of natural causes of mortality (e.g., predation, disease, water temperature), as well as passage downstream of powerhouses and dams at the Mattaceunk, West Enfield, and Milford Projects. Once Atlantic salmon leave the riverine environment, and enter the estuarine environment, mortality rates increase, primarily because of high predation risk (Hawkes *et al.*, 2013) and physiological stress in transitioning to a salt water environment (Handeland *et al.*, 1997). If Atlantic salmon survive the freshwater and estuarine environment, they must then survive the marine environment, which has become an increasingly difficult challenge, as indicated by recent precipitous declines in marine survival, possibly caused by changing ocean conditions (ICES, 2011; Miller *et al.*, 2012). Improving smolt passage survival at the project would help reduce the mortality that occurs in freshwater, and thereby increase the proportion of smolts that migrate out to marine environment.

As discussed above, passage effectiveness of the downstream bypass is low, and although smolt survival studies conducted in 2014 and 2015 indicate relatively high passage survival, passage improvements could be made to provide consistently high downstream survival of smolts. GLHA is proposing to continue operating the existing bypass, and improve passage with new measures to operate the log sluice and install full-depth trash racks with 1-inch clear bar spacing. To evaluate the effectiveness of these proposed measures, and the potential need to improve downstream smolt survival at the project, GLHA is proposing to conduct a minimum of 3 years of Atlantic salmon smolt downstream passage studies to determine if the existing and proposed downstream passage operations and facilities meet a performance standard of 96 percent survival for smolts. NMFS's fishway prescription would require the studies to begin in second year after license issuance. This is consistent with GLHA's proposal to begin the studies after installation of the full-depth trash racks with 1-inch clear bar spacing (i.e., within 2 years). Beginning the studies in the second year and after installation of the trash racks would allow the studies to occur when all of GLHA's proposed measures for protecting smolts are present and/or operational (i.e., trash racks, log sluice, and bypass), and would allow procedures for monitoring the bypass to be in place (i.e. See *Real-time Monitoring of the Downstream Fishway* above in this section).

Studies would help to determine whether the project is able provide passage that meets the 96 percent survival standard for smolts, subsequent to the implementation of

the proposed log sluice operations and installation of full-depth trash racks. Passing smolts downstream of the Mattaceunk Project with 96 percent survival would meet the survival standard determined by NMFS to be protective of smolts migrating downstream in the Penobscot River.²²⁸ A minimum of three years of studies would inform whether the project consistently passes smolts at the proposed and recommended 96 percent survival rate, which would help in the recovery of the GOM DPS.

GLHA proposes that the performance standard of 96 percent survival be considered achieved, if in each of 3 years of studies, the lower and upper 75 percent confidence limits include 96 percent survival.²²⁹ A confidence limit is needed to address the inherent uncertainties surrounding estimates of downstream passage survival (e.g., some surviving fish may not be detected by telemetry arrays, some surviving radio-tagged fish may lose their tags), and a 75 percent limit, provides a reasonable amount confidence that survival is close to the desired rate of 96 percent.²³⁰

NMFS states in its fishway prescription that during the downstream passage studies, smolts and kelts must pass the project forebay area within 24 hours to be considered a successful passage attempt that can be applied toward calculation of downstream passage survival. To support its conclusion, NMFS suggests that a study conducted by Stich *et al.* (2015a) indicates that downstream passage delay of more than 24 hours at each dam in freshwater habitat of the Penobscot River causes increased mortality in the Penobscot River estuary.²³¹ It is true, that delayed downstream migration can be problematic for smolts. Smolts that are delayed can experience predation, elevated energetic costs, and decreased migration speed (McCormick *et al.*, 1998; Antolos *et al.*, 2005; Norrgård *et al.*, 2012). In addition, an increase in time spent migrating can lead to loss of migratory motivation, reversion of physiological adaptations

²²⁸ A performance standard of 96 percent smolt survival is currently a requirement at the Orono, Stillwater, Milford, and West Enfield Projects, and is based on NMFS's terms and conditions for those projects. See 142 FERC ¶ 62,118 (2013)

²²⁹ The 75 percent confidence limit for smolt survival estimates represents a range of survival values, within which there is a 75 percent probability of including the true survival estimate.

²³⁰ The performance standard of 96 percent smolt survival, within the lower and upper 75 percent confidence limits is currently a requirement at the Orono, Stillwater, Milford, and West Enfield Projects, and would be adequate for the Mattaceunk Project.

²³¹ NMFS also cites Stich *et al.* (2015a) when stating in its May 23, 2017 filing, that smolts have more than 20 percent lower probability of survival in the estuary based on a 44 hour delay. However, staff were unable to verify NMFS calculations based on the available information in Stich *et al.* (2015a).

for life in the seawater, lost feeding opportunities, and mistimed arrival in relation environmental conditions in the ocean (McCormick *et al.*, 1999; Muir *et al.*, 2006; Tétard *et al.*, 2016).

Despite evidence supporting the negative effects of delay, in general, the specific duration of delay (e.g., 24-hours) that can lead to negative consequences for smolts is not well understood. Specifically, there is no evidence to indicate that smolts that do not pass a dam within 24-hours will experience excessive mortality. In fact, Stich *et al.* (2015a) indicate that smolt survival in the Penobscot River estuary was unrelated to movement rate (i.e., a means to measure potential delay) of smolts in the Penobscot River. This specific observation suggests that if there is delay that is caused by dams in the Penobscot River, it does not affect survival of smolts in the estuary. Consequently, neither the Stich *et al.* (2015a) study, nor any other source provides evidence that passage delay affects survival in the Penobscot River estuary. Further, the Stich *et al.* (2015a) study provides no specific justification that would support NMFS's requirement for a 24-hour passage criteria.

In addition to the lack of support for a 24-hour passage criteria, in general, there also is little information to suggest that downstream passage delay is problematic at the project. In 2014, two of the 69 smolts (2.9 percent) took slightly longer than 24 hours (27.3 and 29.0 hours) to pass the project after being detected in the forebay. In 2015, 12 of 137 (8.8 percent) smolts detected in the forebay took longer than 24 hours to pass the project. Further, all of the smolts that did not pass the dam within 24 hours were detected at downstream arrays (located 3 to 4 miles downstream of the dam) and determined to have survived passage past the dam. Thus, under existing conditions, there is little indication that downstream passage delay is excessive at the project, and given the proposed improvements for downstream passage, there is no reason to believe that passage delay would be problematic under a new license.

Adaptive Management

An adaptive management approach for managing downstream passage survival of Atlantic salmon, as discussed in the sections above, could help address uncertainty as to whether or not the existing downstream bypass with additional measures would allow the project to meet the proposed performance standards. If the downstream bypass, together with the proposed structural and operational enhancements (i.e., full-depth trash racks with 1-inch clear bar spacing, opening the log sluice for 3 weeks), meet smolt performance criteria during 3 years of study, GLHA proposes that it would evaluate downstream passage for smolts at the project once every 10 years thereafter to verify continued achievement of the performance standard of 96 percent survival.

The ability to meet the 96 percent performance standard during each of 3 years of study would indicate that the downstream passage structures are effective at passing

smolts downstream, and if the downstream passage structures are maintained (discussed in section 3.3.2.2, *Fish Passage Design, Maintenance, and Monitoring*) they would likely meet the 96 percent standard indefinitely. Further, if the 96 percent performance standard is met during each of 3 years of study, there would be no justification for reevaluating downstream passage survival for smolts every 10 years, as proposed by GLHA, because there are no proposed or anticipated changes that would cause smolt survival to change every 10 years. If passage effectiveness for smolts does not achieve the 96 percent performance standard, GLHA could consult with the resource agencies and Penobscot Indian Nation on the need for additional operational or structural modifications, followed by additional study, and implement additional measures upon Commission approval until a 96-percent performance standard is met.

If the existing bypass with additional proposed measures does not allow GLHA to meet the proposed performance standard for downstream survival of migrating smolts, GLHA could then implement additional measures to improve downstream passage of smolts and help meet the performance standard of 96 percent survival. GLHA proposes that if the existing bypass with additional proposed measures do not allow smolts to pass downstream with 96 percent survival, it would consult with the resource agencies and Penobscot Indian Nation to determine appropriate structural or operational modifications, make any modifications that are deemed appropriate, and reevaluate the downstream passage structures until the performance standard is met. Implementing structural or operational modifications may be necessary to meet the performance standard and allow smolts to pass downstream with 96 percent survival. However, at this time, there are no specific structural or operational modifications to analyze. Thus, there are currently no known benefits to implementing unspecified structural or operational measures. Nevertheless, if specific structural and/or operational modifications are determined to be necessary at some future date, implementation could occur, but only after Commission approval.

GLHA proposes that if operational or structural modifications are not feasible, it would move to the phased spill approach outlined above. Spill can be a benign means of passing smolts downstream of hydroelectric projects, and has been used to mitigate the negative effects of hydroelectric dams on downstream migrating fish (Noonan *et al.*, 2012; Adams *et al.*, 2014). A positive relationship between spill and smolt survival has been observed (Čada *et al.*, 1997; Stich *et al.*, 2014). As discussed in section 3.3.4.1, *Affected Environment, Atlantic Salmon*, studies conducted at the project in 2014 and 2015 indicate that smolts do use spill, although survival by spill was lower than it was through the bypass. GLHA's proposed phased spill measures would increase spill incrementally, as needed, beginning with spill that is equal to a minimum of 20 percent of river flow and increase it to 100 percent of river flow from 8 pm to 4 am for 3 weeks during the smolt out-migration period. Based on the information above, the phased spill approach could improve downstream passage of smolts and allow the project to provide 96 percent survival for smolts. However, like operation of the log sluice, determining the 3 week

period of spill in consultation with the resource agencies would help maximize the likelihood of matching spill with the smolt out-migration. Approval from the Commission would also be needed.

GLHA's proposal does not clearly define when the phased spill measures would be implemented. The implementation of phased spill measures could begin at a time determined in consultation with the resource agencies and Penobscot Indian Nation, with approval from the Commission. However, implementation of the phased spill approach would need to occur after at least 1 year of study shows that implementing the proposed log sluice operations, with the new full-depth trash racks, does not meet the 96 percent survival performance standard for smolts. In addition, to prevent a continuous loop of study followed by structural and/or operational modification(s), implementation of the phased spill measures would need to begin after a maximum of 3 years of downstream passage studies and modifications that show non-achievement of meeting the 96 percent performance standard.

Kelt Passage Performance Standard and Effectiveness Testing

GLHA is proposing to open the log sluice for 3 weeks during the migration season and install full-depth trash racks with 1-inch clear bar spacing to provide additional passage and passage protection for kelts. To confirm that these additional downstream passage measures allow kelts to pass downstream of the project with at least 96 percent survival, GLHA proposes to conduct up to 3 years of Atlantic salmon kelt downstream passage studies in the SPP, using the same returning, imprinted adult salmon that would be used during the upstream passage study (discussed above in this section, *Upstream Passage Performance Standard and Effectiveness Testing*). Maine DMR recommends adopting GLHA's proposal. GLHA also proposes to develop and implement adaptive management to address performance criteria for downstream passage, but does not provide any specific provisions to implement for passage of kelts.

NMFS's fishway prescription would require, and Maine DMR recommends, adopting GLHA's proposal to study passage effectiveness for kelts. However, neither the fishway prescription nor Maine DMR's recommendation include a performance standard of 96 percent survival for kelts. Nevertheless, NMFS's prescription does state that the fishways must operate in a way that complies with any incidental take statement issued as part of the biological opinion, and NMFS indicates that a performance standard of 96 percent for downstream passage is consistent with other performance standards in the Penobscot River. NMFS also states in its prescription that during the downstream passage studies, a kelt must pass the project within 24 hours of entering the forebay area to be considered a successful passage attempt that can be applied toward calculation of downstream passage survival. NMFS defines the project forebay as the area within 200 meters upstream of the dam.

Our Analysis

Although few adult Atlantic salmon will return to the ocean after spawning, their successful downstream migration and return upstream can provide additional reproductive contributions to the population. As discussed above, studies conducted in the early 1990s indicated that the survival of kelts migrating downstream of the project can be quite high (96.3 percent) and the collection efficiency of the existing bypass is good (82 percent) when flows exceed the hydraulic capacity and the project is spilling.²³² Thus, under existing conditions when the project is spilling, the bypass is effective at attracting kelts. Under these conditions survival past the dam meets the 96 percent survival performance standard determined by NMFS to be protective of kelts migrating downstream past other hydropower project in the Penobscot River Basin. However, GLHA is proposing additional measures to operate the log sluice for 3 weeks during the spring and to install full-depth trash racks with 1-inch clear bar spacing.²³³ Thus, there would be a benefit to conducting more studies to determine whether the project is still able to pass kelts downstream with 96 percent survival after implementation of additional measures.

To evaluate the effectiveness of the downstream passage structures for kelts, GLHA proposes, Maine DMR recommends, and NMFS's fishway prescription would require, up to 3 years of kelt downstream passage studies using returning, imprinted adult salmon (discussed above in this section, *Upstream Passage Performance Standard and Effectiveness Testing*), to determine if the proposed operations and facilities are able to pass kelts with 96 percent survival. As discussed above, the use of imprinted adult Atlantic salmon is needed for the upstream passage studies. However, these same fish

²³² The project is spilling (i.e., exceeds the hydraulic capacity of the project) about 60 percent of the time during the downstream spring migration season for kelts.

²³³ As discussed in this section, the proposed trash racks would provide no benefit to the downstream passage of Atlantic salmon, but as discussed in section 3.3.2.2, *Downstream Eel Passage*, the full depth trash racks would help to prevent entrainment of large eel that migrate downstream. GLHA's proposed opening of the log sluice for 3 weeks during the spring has the potential to benefit downstream migrating smolts and kelts; however, the intended purpose of opening the log sluice is to enhance downstream passage for smolts.

can be, and are, proposed to be used to study the effectiveness of the downstream passage structures, if they return downstream after spawning upstream of the project.²³⁴

The proposed performance standard of 96 percent survival of kelts would represent a high rate of survival past the project dam, and would be consistent with other projects in the basin.²³⁵ In addition, for the same reasons discussed above for smolts, considering the performance standard of 96 percent survival for kelts achieved, if the lower and upper 75 percent confidence limits include 96 survival, would provide a reasonable amount of confidence that survival is close to the desired level of 96 percent. Further, like smolts, there is no evidence to support NMFS's prescription that would require kelts to pass the project forebay area and move downstream within 24 hours to be considered a successful passage attempt during the effectiveness study.

Although GLHA proposes to conduct up to 3 years of study to evaluate whether the downstream passage structures are able to meet the 96 percent performance standard for kelts, GLHA does not propose, nor does anyone recommend, specific provisions that would be implemented if, after one year of study, the downstream passage structures do or do not meet the 96 percent performance standard. Nevertheless, because the studies for downstream kelt passage effectiveness would require the use of the same study fish (i.e., the stocked smolts) used in the upstream passage effectiveness studies, similar provisions for additional study and adaptive management should apply after one year of study. Specifically, one year of study may be adequate if the study shows that the downstream passage structures are able to meet the 96 percent performance standard. However, because GLHA is proposing to stock uniquely tagged smolts during the first 3 years after license issuance for the purposes of the adult passage studies, GLHA could conduct an additional 1 or 2 years of upstream passage effectiveness studies to provide additional verification of effectiveness. The need for an additional 1 or 2 years of study would need to be determined in consultation with the resource agencies, and approved by the Commission. After it is determined that the upstream fishway meets the 96 percent effectiveness standard, there would be no benefit to reevaluating the effectiveness of the downstream fishway effectiveness for kelts every 10 years, as proposed, because there

²³⁴ As discussed in section 3.3.3.1, *Affected Environment, Atlantic Salmon*, few returning Atlantic salmon are repeat spawners (most die after spawning). Thus, only a small percentage of adults are expected to migrate back downstream and out to sea.

²³⁵ A performance standard of 96 percent survival for kelts also is currently a requirement at the Milford and West Enfield Projects, which are located downstream of the Mattaceunk Project and represent the second and third dams that kelts would have to pass to reach the ocean after spawning upstream of the Mattaceunk Project. See 146 FERC ¶ 62,224 (2014).

are no proposed or anticipated changes that would cause kelt survival to change every 10 years.

Evaluating the effectiveness of the downstream fishway may show that the downstream passage structures do not meet the 96 percent performance standard for kelts. Under this scenario, GLHA could consult with the resource agencies and Penobscot Indian Nation to identify the need for, and type of additional measures that might be necessary. Currently, there is no known benefit to implementing structural or operational modifications, because no specific modifications have been proposed or recommended. However, if in the future, specific structural or operational measures are determined to be necessary, and benefits to the measures are apparent, then modifications could be implemented, but only after Commission approval.

As discussed previously, NMFS's prescription requires that the effectiveness studies begin at the start of the second migratory season after fishways are operational. However, as discussed above, upstream migrating adult Atlantic salmon would not be available for study until at least the third year after any new license is issued. Thus, NMFS's requirement would not be feasible for the downstream passage effectiveness studies for kelts.

Smolt Mortality in the Impoundment

To evaluate smolt mortality in the project impoundment, GLHA proposes to use the existing study plan,²³⁶ with additional modifications for conducting a more rigorous evaluation of the sources of impoundment mortalities, along with any additional modifications deemed appropriate during agency consultation. Further, GLHA proposes to develop an adaptive management plan, if necessary, to address impoundment mortality.²³⁷

Maine DMR recommends that GLHA conduct up to 3 years of studies to assess the sources of impoundment mortality. NMFS does not recommend a study, but does

²³⁶ GLHA's existing study plan (Downstream Salmon Passage – Interim Species Protection Plan) was originally filed on December 11, 2013 as part of GLHA's revised study plan for relicensing the Mattaceunk Project. However, modifications to the study plan were made in 2015 to accommodate a request from NMFS to study smolt mortality in the project impoundment. The methods of the revised plan are included in the 2015 Atlantic Salmon Passage Study Report, filed on March 31, 2016.

²³⁷ GLHA does not include this proposal in the SPP. However, in a letter filed on July 7, 2017, GLHA states that it is committed to developing an adaptive management plan if necessary, based on the results of the study of smolt mortality in the impoundment.

recommend that GLHA develop a mitigation plan, in consultation with NMFS and resource agencies, for the loss of Atlantic salmon smolts as a result of maintaining the project impoundment. The mitigation plan would: (1) be developed after completion of the downstream smolt survival studies; (2) include an implementation schedule; (3) include measures to be implemented over the duration of the license to reduce the number of smolts that die in the impoundment (potential measures could include predator control, flow manipulations to move smolts through the area faster, etc.); and/or increase the number of smolts in the project area such that a “no net loss” standard is achieved; and (4) be provided in draft form to resource agencies within 6 months of the completion of the smolt survival studies, and in final form ready for implementation within one year of the smolt survival studies.

Our Analysis

As discussed in section 3.3.4.1, *Affected Environment, Atlantic Salmon*, GLHA and Stich *et al.* (2015b) investigated smolt mortality in the project impoundment on separate occasions. The GLHA study demonstrated that the mortality rate in the impoundment (1.8 percent per mile) was lower than in a free-flowing section of river downstream of the project dam (3.8 percent per mile). The Stich *et al.* (2015b) study demonstrated that for hatchery smolts, the mortality rate in the impoundment (average mortality of 2.7 percent per mile) was higher than in free-flowing sections of the Penobscot River (average mortality of 0.8 percent per mile), but for wild smolts the mortality rates were similar between the impoundment (average mortality of 1.6 percent per mile) and free-flowing sections of the river (average mortality of 1.7 percent per mile). The impoundment mortality results from the GLHA and Stich *et al.* (2015b) studies are not consistently higher or lower than in free-flowing sections.

In a letter filed on May 27, 2018, NMFS suggests that the data from Stich *et al.* (2015b) provide the best published data for Atlantic salmon smolt survival in the Penobscot River.²³⁸ In addition, however, the studies conducted by GLHA, though unpublished in peer-reviewed literature, were designed using a methodology approved by NMFS and provide additional information regarding smolt mortality in the project impoundment. Even if we ignore the results of GLHA’s studies, the results of Stich *et al.* (2015b) alone still do not show that mortality in the project impoundment is higher than

²³⁸ In the May 27, 2018 letter, NMFS specifically refers to Table 1 of their letter in which they provide survival rates in the Mattaceunk impoundment and free-flowing reaches (or open river as defined in their Table 1). NMFS indicates that the survival rates are from Stich *et al.* (2014) and Stich *et al.* (2015b). However, the survival estimates in Table 1 of their letter are only published in table S2 of the supplementary material provided with the Stich *et al.* (2015b) article (<http://nrcresearchpress.com/doi/suppl/10.1139/cjfas-2014-0573>).

in free-flowing reaches. As discussed above, smolt mortality was higher in the project impoundment compared to free-flowing reaches for hatchery smolts, but there was no difference in mortality for wild smolts. Thus, the evidence is contrary to NMFS's argument or inconclusive.

The results from Stich *et al.* (2015b) also indicate that mortality through the project impoundment was higher for hatchery smolts (2.7 percent per mile) compared to wild smolts (1.6 percent per mile). This result is consistent with the literature on the differences in performance and survival of hatchery and wild juvenile salmonids. For example, there is evidence that wild Atlantic salmon have enhanced swimming physiology (Anttilla and Manttari, 2009), and exhibit greater swimming performance compared to hatchery fish (Pedersen *et al.*, 2008). Hatchery produced Atlantic salmon juveniles are also known to exhibit reduced predator avoidance behavior compared to wild counterparts (Johnsson *et al.*, 2001; Jackson and Brown, 2011), and there is evidence from other salmonids that predation may be higher on hatchery smolts compared to wild smolts during out-migration (Fresh *et al.*, 2003). Further, wild Atlantic salmon smolts, as well as the smolts of other salmonid species are known to exhibit higher survival during the out-migration compared to hatchery smolts (Jokikokko *et al.*, 2006; Serrano *et al.*, 2009; Melnychuk *et al.*, 2014). These results demonstrate that hatchery smolts exhibit inferior performance compared to wild smolts that are naturally produced in a river. This can result in hatchery smolts exhibiting higher mortality compared to wild smolts during the out-migration, which is consistent with the data from Stich *et al.* (2015b) in the project impoundment (see table 18). Wild GOM DPS smolts produced in the reaches upstream of the project, and not hatchery smolts, are the smolts that pass through the project impoundment annually. Thus, mortality rates for hatchery smolts (including those estimated by Stich *et al.* (2015b)), which tend to be higher, may be unreflective of mortality that occurs in the project impoundment. For these reasons, the Stich *et al.* (2015b) mortality rates for wild smolts are likely more representative of the actual survival through the project impoundment and free-flowing reaches.

As indicated above, the GLHA and Stich *et al.* (2015b) studies provide no information to indicate that mortality in the project impoundment is excessive (i.e., consistently greater than in free-flowing reaches). Further, there are no specific survival performance standards, or otherwise acceptable levels of impoundment mortality that would suggest that mortality in the impoundment is excessive. For these reasons, there is no demonstrated need for measures to mitigate impoundment mortality.

Mortality in the impoundment is caused by a number of factors other than project operations and maintenance, and these other factors would limit the benefits of implementing any measures to lessen impoundment mortality. For example, a number of freshwater fish (e.g., brook trout, American eel, chain pickerel, smallmouth bass) or bird predators (e.g., common mergansers, red-breasted mergansers, osprey) are found in the upper Penobscot River (Dube *et al.*, 2012; Fay *et al.*, 2006) and prey on smolts.

Smallmouth bass, in particular: (1) are very effective predators on both Pacific and Atlantic salmon smolts (Van den Ende, 1993, Fayram *et al.*, 2000); (2) are present in the project impoundment; and (3) could have a negative effect on smolt survival in the impoundment. Further, the presence of predators, like smallmouth bass, is actively supported in the Penobscot River through management.

Based on the information discussed above, there is no indication that smolt mortality in the impoundment is any higher than in the non-impounded reaches such that mitigation measures are needed. Furthermore, because there is already sufficient information to describe and analyze impoundment mortality, there is no need for conducting a post-licensing impoundment mortality study.

Consistency with Atlantic Salmon Recovery Plan

GLHA's proposed, and the agencies' recommended or required, environmental measures would be consistent with the 2016 Draft Recovery Plan for the Gulf of Maine Distinct Population Segment of Atlantic Salmon (NMFS and FWS, 2016a). This is because the proposal and recommendations include: (1) measures to maintain accessible upstream and downstream passage to suitable habitat; (2) measures to maintain water quality conditions that support a recovered population, including water quality that supports Atlantic salmon spawning, incubation, rearing, and migration; (3) measures to provide adequate instream flow conditions to support Atlantic salmon spawning, incubation, rearing, and migration; and (4) measures to 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 GLHA's proposed SPP with additional modifications, 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 does occur in the project area, and the PCEs of critical habitat include sites free from physical and biological barriers that delay or prevent upstream (PCE 8) and downstream migration (PCE 11) of Atlantic salmon. However, with GLHA's proposed SPP, along with additional modifications, including proposed improvements to upstream and downstream passage to meet specific 95 percent upstream passage effectiveness and 96 percent downstream survival, 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.

Cumulative Effects

The cumulative effects of relicensing the Mattaceunk Project have been previously discussed in section 3.3.2.2, *Cumulative Effects*, with respect to fishery resources. The

cumulative effects discussed in that section also apply to Atlantic salmon. Here we discuss the specific cumulative effects on passage of Atlantic salmon.

The Mattaceunk Project is the third hydroelectric project on the mainstem of the Penobscot River upstream from where it enters the sea. Upstream passage is currently maintained at all three dams, as discussed in section 3.3.2.1, *Affected Environment, Fish Community*. License requirements at Milford and West Enfield require that each project maintain a 95 percent upstream passage effectiveness for adult Atlantic salmon. Under existing conditions, upstream passage effectiveness ranges between 71 percent and 100 percent at the Mattaceunk Project. Thus, under current license conditions for all three projects, the cumulative passage effectiveness could be as low as 64 percent (assuming 71 percent effectiveness at the Mattaceunk Project) for adults that are motivated to spawn upstream of the Mattaceunk Project. However, GLHA is proposing to maintain the existing upstream fishway and meet an upstream performance standard of 95 percent. Therefore, under a new license, the cumulative upstream passage effectiveness would improve to about 86 percent, or as much as 22 percentage points higher for adults motivated to spawn upstream of the Mattaceunk Project. Thus, there would be an overall positive cumulative effect on upstream migration for Atlantic salmon.

The three hydroelectric projects on the mainstem of the Penobscot River also act to cumulatively effect the GOM DPS of Atlantic salmon by reducing downstream passage survival of smolts and kelts. As discussed in section 3.3.2.1, *Affected Environment, Fish Community*, downstream passage is currently maintained for Atlantic salmon at all three projects. License requirements at Milford and West Enfield require that each project maintain 96 percent downstream passage survival for adult Atlantic salmon smolts and kelts. Under existing conditions, and the best available information, downstream passage survival for smolts ranges between 84 and 96 percent at the project. Thus, under current license conditions for all three projects, the cumulative passage survival could be as low as 77 percent (assuming 84 percent survival at the Mattaceunk Project) for smolts that originate upstream of the Mattaceunk Project. GLHA is proposing to maintain the existing upstream fishway and make any operational or structural modifications that are necessary to be able to maintain a downstream performance standard of 96 percent survival for smolts. Thus, under a new license, the cumulative downstream passage effectiveness for smolts would improve to 88 percent, or as much as 11 percentage points higher, resulting in an overall positive cumulative effect on downstream migration for Atlantic salmon smolts.

Under existing conditions, the Mattaceunk Project maintains about 96 percent passage survival for kelts when the project is spilling. The 96 percent survival rate, which represents the best available information, indicates that under current license conditions for all three projects, cumulative passage survival can be as high as about 88 percent for kelts that originate upstream of the Mattaceunk Project. Under a new

license, the cumulative downstream passage survival of kelts would not necessarily improve with GLHA's proposal to meet a performance standard of 96 percent survival. However, current license conditions do not require that GLHA maintain 96 percent survival for the downstream passage of kelts. Requiring GLHA's proposal would ensure that the cumulative survival of kelts would be maintained at a high level, and thereby improve the chances of recovery for the GOM DPS of Atlantic salmon.

Canada Lynx and Northern Long-Eared Bat

GLHA does not propose any measures for the protection of the Canada lynx, or northern long-eared bat, and no agency made recommendations regarding the Canada lynx or northern long-eared bat.

Our Analysis

Canada lynx from the eastern part of its range (Maine) have distinctly different habitat preferences from the western populations of lynx (everything west of Maine) that favor boreal spruce-fir forest (FWS, 2014). The eastern populations prefer areas of open early successional vegetation where their prey (snowshoe hares) are located. This type of habitat is more common in the western and northern sections of Maine and is not common in the project area. The ROW, while maintained in an early successional state, is a narrow corridor through the forest, and is not the open habitat preferred by snowshoe hares and Canada lynx in the eastern part of their ranges. Since this habitat is sparse in the project area, it is both unlikely the snowshoe hare and lynx would be present, and that the project would have any impact on this species. Based on this information, we conclude that relicensing the Mattaceunk Project with any of the measures considered in this EA would have no effect on the Canada lynx.

Northern long-eared bat hibernacula sites are not known to occur in the project vicinity; however, no bat surveys were conducted. The project vicinity is largely forested, and should supply suitable habitat for summer roosting and foraging activities. While the applicant does not propose any additional ground disturbing or clearing activities as part of relicensing, project maintenance activities during the term of any new license could require periodic removal of hazardous trees²³⁹ near facilities (e.g., power lines) and the trimming and clearing of trees when necessary in the project boundary and ROW. Removal of hazardous trees is not prohibited under the 4(d) rule, but the clearing of non-hazardous trees would be prohibited if they affect northern long-eared bat (FWS, 2016b).

²³⁹ Hazardous trees are trees that are removed for the protection of human life and property (FWS, 2016b).

If the northern long-eared bat is present in the project vicinity, tree clearing activities may affect its habitat or food availability. Since the project is located inside the white-nose syndrome zone, in an area that may contain potential maternal roost trees, and could require the removal of trees, additional protection measures would help avoid prohibited incidental take of northern long-eared bat. According to the 4(d) rule, removing occupied maternity roost trees, or any trees within 150 feet of an occupied roost tree is prohibited during the northern long-eared bat pup season (i.e., June 1 – July 31). In addition, FWS’s recommendation to allow tree removal only during the northern long-eared bats’ inactive period, which is November 1 through March 31, is a discretionary conservation measure to minimize or avoid adverse effects on this species (FWS, 2016b).

Avoiding non-hazardous tree removal during the pup season and the broader active period would protect northern long-eared bats potentially using the project area and would be consistent with FWS’s determination of effects to this species. To avoid prohibited incidental take and disturbance of northern long-eared bats potentially roosting in trees in the project area, GLHA could establish a species protection plan that restricts non-hazardous tree removal (i.e., including cutting down, harvesting, destroying, trimming, or manipulating in any other way the trees, saplings, snags, or any other form of woody vegetation likely to be used by northern long-eared bats) to the period of November 1 through March 31, which would be outside of the pup season and the broader active season. With this plan in place, we conclude that the project would not be likely to adversely affect the northern long-eared bat.

3.3.5 Land Use and Recreation

3.3.5.1 Affected Environment

Land Use

Lands in the project vicinity are largely undeveloped. State Routes 157 and 115 run adjacent to the project on the north and south sides of the impoundment and Interstate 95 crosses the upper impoundment downstream of the confluence of the East and West Branches. Several homes and businesses are located along the roadways near the shoreline of the impoundment.

Generally, the Mattaceunk Project boundary follows the 240 foot elevation contour around the impoundment and islands; portions of islands above the 240 foot elevation are not included in the project boundary, and GLHA does not consider them to be part of the project. GLHA maintains all rights necessary for flowage within the project boundary but does not implement shoreline management policies that direct land use along the impoundment. Zoning along the impoundment is regulated by municipal zoning ordinances as required by the State of Maine. All land within 250 feet of the impoundment is controlled by each municipality’s Shoreline Zoning Ordinance. The

impoundment shoreline is zoned as “resource protection,” which is defined as areas in which development would adversely affect water quality, productive habitat, biotic systems, or scenic or natural values. Non-intensive recreation use is allowed within areas zoned “resource protection.”

The project boundary deviates from the 240 foot elevation to enclose all project facilities, including the dam, powerhouse, switchyard, and transmission line corridor. The project boundary also encloses the Downstream Angler Access Area and a portion of the canoe portage. Under a new license, GLHA proposes to enclose the entirety of the canoe portage within the project boundary. Downstream from the dam, the project boundary extends along the shoreline to meet the upper extent of the downstream Medway Project boundary. Other than the lands specifically needed for project operation and project recreation, GLHA owns little land within the project boundary.

No portions of the East Branch, West Branch or mainstem Penobscot River are designated as wild and scenic; however, portions are listed on the National Park Service’s Nationwide Rivers Inventory (NRI). The NRI, which was created in 1982 and amended in 1993, identifies river segments in the United States that are believed to possess one or more “outstandingly remarkable” natural or cultural values judged to be of more than local or regional significance. The NRI classifies 21 miles of the West Branch upstream from the project²⁴⁰ as outstandingly remarkable for its scenic and fish resources. The NRI also classifies 16 miles of the mainstem Penobscot River downstream from the project²⁴¹ as outstandingly remarkable for its geologic and hydrologic values, specifically for the unique characteristics of the islands in the river. Several tributaries of the Penobscot River are also listed on the NRI, but none are in the immediate project vicinity (NPS, 2009).

Statewide-Recreation Outlook

The Maine State Comprehensive Outdoor Recreation Plan (SCORP), 2014-2019 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 terms of water-based activity, the SCORP identifies strong growth both nationally and regionally for this form of recreation. The SCORP recommends expanding identification, signage, and branding of

²⁴⁰ The classified reach includes the segment of the West Branch from Ripogenus Dam to Ambajejus Lake.

²⁴¹ The classified reach includes the segment of the mainstem Penobscot River from Passadunkeag to Socks Island.

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 Penobscot River Basin contains numerous opportunities for recreation, including fishing, hunting, river and lake boating, camping, hiking, snowmobiling, and picnicking. Baxter State Park, a 200,000-acre recreation area located just north of the project, contains the northern terminus of the Appalachian National Scenic Trail at Mount Katahdin. In 2016, President Obama designated 87,500 acres of land in Penobscot County, Maine as Katahdin Woods and Waters National Monument. The National Monument designation preserves the area's outdoor recreation, wildlife, and scenic resources (NPS, 2016). Other regionally-significant recreation areas in the project vicinity include the Penobscot River Corridor public lands and Allagash Wilderness Waterway. Commercial outfitters provide opportunities for rafting and whitewater kayaking.

Recreation at the Project

As discussed previously, the project impounds both the East and West Branches of the Penobscot River, as well as the mainstem Penobscot River below the confluence. On the impounded portion of the East Branch, the Town of Medway owns and operates a recreation complex. The complex includes sports facilities (baseball, tennis, and basketball) and a playground, as well as a swimming beach, picnic facilities, a boat ramp, and parking. The boat ramp is accessible and provides the only direct access for motorized boats to the project's impoundment.

Downstream from the project's dam, there is a fishery for landlocked salmon, brook trout, and smallmouth bass. More information about the project's fishery resources is located in section 3.3.2.1, *Affected Environment, Fish Community*.

Project Recreation Facilities

GLHA owns and operates two recreation facilities at the project: (1) a canoe portage; and (2) a recreation site downstream with angler access and picnic facilities (figure 20).

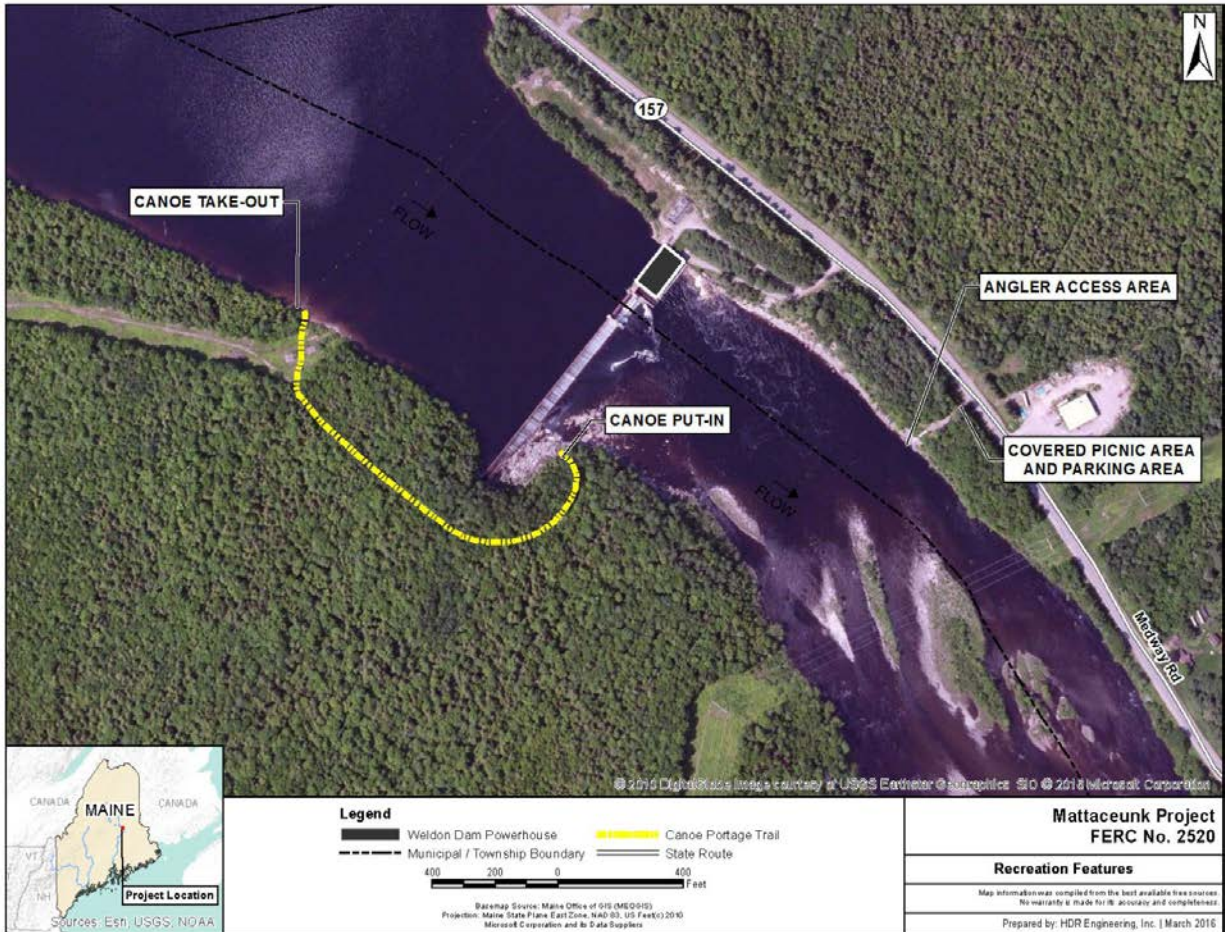


Figure 20. Recreation sites at the Mattaceunk Project.
 (Source: GLHA, 2016a).

The canoe portage take-out is located on the western shore of the impoundment approximately 650 feet upstream from the dam. The portage trail follows a compacted gravel road that is approximately 9 feet wide and used only occasionally by the licensee to access the west side of the dam. The canoe put-in is located on the western shore of the project, downstream from the dam. Signage associated with the portage trail includes signs indicating the put-in and take-out locations, as well as signs to guide trail users and information related to public safety. Signs are periodically inspected and maintained as needed.

On the east bank of the river, GLHA owns and operates a recreation site that provides angler access, a picnic area, and parking for six to eight vehicles. The facility is located adjacent to State Route 157, approximately 1,000 feet downstream from the dam. The angler access consists of a set of wooden stairs that lead from the top of the bank to the river's edge. A picnic table with shelter is located at the top of the bank, adjacent to the compacted gravel parking area. Signage associated with the recreation area includes public safety signs that are routinely inspected and maintained.

Recreational Use

Use of the project's recreation facilities is estimated at 3,696 recreation days²⁴² during the peak recreation season from Memorial Day to Labor Day. This rate of use is very low compared to the capacity of the facilities (use was estimated at 4.5 percent of capacity). Recreational observations recorded during the 2014 recreation season showed no use of the portage trail and very limited use of the angler access/picnic area (three total observations). The primary source of recreation at the project is from the Town of Medway's recreation complex, which received significantly higher rates of vehicular traffic than GLHA's facilities. Although the Town of Medway does not keep records of recreation use at the complex, they estimate approximately 40 users per day at the swim beach on weekends during the peak recreation season. Motorized boats, likely originating from the town's boat ramp, were observed infrequently. No non-motorized boats were observed.

3.3.5.2 Environmental Effects

Special Designation Lands and Waters

Both the Atlantic Salmon Federation and the Penobscot Indian Nation request that the Commission analyze the effects of the project on special-designation lands and waters, specifically the Katahdin Woods and Waters National Monument. However, neither the Atlantic Salmon Federation nor the Penobscot Indian Nation provide specific recommendations for protection, mitigation, or enhancement measures relating to Katahdin Woods and Waters National Monument although both state that restoration of Atlantic salmon to the East Branch of the Penobscot River would benefit the National Monument's mission.

Our Analysis

Katahdin Woods and Waters National Monument, which was designated for the protection of both the "historic and scientific objects" within its boundary, encompasses 87,000 acres, including areas of the East Branch of the Penobscot River just upstream from the project (NPS, 2016). As discussed previously, in section 3.3.2.1, *Affected Environment, Fish Community* and section 3.3.4.1, *Affected Environment, Atlantic Salmon*, the East Branch of the Penobscot River has historically been home to high-quality habitat for diadromous fish species, including spawning and rearing habitat for Atlantic salmon. As the Atlantic Salmon Federation and Penobscot Indian Nation assert, areas within Katahdin Woods and Waters National Monument are ecologically linked with areas downstream, including the Mattaceunk Project. Protection measures for

²⁴² Recreation days are defined as each visit by a person to the project for recreational purposes during any portion of a 24-hour period.

diadromous fish species, as part of any new license issued for the project (discussed in section 3.3.2.2, *Aquatic Resources, Environmental Effects* [i.e., eel and alosines] and section 3.3.4.2, *Threatened and Endangered Species, Environmental Effects* [i.e. Atlantic salmon]), would minimize the effects of the project on habitat, and upstream and downstream migration of such species and would cause no adverse effects on the current natural resource values of Katahdin Woods and Waters National Monument.

Recreation Use and Access

Over the term of a new license, GLHA proposes to continue to operate and maintain the existing project recreation sites.

In response to stakeholder comments about the need for improved amenities at the Downstream Angler Access Area, GLHA also proposes to implement recreation facility improvements within 3 years of license issuance, including installation of: (1) a pulley system to assist boaters with moving car top boats and other small watercraft up and down the existing stairs at the angler access area, located on the east side of the Penobscot River, downstream from the project's powerhouse; and (2) a ramp adjacent to the existing recreation pavilion to provide wheel chair access to the pavilion and its associated picnic table.

Interior provided comments recommending that GLHA develop a portage plan for improvements to the project's existing portage trail in consultation with the Penobscot Indian Nation stating that Mattaceunk (Weldon) Dam currently impedes downstream travel by canoe and that passage around the dam is difficult through the woods.

Our Analysis

The existing project facilities provide an appropriate level of recreation access for this portion of the Penobscot River, which receives relatively low recreation use.

The canoe portage, which GLHA proposes to continue to operate and maintain, provides necessary downstream access for boaters paddling the Penobscot River. Interior provides no support for the statement that there is no easy way to portage a boat around the project. Photos of the existing portage trail provided by GLHA in the final license application indicate that the trail is maintained and signed. During site visits to discuss recreation access at the project, no comments were raised about the condition of the trail.

The Downstream Angler Access Area provides access to a fishery for brook trout, smallmouth bass, and landlocked salmon. The facility is not at or near capacity, according to studies conducted during relicensing. GLHA's proposed recreation improvements would further enhance the existing recreation facilities by improving the usability of the Downstream Angler Access Area. Installing a pulley system to help boaters transport canoes down the steep stairs between the parking area and water would

provide better access to the Penobscot River downstream of the project. Minor enhancements to the Downstream Angler Access Area's picnic facilities would improve access for the disabled on the project's east side, while consultation with Maine DIFW indicated that the Town of Medway's Recreation Complex provided adequate access for persons with disabilities to the project's western and upstream reaches.

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 a project's APE could be affected by 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. The APE for the project includes: (1) lands enclosed by the project boundary; and (2) lands or properties outside the project boundary where 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. By letter dated August 27, 2015 and filed October 13, 2017, the Maine SHPO concurred with the proposed definition of the APE.

Cultural History Overview

The archaeological record in Maine begins over 11,000 years before present (B.P.). This section provides an overview of the cultural context of the region.

Pre-contact Period

The earliest inhabitants of the region and throughout North America were 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 11,500 to 9,500 B.P. when much of the landscape was still vegetated in tundra and/or woodlands. Paleoindian people living in the region are characterized as highly mobile hunters and gatherers reliant mainly on caribou that were abundant in the environment of 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. 9,500 - 3,000 B.P.) represents the longest cultural period in the region, spanning around 6,500 years. 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. Tools were typically produced from local stone, and lack the finely crafted, chipped stone spear points that characterize the Paleoindian period. In addition, a new technology using pecking and grinding techniques appears for the first time in the archaeological record (Robinson, 1992). This new technology produced a suite of groundstone tools that became more elaborate through time. During the Middle Archaic period, chipped stone spear points became increasingly more abundant. Increased ceremonialization is represented in the record by the presence of cemetery sites which reveal mortuary practices that included the sprinkling of graves with red ocher and the offering of grave goods (Willoughby, 1898; Moorehead, 1922; Robinson, 1992; Will and Cole-Will, 1996).

The close of the Late Archaic period is characterized by a transition to the Susquehanna Tradition, which is widespread in Maine and New England (Sanger, 1979; Bourque, 1995). The people of the Susquehanna Tradition appear to have been more focused on a terrestrial economy than a marine economy. They also largely abandoned the use of red ocher in their graves and often cremated their corpses rather than buried them intact. Diagnostic tool forms include large, broad-bladed chipped stone spear points.

The introduction of pottery manufacture 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 both the coast and in the Maine interior (Bourque, 1971; Sanger, 1979). 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.

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, Abenaki of western Maine and the Abenaki of Quebec, although there is no consensus on use of the term Wabanaki and the peoples who identify as Wabanaki (AFSC, 1989).

Throughout the sixteenth century, European fishing vessels frequently made contact with the Wabanaki as they traveled through the Gulf of St. Lawrence; but, it was not until the first years of the seventeenth 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. 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 (AFSC, 1989).

European settlement also changed Wabanaki society in other ways. Extensive trade grew between European settlers and Wabanaki peoples. These trading relationships reduced traditional subsistence practices and increased the Wabanaki’s reliance on European goods. European settlement patterns resulted in significant changes in the landscape as timbering and farming became more prevalent in the region. As the traditional social structure changed, the Wabanaki peoples allied with the French, with whom they had significant trading relationships, to reduce English encroachment into their territory. However, after the French and Indian War, England claimed the lands in Maine and Maritime Provinces. Treaties with both the British government and, subsequently, the state of Massachusetts, further reduced the tribes’ territories within the region (AFSC, 1989).

Surveys of the area in 1820, by Joseph Treat and his Penobscot guide John Neptune, documented Penobscot families camping both on reservation lands, consisting of the “upper four townships” and islands in the Penobscot River. According to Treat’s survey, there were two Penobscot townships and six identified Native American encampment villages located within the Mattaceunk Project’s APE. These villages and encampments were located near rapids and falls in the river, which were important for sustenance fishing. The locations of these settlements now lay below the Mattaceunk impoundment’s surface (letter from K. Francis, Tribal Chief, Penobscot Indian Nation, Indian Island, ME to K. Bose, Secretary, FERC, Washington, D.C. filed May 23, 2017).

Europeans began settling towns near the present-day location of the Mattaceunk Project in the early-to-mid nineteenth century. Medway, then known as “Nicatou” (The Forks - referring to its location at the confluence of the East and West Forks of the Penobscot River) and Mattawamkeag were first settled in the 1820s as rail and stage lines were constructed into the region. These towns, along with Woodville and Molunkus were both strongly affected by the growth and development of the timber industry in Maine. In Medway, which was officially incorporated in 1865, the town boasted a number of water-powered sawmills along the Penobscot River with dense settlement along both sides of the river. Use of the river by sawmills and for power production, continued into the late twentieth century (Wheeler and Marlatt, 2015).

Cultural Resource Investigations

Pre-contact Archaeological Resources

In 2015, GLHA retained TRC Environmental Solutions (TRC) to conduct a Phase IA pre-contact archaeological review and assessment of the project’s APE (Phase IA Pre-Contact Study). The goal of the study was to identify previously reported archaeological sites within the project’s APE and to support development of a sensitivity model to guide subsequent field investigations within the APE. The study indicated that the shoreline of the project’s impoundment was sensitive for pre-contact cultural resources (Will, 2015).

As a result of the findings from the Phase IA Pre-contact study, six archeologically-sensitive areas, as well as seven sites with previously-identified archaeological resources, were examined as part of a Phase IB Pre-Contact Study (Will and Clark, 2016). The investigators used subsurface testing to document the presence of pre-contact archaeological sites. In total, the Phase IB Pre-Contact Study included the excavation of 175 test holes within the project’s APE. No evidence of the seven previously-reported archaeological sites was encountered during the Phase IB Pre-Contact Study; however, one new pre-contact archaeological site was discovered and was further evaluated as part of a Phase II Archaeological Site Evaluation. The Phase II investigation report was filed with the Commission on February 22, 2018. The report describes pre-contact period archaeological Site 122.30 as significant and eligible for listing on the National Register.

Post-Contact Archaeological Resources

In 2015, GLHA retained Independent Archaeological Consulting, LLC (IAC) to conduct a desktop post-contact archaeological review and assessment of the project’s APE (Desktop Post-Contact Study). The Desktop Post-Contact Study included a site file search at the Maine SHPO to learn of any recorded sites proximate to the project, as well as a cartographic analysis to identify the location of areas sensitive for post-contact archaeological resources. Based on the Desktop Post-Contact Study, IAC identified

40 areas in the project’s APE considered sensitive for post-contact archaeological resources (Wheeler and Marlatt, 2015).

In September 2015, IAC conducted a Phase 0 walkover survey of the previously-identified locations within the APE identified as sensitive for Post-Contact archaeological resources. During the walkover, IAC identified three archaeologically sensitive areas requiring further study (Wheeler and Marlatt, 2015). IAC conducted a Phase IB archaeological field reconnaissance survey (Phase IB Post-Contact Survey) of these areas.

In total, IAC identified five post-contact archaeological resources through inspection of the project’s APE by pedestrian and boat surveys, the Phase IB Post-Contact Survey, and additional consultation with Penobscot Indian Nation’s Tribal Historic Preservation Officer (THPO) (Wheeler and Marlatt, 2016). A description of these resources, and IAC’s recommendation for further study are included in table 21, below. Two resources were under water during the investigations. In those instances, IAC recommends additional archaeological investigations should a project drawdown of more than 24 feet occur in the future.

Table 21. Post-contact archaeological investigations within the project’s APE.

Resource	Site Number	Recommendation
W. Wait Homestead	ME 275001	No further archaeological investigations.
Medway Village Sawmill Complex	ME 275002	No further archaeological investigation of earthen dam.
Earthen Dam Mill Foundation		If impoundment is drawn down 24 feet or more, consult with the MHPC and conduct additional Phase IB Archaeological Investigations of Mill Foundation.
G.H. Baker Homestead	ME 275003	No further archaeological investigations.
W. Reed Homestead	ME 275004	No further archaeological investigations.
Medway Unidentified Foundation	ME 275005	If impoundment is drawn down 24 feet or more,

Resource	Site Number	Recommendation
		consult with the MHPC and conduct additional Phase IB Archaeological Investigations.

(Source: Wheeler and Marlatt, 2016; as modified by staff).

Historic Architectural Resources

In 2015, TRC conducted an architectural survey to identify historic architectural resources (above-ground structures) within the project boundary that are listed in or eligible for listing in the National Register. Background research conducted by TRC confirmed that no properties currently listed on the National Register are located within the project boundary. Two resources, the Weldon Dam and powerhouse,²⁴³ were previously surveyed in 2010 and determined to be eligible for the National Register by the Maine SHPO under Criteria A and C²⁴⁴ (Henry, 2015).

The National Register-boundary for the project includes the dam and powerhouse, a small part of the tailrace to the south, as well as that part of the upstream impoundment which conveys the historic purpose and effect of the dam’s construction. The National Register boundary does not include that part of the impoundment not visible from the two NRHP-eligible resources, including Salmon Stream and the confluence of the East and West Branches located some distance away from the eligible structures (Henry, 2015). The project, and its contributing resources, remain operable and in good condition and have been continuously used for hydropower generation since their construction.

²⁴³ The Architectural Survey and Findings of Effects Report (Henry, 2015) refers to the dam as Mattaceunk Dam and powerhouse as the Roy V. Weldon Power Station. For consistency, we refer here to the name of the dam as “Weldon Dam” and use the term “powerhouse” to refer to the Roy V. Weldon Power Station.

²⁴⁴ Resources eligible for listing on the National Register under criterion A are those that are associated with events that have made a significant contribution to the broad patterns of our history. Resources eligible for listing on the National Register under criterion C are those that embody the distinctive characteristics of a type, period, or method of construction, or that represent the work of a master, or that possess high artistic values, or that represent a significant and distinguishable entity whose components may lack individual distinction (NPS, 2002).

Traditional Cultural Properties

By letter dated September 11, 2012, Commission staff initiated consultation with the Aroostook Band of Micmacs, Houlton Band of Maliseet Indians, Passamaquoddy Tribe, and Penobscot Indian Nation regarding the effects of relicensing the Mattaceunk Project on issues of tribal concern.

By letter filed July 17, 2013, the Penobscot Indian Nation provided comments on GLHA's PAD and the Commission's SD1, expressing the tribe's interests in participating in the relicensing proceedings for the project. Throughout pre-filing and post-filing consultation, the Penobscot Indian Nation has asserted its interest in the Penobscot River basin as both the ancestral home of the tribe as well as sustenance fishery for current tribal members. As described previously, lands of historic and current interest to the tribe are located within and adjacent to the project boundary, including submerged islands within the project's impoundment.²⁴⁵

3.3.6.2 Environmental Effects

Historic Properties

Project-related effects on cultural resources within the APE can result from modifications to project facilities or project operations; project-related ground-disturbing activities; construction, modification, or maintenance of project recreation facilities and use of such facilities by visitors; project-induced shoreline erosion;²⁴⁶ and vandalism. GLHA does not propose to modify project operation; however, GLHA and resource agencies have proposed modifications to the project facilities to improve fish passage. GLHA also proposes some minor improvements to the Downstream Angler Access Area, including installation of a pulley system for moving car-top boats from the recreation site's parking area to the river and construction of a ramp to provide wheelchair access to the covered picnic shelter. These activities, and other maintenance activities associated with routine operation of the project, have the potential to adversely affect resources eligible for listing on the National Register, including the National Register-eligible

²⁴⁵ The boundaries of the Penobscot Reservation and the Penobscot Indian Nation's hunting, fishing, and gathering rights in the waters of the Penobscot River are currently the subject of federal court litigation. At this time the BIA has provided no documentation of federal reservation lands within the project boundary.

²⁴⁶ 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.

pre-contact period archaeological Site 122.30 as well as the project's dam and powerhouse.

To avoid, minimize, or mitigate for adverse effects on historic properties that may be affected by relicensing the project, GLHA proposes to develop an HPMP which directs the management of historic properties within the project's APE. The HPMP would be developed in consultation with the Maine SHPO and Penobscot Indian Nation THPO. The HPMP would address the following items: (1) any additional measures necessary to assist in the identification or management of historic properties within the project's APE; (2) Phase IB archaeological investigations of the Medway Village Sawmill Complex when the impoundment is lowered 24 feet or more; (3) potential effects on historic properties resulting from the continued operation and maintenance of the project; (4) management and treatment measures for historic properties; (5) procedures for the review of proposed future ground-disturbing activities or other activities within the project's APE which would have the potential to adversely affect historic properties; (6) protection of historic properties threatened by direct or indirect project-related activities, including routine project maintenance; (7) resolution of unavoidable adverse effects on historic properties; (8) treatment and disposition of any human remains that may be discovered within the project's APE; (9) provisions for unanticipated discoveries of previously unidentified cultural resources within the project's APE; (10) a dispute resolution process; (11) a list of categorical exclusions from further review of effects; (12) project-specific measures and a schedule for implementing the HPMP; (13) roles and responsibilities for the licensee, Maine SHPO, Penobscot Indian Nation THPO, and other individuals and organizations in regards to implementation of the HPMP; and (14) coordination with the Maine SHPO, Penobscot Indian Nation THPO and other consulting parties during implementation of the HPMP.

By letter dated January 3, 2018, and filed by the licensee on February 22, 2018, the Maine SHPO concurred with GLHA's finding that pre-contact archaeological Site 122.30 was significant and eligible for listing on the National Register. The Maine SHPO recommends that GLHA's HPMP include Site 122.30 and consider the effects of ongoing erosion to the integrity of the site. The SHPO recommends that future mitigation for adverse effects could include archaeological data recovery. Development of appropriate treatment and mitigation measures for inclusion in the HPMP would require additional consultation with both the Maine SHPO and the Penobscot Indian Nation.

Our Analysis

An HPMP, with measures for continued use and maintenance of historic properties and treatment of historic properties affected by project-related activities, developed in consultation with the Maine SHPO and Penobscot Indian Nation, GLHA would ensure that continued operation and maintenance of the project would either have no effect on

known historic properties or that any unavoidable effects would be minimized and appropriately mitigated. The HPMP would include measures for protecting Site 122.30 or mitigating adverse effects to the site caused by project operations. The HPMP would also provide guidance specific to the maintenance and upkeep of the dam and powerhouse with respect to the project facilities' historic character. Additionally, the HPMP would also establish consultation protocols for non-routine activities occurring at the project as well as treatment of previously unidentified historic properties discovered at the project over the term a license.

To meet the requirements of section 106, the Commission intends to execute a PA with the Maine SHPO and Penobscot Indian Nation THPO for the proposed project to protect historic properties that would be affected by the continued operation and maintenance of the project. The terms of the PA would require GLHA to address all historic properties identified within the project's APE through the development of an HPMP in consultation with the Maine SHPO and Penobscot Indian Nation THPO.

Gathering of Indigenous Plants

Under any license issued by the Commission, GLHA would be required to maintain public access to project lands and waters. In comments filed in response to the Commission's REA notice, BIA requested that tribal members be provided unrestricted access to lands within the project boundary for collecting indigenous plants.

Our Analysis

As discussed previously, the Penobscot River basin is the ancestral home of the Penobscot Indian Nation and serves an important role in the tribe's culture today. To the extent possible, the Commission requires licensees to provide public access to project lands and waters, which would include access for the gathering of indigenous plants. However, the Commission also has an obligation to protect public safety and requires licensees to enact public safety measures at their projects. Therefore, the Commission cannot ensure unrestricted access to areas of the project that contain the project facilities or other safety hazards. It is important that any access to the project for gathering of indigenous plants not conflict with any public safety plan for the project or otherwise interfere with project operation. Further, the Commission has no jurisdiction to require access across private property to reach remote areas within the project boundary, unless such access is deemed necessary for project purposes.

4.0 DEVELOPMENTAL ANALYSIS

In this section, we look at the project's use of the Penobscot 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.*,²⁴⁷ 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 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 22 summarizes the assumptions and economic information we use in our analysis for the project. This information was provided by GLHA in its license application or estimated by staff. We find that the values provided by GLHA 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.

²⁴⁷ See *Mead Corporation, Publishing Paper Division*, 72 FERC ¶ 61,027 (July 13, 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.

Table 22. Parameters for economic analysis of the Mattaceunk Project.

Parameters	Values (2017 dollars)	Sources
Period of analysis	30 years	Staff
Term of financing	20 years	Staff
Escalation rate	0 percent	Staff
Alternative energy value	\$40.00/MWh	GLHA
Federal tax rate	Included in O&M ^a	GLHA
local tax rate	Included in O&M ^a	GLHA
Interest rate	7 percent	Staff
Discount rate	7 percent ^b	Staff
Net remaining investment	\$26,318,288 ^c	GLHA
Annual operation and maintenance cost	2,572,427 ^d	GLHA

^a All taxes were included in the project's O&M.

^b Assumed by staff to be the same as the interest rate.

^c Based on GLHA's remaining undepreciated net investment and cost to develop the license application for the project.

^d GLHA's value for the project's operation & maintenance cost includes fees, insurance, overhead, depreciation, local, state and Federal taxes.

4.2 COMPARISON OF ALTERNATIVES

Table 23 summarizes the installed capacity, annual generation, cost of alternative power, estimated total project cost, and difference between the cost of alternative power and total project cost for each of the alternatives considered in this EA: no-action, GLHA's proposal, the staff alternative and staff alternative with mandatory conditions.

Table 23. Summary of the annual cost of alternative power and annual project cost for the four alternatives for the Mattaceunk Project.

	No Action	GLHA's Proposal	Staff Alternative	Staff Alternative with Mandatory Conditions
Installed capacity (megawatts)	19.2	19.2	19.2	19.2
Annual generation (MWh)	123,334	116,339	112,759	112,759
Annual cost of alternative power (\$ and \$/MWh)	\$5,874,303 47.63	\$5,541,227 ^a 47.63	\$5,370,711 ^a 47.63	\$5,370,711 ^a 47.63
Annual project cost (\$ and \$/MWh)	\$4,848,180 39.31	\$7,065,267 60.73	\$5,472,194 48.53	\$6,076,583 53.89
Difference between the cost of alternative power and project cost (\$ and \$/MWh)	\$1,026,122 8.32	(\$1,524,041) ^b (13.10)	(\$101,483) ^b (0.90)	(\$705,871) ^b (6.26)

^a The loss of generation is reflected as a higher project cost, rather than a lower power value.

^b 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 19.2 MW, and generate an average of 123,334 MWh of electricity annually. The average annual cost of alternative power would be \$5,874,303, or about \$47.63/MWh. The average annual project cost would be \$4,848,180, or about \$ 39.31/MWh. Overall, the project would produce power at a cost that is \$1,026,122, or \$8.32/MWh, less than the cost of alternative power.

4.2.2 GLHA's Proposal

Table 24 lists all environmental measures, and the estimated cost of each, considered for the Mattaceunk Project. Under GLHA's proposal, the Mattaceunk Project would have an installed capacity of 19.2 MW, and generate an average of 116,339 MWh of electricity annually. The average annual cost of alternative power would be \$5,541,227, or about \$47.63/MWh. The average annual project cost would be \$7,065,267, or about \$60.73/MWh. Overall, the project would produce power at a cost that is \$1,524,041, or \$13.10/MWh, more than the cost of alternative power.

4.2.3 Staff Alternative

The staff alternative is based on GLHA's proposal with staff modifications and additional measures. The staff alternative would have an installed capacity of 19.2 MW and an average annual generation of 112,759 MWh, the cost of alternative power would be \$5,370,711, or about \$47.63/MWh. The average annual project cost would be \$5,472,194, or about 48.53/MWh. Overall, the project would produce power at a cost that is \$101,483, or about \$0.90/MWh, more than the cost of alternative power.

4.2.4 Staff Alternative with Mandatory Conditions

Under the staff alternative with mandatory conditions the Mattaceunk project would have an installed capacity of 19.2 MW and an average annual generation of 112,759 MWh, the cost of alternative power would be \$5,370,711, or about \$47.63/MWh. The average annual project cost would be \$6,076,583, or about \$53.89/MWh. Overall, the project would produce power at a cost that is \$705,871, or about \$6.26/MWh, more than the cost of alternative power.

4.3 COST OF ENVIRONMENTAL MEASURES

Table 24. Cost of environmental mitigation and enhancement measures considered in assessing the effects of operating the Mattaceunk Project.

Enhancement/Mitigation Measures	Entity	Capital cost ^a	Annual cost ^{a, b}	Levelized annual cost ^c
General				
Operate in a run-of-river mode, such that outflow approximately equals inflow, and impoundment water levels are maintained within 1.0 foot of the top of flashboard crest elevation (240.0 feet) during normal operations, and within 2.0 feet of the flashboard crest elevation (240.0 feet) for irregular circumstances (i.e., to allow adequate margin for debris loads, ice loads, or sudden pool increases that might cause flashboard failure), and up to 1.0 foot of the crest of dam elevation (236.0 feet) when replacing the flashboards.	GLHA, NMFS, ^d Interior, ^d Maine DMR, ^d Staff	\$0	\$0	\$0

Enhancement/Mitigation Measures	Entity	Capital cost ^a	Annual cost ^{a, b}	Levelized annual cost ^c
Develop an operation compliance monitoring plan that specifies the methods that will be used at the project to monitor the project and maintain minimum flows and impoundment water levels within licensed limits, including methods to verify the accuracy of the flow curves, make historical data available to the public upon request, and making near-real time data available on the internet.	Maine DEP, NMFS, ^d Staff	\$5,000 ^f	\$1,900 ^g	\$2,332
Develop a plan to monitor minimum flows as discussed in the measure above, with the addition of making historical flow data electronically accessible via the internet within 1 year of license issuance.	NMFS ^d	\$4,000 ^f	\$200 ^h	\$546

Enhancement/Mitigation Measures	Entity	Capital cost ^a	Annual cost ^{a, b}	Levelized annual cost ^c
Aquatic Resources				
Continue to provide a year-round continuous minimum base flow of 1,674 cfs or inflow, whichever is less. Continue to provide a daily average minimum flow of 2,392 cfs from July 1 through September 30 and 2,000 cfs from October 1 through June 30, or average inflow, whichever is less.	GLHA, NMFS, ^d Maine DMR, ^d Staff	\$0	\$0	\$0
Conduct continuous stream temperature monitoring downstream of the dam between April 1 and October 31 to assure that the dam and its operations do not intensify the effects of climate change that can affect smolt emigration, adult immigration, and juvenile development in nursery habitats downstream of the dam.	NMFS ^d	\$2,800 ⁱ	\$200 ⁱ	\$442
A plan to monitor water temperature in the impoundment for multiple years to determine project effects on impoundment water temperature.	Penobscot Indian Nation	\$5,000 ^f	\$0	\$432

Enhancement/Mitigation Measures	Entity	Capital cost ^a	Annual cost ^{a, b}	Levelized annual cost ^c
Install full-depth trash racks with 1-inch clear bar spacing during the downstream migration seasons for eel and Atlantic salmon (a measure proposed in the SPP for Atlantic salmon).	GLHA, Interior, ^e NMFS, ^e Maine DMR ^d	\$1,000,000	\$787,500	\$873,962
Install trash racks that meet the FWS design criteria.	Penobscot Indian Nation	2,600,000 ^j	\$1,370,095 ^j	\$1,594,896
Install full-depth trash racks with 1-inch clear bar spacing during the downstream migration seasons for eel.	Staff	\$1,000,000	\$330,750 ^k	\$417,212
Begin installing the seasonal full-depth trash racks with 1-inch clear bar spacing within 2 years (a measure proposed in the SPP for Atlantic salmon).	GLHA, NMFS, ^e Staff	\$0	\$0	\$0
Begin installing the seasonal full-depth trash racks with 1-inch clear bar spacing during the first passage season for Atlantic salmon and eel.	Maine DMR ^d	\$0	\$0	\$0

Enhancement/Mitigation Measures	Entity	Capital cost ^a	Annual cost ^{a,} _b	Levelized annual cost ^c
Estimate approach velocities after installation of 1-inch full-depth trash racks using point measurements immediately upstream of the intakes and trash racks to ensure that velocities do not exceed 2.0 fps.	NMFS ^e	\$3,000 ^f	\$0	\$259
Install and maintain, seasonally, an upstream eel ladder within 2 years of the effective date of the new license and operate the facility from June 1 to September 15 each year.	GLHA, Maine DMR, ^d Interior, ^e Staff	\$50,000	\$10,000	\$14,323
Monitor the upstream eel ladder for use and effectiveness for one passage season.	GLHA, Maine DMR, ^d NMFS, ^e Staff	\$15,000	\$0	\$1,297
Develop a plan to monitor the efficiency and effectiveness of the upstream eel passage measures.	Interior, ^e	\$5,000 ^f	\$0	\$432

Enhancement/Mitigation Measures	Entity	Capital cost ^a	Annual cost ^{a, b}	Levelized annual cost ^c
Develop a plan to monitor the efficiency and effectiveness of the upstream eel passage measures, as required by Interior's prescription, with specific provisions (see section 2.4, <i>Staff Alternative</i> for list of provisions).	Staff	\$5,000 ^f	\$0	\$432
Provide downstream passage up to 6 weeks each year for eel by implementing annual nighttime turbine shutdowns, in combination with opening the project's roller gate and installing full-depth 1-inch-spaced trash rack [capital cost provided above].	GLHA, Staff	\$0	\$313,000	\$313,000
Provide downstream passage, as proposed, except every night for 12 weeks from August 1 through October 31 each year.	Maine DMR, ^d Interior ^e	\$0	\$626,000 ^m	\$626,000

Enhancement/Mitigation Measures	Entity	Capital cost ^a	Annual cost ^{a, b}	Levelized annual cost ^c
Conduct 2 years of monitoring to determine the effectiveness of the nighttime shutdowns, coupled with installation of the full-depth trash racks with 1-inch clear spacing and water releases from the roller gate for passing eel downstream in a safe, timely, and effective manner.	GLHA, NMFS, ^e	\$0	\$36,000 for 2 years ⁿ	\$5,245
Conduct 3 years of monitoring to determine the effectiveness of the nighttime shutdowns, coupled with installation of the full-depth trash racks with 1-inch clear bar spacing and water releases from the roller gate for passing eel downstream in a safe, timely, and effective manner.	Staff, Maine DMR, ²⁴⁸ Interior	\$0	\$36,000 for 3 years ⁿ	\$7,613
Develop a plan to monitor the effectiveness of the downstream eel passage measures.	Interior, ^e	\$5,000 ^f	\$0	\$432

²⁴⁸ In its comments on the draft EA, Maine DMR stated that a 3-year telemetry study will be necessary to develop an accurate predictive model. In its comments on the draft EA, Interior does not recommend, but suggests, that 4 years of monitoring may be needed to develop a predictive model that can be relied upon to refine turbine operation and protect downstream migrating eel.

Enhancement/Mitigation Measures	Entity	Capital cost ^a	Annual cost ^{a,} _b	Levelized annual cost ^c
Develop a plan to monitor the effectiveness of the downstream eel passage measures, as required by Interior's prescription with specific provisions (see section 2.4, <i>Staff Alternative</i> for list of provisions).	Staff	\$5,000 ^f	\$0	\$432
Develop a Fishway Operation and Maintenance Plan, within 12 months, covering all maintenance and operation of the upstream and downstream fishways provided for eel.	Interior, ^e Staff	\$5,000 ^f	\$0	\$432
Install, in year 15 of a new license, an upstream fishway for alosines.	GLHA, NMFS, ^e Maine DMR, ^d Maine DEP	\$7,000,000	\$100,000 ^o	\$233,981
Install upstream and downstream passage for alosines as soon as possible.	Bruce Haines; Penobscot Indian Nation	\$7,000,000	\$100,000 ^o	\$705,233

Enhancement/Mitigation Measures	Entity	Capital cost ^a	Annual cost ^{a, b}	Levelized annual cost ^c
Operate the new upstream fishway for alosines from May 1 through July 31 of each year.	NMFS, ^e Maine DMR ^d	\$0	\$179,000 ^p	\$47,619
Monitor the upstream and downstream passage of alosines for two years once a new upstream fishway is operational (expected in year 16 of a license).	GLHA, NMFS, ^d Maine DMR ^d	\$113,000 ^l	\$80,000 ^q	\$7,033
Develop a study plan, in consultation with the resource agencies, for monitoring upstream and downstream passage effectiveness of fishways for alosines.	NMFS ^e	\$5,000 ^f	\$0	\$432

Enhancement/Mitigation Measures	Entity	Capital cost ^a	Annual cost ^{a, b}	Levelized annual cost ^c
Provide downstream passage for alosines after a new upstream fishway for alosines is operational (expected in year 16), by: (1) extending the operation of the existing downstream fish bypass such that it operates continuously from April 1 to December 1; and (2) by opening the log sluice (and releasing between 3 percent [225 cfs] and 9 percent [690 cfs] of station hydraulic capacity) from June 1 to December 1, as needed for alosines, based on monitoring results.	GLHA, NMFS, ^e Maine DMR ^d	\$0	\$342,000	\$342,000
Develop an operation and maintenance plan for the new upstream alosine fishway.	Maine DMR ^d	\$5,000 ^f	\$0	\$432
Design the new upstream fishway to provide safe passage for sea lamprey.	NMFS ^d	\$0	\$0	\$0

Enhancement/Mitigation Measures	Entity	Capital cost ^a	Annual cost ^{a,} _b	Levelized annual cost ^c
Modify the fishway operating schedules during the term of the license based on migration data, new information, and in consultation with the Maine DMR, FWS, and NMFS. Upon request of licensee, the actual dates of operation may be varied in any given year in response to river conditions, maintenance requirements, or annual variability in fish migration patterns, with the approval of Maine DMR, FWS, and NMFS, as appropriate.	Maine DMR, ^d NMFS ^e	\$0	\$0	\$0
Implement additional operational and structural modifications and/or habitat enhancement measures, if necessary, to provide effective eel and alosine passage (passage criteria for eel and alosines shall be based on a review of the performance of comparable fish passage measures in New England).	GLHA, NMFS, ^e Maine DMR ^c	\$0	\$0	\$0

<p>Use the following general provisions for monitoring the effectiveness of all fishways: (1) monitoring plans will be developed in consultation with NMFS and state and federal resource agencies. The monitoring plan to be approved by the agencies prior to filing with the Commission for final approval; (2) all monitoring will be completed with scientifically accepted practices; (3) monitoring shall begin at the start of the second migratory season after the each fishway facility is operational, except for upstream Atlantic salmon and downstream kelt studies, and shall continue to be conducted for the time frames proposed or as otherwise required; (4) conduct fishway “shakedowns” the first season after fishways are constructed; (5) reports of the monitoring studies shall be provided to the resource agencies for a minimum 30-day review and consultation prior to submittal to the Commission for final approval; and (6) the Licensee shall include resource agencies’ comments in the annual reports submitted to the Commission for final review.</p>	Staff	\$0	\$0	\$0
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Enhancement/Mitigation Measures	Entity	Capital cost ^a	Annual cost ^{a, b}	Levelized annual cost ^c
Use the general provisions for studying the effectiveness of fishways as recommended by staff, except monitoring shall begin at the start of the second migratory season, without exception.	NMFS ^e	\$0	\$0	\$0
Continue to implement the FPOMP, which defines the: (1) operational period of the existing upstream and downstream fishways; (2) annual start-up and shut-down procedures; (3) opening methods; (4) debris management; and (5) safety rules and procedures.	GLHA, Staff	\$0	\$10,000	\$10,000
Modify the FPOMP to include additional provisions (see section 2.4, <i>Staff Alternative</i> for list of provisions)	Maine DMR, ^d Interior, ^e Staff	\$3,000 ¹	\$0	\$259

Enhancement/Mitigation Measures	Entity	Capital cost ^a	Annual cost ^{a, b}	Levelized annual cost ^c
Operate each fishway for a “shakedown” period subsequent to any new fishway construction, or operational or structural modifications to existing fishways, and prior to the relevant fish passage season and pertinent effectiveness studies to ensure it is operating as designed and to make minor adjustments to facilities and operations, as needed.	Maine DMR ^d	\$0	\$0	\$0
Operate the upstream eel ladder for a “shakedown” period subsequent to installation, and prior to the passage season and pertinent effectiveness studies to ensure it is operating as designed and to make minor adjustments to facilities and operations, as needed.	Staff	\$0	\$0	\$0
Have a licensed engineer certify that fishways are constructed and operating as designed at the end of each shakedown period.	Maine DMR ^d	\$0	\$0	\$0

Enhancement/Mitigation Measures	Entity	Capital cost ^a	Annual cost ^{a, b}	Levelized annual cost ^c
Provide the Maine DMR, FWS, and NMFS with a copy of the as-built fishway drawings for any new or modified fishways as submitted to the Commission, along with the licensed engineer's letter of certification.	Maine DMR ^d	\$0	\$0	\$0
Prepare an annual report to include all available fish passage operations data.	Staff	\$3,000 ¹	\$0	\$259
Prepare an annual report, as recommended by staff, except include in the report the number of fish passed daily (by species), daily water temperature, and air temperature.	Maine DMR ^d	\$3,000 ¹	\$0	\$259
Meet annually in March with the resource agencies to review fish passage operations data.	Maine DMR ^d	\$0	\$0	\$0
Prepare a fishway operations plan for all fishways each year following the annual meeting to review fish passage operations.	Maine DMR ^c	\$0	\$3,000 ¹	\$3,000

Enhancement/Mitigation Measures	Entity	Capital cost ^a	Annual cost ^{a, b}	Levelized annual cost ^c
Provide FWS personnel and other FWS-designated representatives, timely access to the fishways and to pertinent project operational records for the purpose of inspecting the fishways to determine compliance with the fishway prescription.	Interior ^e	\$0	\$0	\$0
Conduct real-time monitoring of the downstream bypass fishway to ensure safe and effective operation.	NMFS	\$8,000 ^r	\$200 ^r	\$892
Redesign the downstream bypass to provide 5 percent attraction flow.	Penobscot Indian Nation, Bruce Haines	\$2,000,000 ^l	\$0	\$172,924
Provide 5 percent attraction flows through the downstream bypass 365 days per year.	Bruce Haines	\$0	\$190,095 ^s	\$190,095

Enhancement/Mitigation Measures	Entity	Capital cost ^a	Annual cost ^{a,} _b	Levelized annual cost ^c
Design fishways using the following provisions: (1) submit design plans to the resource agencies for review and consultation during the conceptual, 30, 60 and 90 percent design stages; (2) provide conceptual designs to the resource agencies no later than two years before the anticipated operational date; (3) provide the resource agencies with conceptual designs for the proposed full-depth trash racks with 1-inch bar spacing at least six months prior to the first downstream passage season following issuance of any new license; (4) submit final design plans to the Commission for final approval after resource agency approval and prior to the commencement of fishway construction activities, with all unaddressed resource agency comments; and (5) file final as-built drawings with NMFS and FWS that accurately reflect the project as constructed after the fishway is constructed.	NMFS, ^e Staff	\$0	\$0	\$0

Enhancement/Mitigation Measures	Entity	Capital cost ^a	Annual cost ^{a, b}	Levelized annual cost ^c
Threatened and Endangered Resources				
Continue to maintain and operate the upstream fishway annually from May 1 to November 10 for adult Atlantic salmon, including a 7 cfs attraction flow at the fishway entrance.	GLHA, NMFS, ^e Maine DMR, ^d Staff	\$0	\$25,000	\$25,000
Open the existing upstream fishway prior to May 1, if adult Atlantic salmon are caught in the Milford fishway prior to May 1.	NMFS ^e	\$0	Undefinable ^t	Undefinable
Continue to maintain and operate the downstream fish bypass to provide downstream passage for Atlantic salmon smolts from April 1 to June 15 and Atlantic salmon kelts from October 17 to December 1.	GLHA, NMFS, ^e Maine DMR, ^d Staff	\$0	\$25,000	\$25,000

Enhancement/Mitigation Measures	Entity	Capital cost ^a	Annual cost ^{a, b}	Levelized annual cost ^c
Monitor the upstream fishway and count the number of adult Atlantic salmon passing upstream of the project, using a methodology developed in consultation with resource agencies, to provide resource managers with data to estimate the size of the spawning population upstream of the project.	GLHA, Maine DMR ^d	\$0	\$0	\$0
Maintain and monitor the existing fish trap at the exit of the existing upstream fishway for counting adult Atlantic salmon.	NMFS ^e	\$0	\$5,000 ^l	\$5000
Coordinate with resource agencies to stock uniquely marked Atlantic salmon smolts upstream of Weldon Dam in the first three years after relicensing to serve as a source of imprinted adult salmon (i.e., fish homing to areas upstream of Weldon Dam) used for studying upstream passage of adults and downstream passage of kelts (a measure in the proposed SPP for Atlantic salmon).	GLHA, Maine DMR, ^d Staff	\$45,000	\$15,000 ^u	\$7,063

Enhancement/Mitigation Measures	Entity	Capital cost ^a	Annual cost ^{a, b}	Levelized annual cost ^c
Conduct up to three years of upstream fishway effectiveness monitoring for adults and up to three years of downstream passage monitoring for kelts, using the returning imprinted adult salmon (a measure in the proposed SPP for Atlantic salmon).	GLHA, NMFS, ^e Maine DMR, ^d Staff	\$60,000	\$45,000 ^v	\$14,705
Open the project's log sluice (between 3 percent [225 cfs] and 9 percent [690 cfs] of station hydraulic capacity) starting the first passage season following relicensing to provide additional passage for downstream Atlantic salmon smolts for a 3-week period during the spring that would be determined in consultation with resource agencies (a measure in the proposed SPP for Atlantic salmon).	GLHA, NMFS, ^e Maine DMR, ^d Staff	\$0	\$37,250	\$37,250

Enhancement/Mitigation Measures	Entity	Capital cost ^a	Annual cost ^{a, b}	Levelized annual cost ^c
Conduct a minimum of 3 years of monitoring to evaluate the effectiveness of existing passage operations and additional measures (operation of the log sluice and installation of the 1-inch clear spacing full-depth trash racks), in passing Atlantic salmon smolts downstream past the dam (a measure in the proposed SPP for Atlantic salmon).	GLHA, NMFS, ^e Maine DMR, ^d Staff	\$110,000	\$75,000 ^w	\$25,372
Evaluate smolt mortality in the project impoundment (a measure in the proposed SPP for Atlantic salmon).	GLHA	\$110,000 ^x	\$25,000 ^y	\$11,270
Conduct up to 3 years of studies to assess the sources of impoundment mortality for Atlantic salmon smolts.	Maine DMR ^d	\$110,000 ^x	\$75,000 ^z	\$25,372
Develop a mitigation plan, in consultation with NMFS and resource agencies, for the loss of Atlantic salmon smolts as a result of maintaining the project impoundment.	NMFS ^d	\$5,000 ^f	\$0	\$432

Enhancement/Mitigation Measures	Entity	Capital cost ^a	Annual cost ^{a, b}	Levelized annual cost ^c
Implement adaptive management that would include additional operational, structural, and/or habitat enhancement measures, if necessary, to improve passage and/or address performance criteria for upstream and downstream migrating Atlantic salmon (a measure in the proposed SPP for Atlantic salmon).	GLHA, NMFS, ^e Maine DMR, ^d	\$0	\$0	\$0
Modify the SPP for Atlantic salmon to include at minimum, the existing provisions in the existing SPP and additional measures.	Staff	\$5,000 ^f	\$0	\$432
Develop an SPP for the northern long-eared bat that limits non-hazardous tree removal to the period of November 1 through March 31.	Staff	\$5,000 ^f	\$0	\$432
Recreation and Land Use Resources				
Maintain existing project recreation facilities including: (1) a canoe portage trail, and (2) a downstream angler access area.	GLHA, Staff	\$0	\$1,000	\$1,000

Enhancement/Mitigation Measures	Entity	Capital cost ^a	Annual cost ^{a, b}	Levelized annual cost ^c
Implement recreation facility improvements at the existing downstream angler access area.	GLHA, Staff	\$3,000	\$300	\$559
Develop a portage plan in consultation with the Penobscot Indian Nation.	Interior	\$5,000 ^f	\$500	\$932
Cultural Resources				
Develop an HPMP.	GLHA, Staff	\$10,000	\$2,000	\$2,865

^a Costs provided by the applicant unless otherwise noted.

^b Annual costs typically include operational and maintenance costs and any other costs which occur on a yearly basis.

^c 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.

^d 10(j) recommendation.

^e Section 18 fishway prescription.

^f Staff estimated cost for the development of the plan.

^g Staff estimated cost to conduct field verification surveys during the first year after license issuance and every ten years thereafter.

^h Staff estimated cost for maintaining data on the internet.

ⁱ Staff estimated \$2,800 in capital costs for one temperature sensor and a back-up sensor, and a data logger. Staff estimated \$200 in annual costs for maintenance and repair.

^j Staff estimated a capital cost of \$2,600,000 to install angled or inclined trash racks that meet the FWS design criteria and an annual cost in lost generation of \$1,370,095 caused by reducing bar spacing to 0.75 inches.

^k Staff estimated this cost based on the reduced number of days that the 1-inch trash rack overlays would be installed if the overlays are only installed during the downstream migration for eel. If the trash rack overlays are installed during

the downstream passage seasons for eel (August 15 to October 31 [or 78 days]), smolts (April 1 to June 15 [76 days]), and kelts (October 17 to December 1 [31 total days beyond the end of the eel passage season], they would be in place for 185 days. However, if the trash rack overlays are only installed during the downstream eel passage season, they would only be in place for 78 days, or 42 percent less time than if they are also in place during the smolt and kelt passage seasons. Staff estimated that annual costs would be reduced 42 percent, or from \$787,500 to \$330,750.

- ^l Staff estimated cost.
- ^m Staff estimated cost based on 12 weeks of spill and an estimated 12,520 MWh in lost generation.
- ⁿ Staff estimated the cost to be \$36,000 per year for either 2 or 3 years.
- ^o Based on GLHA's cost estimate of \$100,000 per year in additional expenditures for the upstream fishway, beginning in year 16 of any new license.
- ^p Based on GLHA's cost estimate of \$179,000 per year in lost generation beginning in year 16 of any new license.
- ^q Staff estimate an annual cost of \$80,000 per year for 2 years of monitoring.
- ^r Staff estimated \$8,000 for a flow gauge, telemetry system for real-time monitoring, and installation, and \$200 per year to maintain the gauge.
- ^s Staff estimated this cost based known information (i.e., the existing bypass operates at 2 percent of station hydraulic capacity, 120 days per year, which reduces generation by 886 MWh and costs \$25,000 per year). This information was used to extrapolate costs using 5 percent flows at 365 days per year.
- ^t NMFS's fishway prescription represents a measure without limits and therefore a specific annual cost cannot be estimated, because there is uncertainty regarding the number of additional days of fishway operation that would be necessary.
- ^u Based on GLHA's cost estimate of \$15,000 for 3 years of stocking smolts.
- ^v Based on GLHA's cost estimate of \$45,000 for 3 years of studies.
- ^w Based on GLHA's cost estimate of \$75,000 for 3 years of studies.
- ^x Staff estimated this cost, assuming that the capital costs associated with estimating smolt mortality in the impoundment would be the same as the capital costs associated with estimating mortality past the dam (i.e., \$110,000).
- ^y Staff estimated this cost, assuming that the annual cost of conducting 1 year of study to estimate smolt mortality in the impoundment would be a third of the annual cost associated with estimating mortality past the dam (i.e., \$75,000).
- ^z Staff estimated that this annual cost would be the same as the annual cost associated with estimating mortality past the dam (i.e., \$75,000).

(Source: staff).

5.0 CONCLUSIONS AND RECOMMENDATIONS

5.1 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 major license for the project would allow GLHA to continue to operate its project as a dependable source of electrical energy; (2) the 19.2 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 and would improve public recreation opportunities at the project.

In the following section, we make recommendations as to which environmental measures proposed by GLHA or recommended by agencies or other entities should be included in any license issued for the project. In addition to GLHA's proposed environmental measures listed below, we recommend additional staff-recommended environmental measures to be included in any license issued for the project.

5.1.1 Measures Proposed by GLHA

Based on our environmental analysis of GLHA'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 GLHA 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.

To protect or enhance aquatic habitat, fish and wildlife habitat, and recreation at the project, GLHA proposes to:

- Continue to operate the project in a run-of-river mode with year-round use of 4-foot-high flashboards;
- Continue to operate the impoundment with fluctuation limits that consist of maintaining the impoundment surface elevation: (1) within 1.0 foot of the flashboard crest elevation (240.0 feet) on a regular basis when the flashboards are in place; (2) no lower than 2.0 feet below the flashboard crest elevation when needed for maintenance, to allow an adequate margin for wave action, debris loads, ice loads, or sudden pool increases that might cause flashboard failure when the flashboards are in place; and (3) no lower than 1.0 foot below the dam crest elevation of 236.0 feet when the flashboards are not in place;
- Continue to provide a year-round continuous minimum flow of 1,674 cfs, or inflow, whichever is less, downstream from the project, and continue to provide a daily average minimum flow of 2,392 cfs from July 1 through September 30 and 2,000 cfs from October 1 through June 30, or average inflow, whichever is less, to protect aquatic resources downstream from the project;
- Install and maintain, on a seasonal basis, an upstream eel ladder within 2 years of the effective date of the new license;
- Monitor the upstream eel ladder for use and effectiveness for one eel passage season;
- Provide downstream passage for eel by implementing annual nighttime turbine shutdowns (8:00 pm to 4:00 am), for a 6-week period between August 15 and October 31,²⁴⁹ in combination with opening the project's roller gate and installing full-depth trash racks with 1-inch clear bar spacing (*see* measures included in the

²⁴⁹ GLHA would develop the annual schedule in consultation with the resource agencies, and based on a predictive model for eel movement through the project. GLHA refined its proposed window for downstream passage events as follows: “until such time that a predictive model is developed, GLHA would implement a night-time shutdown period of up to 6 weeks (8 pm to 4 am nightly) as early as the first significant rain event (defined as greater than 1 inch of precipitation) occurring on or after August 15, but that the nighttime shutdown period will start no later than September 15 in years that a significant rain event does not occur during the August 15-September 15 time period.” *See* GLHA’s July 7, 2017, filing at Attachment 1, page 40.

SPP for Atlantic salmon), beginning the first passage season following license issuance;

- Continue to implement the FPOMP, as modified below;
- Continue to maintain and operate the upstream fishway annually from May 1 to November 10 for adult Atlantic salmon, including the 7-cfs attraction flow at the fishway entrance;
- Continue to maintain and operate the downstream surface bypass to provide downstream passage for Atlantic salmon smolts from April 1 to June 15 and Atlantic salmon kelts from October 17 to December 1;
- Implement an SPP for the federally endangered Atlantic salmon, as modified below;
- Continue to operate and maintain the project recreation facilities;
- Implement recreation facility improvements at the existing downstream angler access area within 3 years of license issuance, including installation of: (1) a pulley system to assist boaters with moving car top boats and other small watercraft up and down the stairs; and (2) a ramp adjacent to the existing recreation pavilion to provide wheel chair access to the pavilion and associated picnic table; and
- Develop an HPMP for the protection of historic properties within the project's APE.

5.1.2 Additional Measures Recommended by Staff

In addition to GLHA's proposed measures noted above, we recommend including the following additional and modified measures in any license that may be issued for the Mattaceunk Project.

- Develop an operation compliance monitoring plan to document compliance with the proposed operations described above (i.e., run-of-river operation, limited impoundment fluctuations, and minimum flows) for the protection of aquatic resources in the impoundment and downstream of the dam;
- Monitor the effectiveness of the downstream eel passage measures for three passage seasons from August 1 through October 31;
- Develop individual monitoring plans for upstream and downstream eel passage, as required by Interior's fishway prescription, that include:

- (1) the goals and objectives of the monitoring;
 - (2) performance criteria for determining the success of the eel passage measures;
 - (3) the methodology used to monitor the effectiveness and efficiency of the upstream and downstream passage measures to pass eel;
 - (4) provisions for reporting the results of the monitoring (i.e., development of a report) and consulting with the agencies regarding the results (including an annual meeting); and
 - (5) a provision to identify and implement (upon Commission approval):
 - (a) additional monitoring studies; or
 - (b) operational and structural modifications and/or habitat enhancement measures to provide eel passage, if after 1 year of upstream monitoring and 3 years of downstream monitoring, the proposed passage measures for eel are ineffective at achieving the upstream and downstream effectiveness and survival performance criteria.
- Modify the FPOMP to include additional provisions for:
 - (1) performing routine maintenance before the migration season, such that the existing fishways would be fully operational during the migratory period;
 - (2) clearing debris from the trash racks of all turbine intakes prior to the migration season, and identify, with final Commission approval, the frequency of debris clearing during the migration season;
 - (3) monitoring flows in the downstream bypass pipe to detect debris blockages using a method approved by the Commission;
 - (4) clearing debris from the downstream bypass pipe when blockages are detected;
 - (5) procedures for filing with the Commission for informational purposes, an annual report on the operation of the existing fishways and on project generation;
 - (6) developing shutdown procedures for the existing fishways; and
 - (7) developing procedures for operation and maintenance of the existing fishways during emergencies and project outages;
 - Operate the proposed upstream eel ladder for a “shakedown” period subsequent to installation, and prior to the passage season and pertinent effectiveness studies to ensure it is operating as designed and to make minor adjustments to facilities and operations, as needed;
 - Modify the SPP for Atlantic salmon to include the following additional provisions:
 - (1) remove the provision to seasonally install trash racks with 1-inch clear bar spacing to the full depth of the turbine intakes for the purpose of protecting smolts and kelts;

- (2) revise, with final approval from the Commission, the upstream passage effectiveness study methodology to include the type of telemetry tag to be used on upstream migrating adults and the appropriate timing for stocking tagged smolts, and refile the SPP with the revised study plan;
- (3) include the proposed passage effectiveness study plans as attachments to the SPP;
- (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 95 percent performance standard after the first year;
- (5) determine the need for future effectiveness studies or measures, with final approval from the Commission, if after 3 years of upstream passage effectiveness studies, the upstream fishway does not meet the 95 percent effectiveness performance standard;
- (6) revise the number of downstream passage effectiveness studies for smolts to indicate that a minimum of 3 years of study would be conducted;
- (7) revise the criteria for achieving the downstream performance standard for smolts to state that the standard would be considered achieved if a total of 3 years of effectiveness studies for smolts demonstrate that the downstream passage structures meet a 96 percent survival performance standard;
- (8) determine, with final approval from the Commission, when to begin implementation of phased spill measures for downstream passage of smolts, with the restriction that phased spill measures would be implemented after a minimum of 1 year and a maximum of 3 years of conducting downstream passage survival studies for smolts, and non-spill passage measures;
- (9) determine, with final approval from the Commission, the 3-week period during which any log sluice or phased spill measures would occur for downstream passage of smolts;
- (10) determine the need for an additional 1 or 2 years of downstream passage effectiveness studies for kelts, with final approval from the Commission, if the downstream passage structures meet the 96 percent survival performance standard for kelts after the first year;
- (11) determine the need to conduct at least 1 year of additional effectiveness study, with final approval from the Commission, if the downstream passage structures do not meet the 96 percent survival performance standard for kelts after the first year;
- (12) determine the need for future effectiveness studies, and/or downstream passage measures, with final approval from the Commission, if after 3 years

of downstream passage effectiveness studies, the downstream passage structures do not meet the 96 percent survival performance standard for kelts;

- (13) remove the provision to conduct a study to evaluate smolt mortality in the project impoundment;
 - (14) remove the provisions requiring reevaluation of upstream and downstream passage effectiveness every 10 years;
 - (15) 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.
- Develop an SPP for the federally threatened northern long-eared bat that limits non-hazardous tree removal to the period of November 1 through March 31, which is outside the pup season (June 1 to July 31), and the broader active season (April 1 to October 31).

In addition, we are recommending all of the final fishway prescriptions, with the exception of those discussed in section 5.1.3, *Measures Not Recommended*.²⁵⁰

Below, we discuss the basis for the staff-recommended measures and modifications.

Operation Monitoring Compliance Plan

Impoundment Fluctuations and Minimum Flows

As discussed in section 2.1.3, *Existing Project Operation*, GLHA proposes to continue to operate in a run-of-river mode, while maintaining impoundment fluctuations: (1) within 1.0 foot or less of the top of the flashboard crest during normal project operation, or within 2.0 feet of the flashboard crest when necessary (i.e., to allow an adequate margin for debris, or sudden pool increases that might cause flashboard failure); and (2) within 1.0 foot of the dam crest when the flashboards are down for repair or installation. Additionally, GLHA proposes to continue supplying a continuous minimum flow of the less of 1,674 cfs or inflow, and maintaining a daily average minimum flow of the less of 2,392 cfs or average inflow, from July 1 through September 30 and the less of 2,000 cfs or average inflow, from October 1 through June 30. Interior, NMFS, and Maine

²⁵⁰ Although we do not recommend some of the fishway prescriptions, we recognize that the Commission is required to include all section 18 fishway prescriptions in any license issued for the project.

DMR all recommend GLHA's proposed operations, impoundment fluctuation limits, and minimum flows.

Operating the project in a run-of-river mode minimizes impoundment fluctuations, maintains a stable shoreline, and protects shoreline and riparian habitat used by wildlife upstream of the dam. Additionally, the run-of-river operation provides the diurnal cues to stimulate fish migration. The current and proposed minimum flows also support aquatic life and habitat below Weldon Dam, while providing a zone of passage suitable for upstream and downstream fish migration. Therefore, we recommend that GLHA continue the current project operation and minimum flows, which would not add any additional cost.

Operation and Minimum Flow Compliance

GLHA uses an existing monitoring system that monitors project operation and minimum flows by measuring impoundment water levels directly, and records both impoundment water levels and flow through the individual turbines. Additionally, GLHA maintains and stores mean daily and hourly data for inflow to the impoundment, outflow from the project, and water levels in the project impoundment. GLHA also supplies these data to the agencies within 30 days of a request.

To ensure the project is operated as proposed and recommended, GLHA also has agreed, as an outcome of the 10(j) meeting held on June 7, 2018, to develop an operation compliance monitoring plan,²⁵¹ in consultation with NMFS, FWS, Maine DMR, and Maine DIFW that would include: (1) methods used to verify the accuracy of the existing monitoring system, including recalibration, as necessary; (2) a schedule of verification and recalibration events; and (3) a provision to make flow data available to the public upon request. Maine DEP and NMFS recommend that GLHA develop a plan or plans that specify the methods used to monitor and maintain impoundment elevation levels and minimum flows within the licensing limits. NMFS also recommends that GLHA conduct a study, within 1 year of any new license issued, to verify the accuracy of the existing flow monitoring system and develop a minimum flow monitoring plan that would include making near-real time and historic flow data electronically accessible to the public via the internet within 1 year of license issuance.

As discussed in section 3.3.2.2, *Operation Compliance Monitoring*, developing a formal project operation compliance monitoring plan would provide a mechanism for reporting operational data and deviations, facilitate administration of the license, and ensure the protection of resources sensitive to impoundment surface elevation

²⁵¹ GLHA filed an operation compliance monitoring plan on September 14, 2018. We will address the merits of the plan in the license order.

fluctuations. Additionally, developing such a plan would provide a better understanding of the flow releases, and would ensure that the minimum flows required in any license issued for the project are met and monitored effectively and efficiently.

As discussed in section 3.3.2.2, GLHA has an existing system that is fully capable of monitoring project operation and minimum flows under any new license issued. Nevertheless, the curves (i.e., relationship between generation and flow) used to estimate flows through the turbines have not been verified since 2005, when the turbine runners were replaced. Because turbine efficiency changes over time, the curves that describe the relationship between generation and flow can change. Therefore, the existing curves used to determine compliance with minimum flows may now be inaccurate. To ensure the project releases correct minimum flows, there is a need to (a) verify the accuracy of the curves using in-stream field measurements within 1 year of license issuance, and recalibrate as necessary, and (b) verify and recalibrate the curves subsequent to the first verification event, as needed (based on the specifications of the project's turbines), during the term of any new license issued for the project.

For reasons discussed above, we recommend that GLHA develop an operation compliance monitoring plan with measures to: (1) monitor minimum flows and impoundment elevation levels using the existing system; (2) document compliance with project operation; (3) verify the accuracy of the curves used to estimate minimum flows within 1 year of any new license issued, and recalibrate as necessary; (4) verify and recalibrate the curves subsequent to the first verification event, as needed, during the term of the new license; (5) report operational data and deviations; and (6) facilitate administration of the license. We estimate that the annual levelized cost of developing an operation compliance monitoring plan would be \$2,332, and conclude that the benefits of the plan outweigh the cost.

GLHA currently makes recent project flow data available on the internet in near-real time. Making flow data available on the internet in near-real time allows resource agencies and the public an opportunity to review recent flow conditions at the project. Therefore, we recommend that GLHA continue to make project flow data available on the internet in near-real time, which we estimate to have no additional cost. In addition, GLHA currently provides historical flow data to the agencies upon request. For transparency, it would be beneficial to also provide historical flow data to the public upon request. Given GLHA's current practice on reporting flow data, there would be no additional benefit to providing historical flow data on the internet. Therefore, we do not recommend that GLHA make historical flow data available on the internet. We do, however, recommend that historical flow data be made available to the public upon request, which we estimate to have no additional cost.

Eel Passage Effectiveness Studies

GLHA proposes to: (1) monitor the seasonal upstream eel ladder for use and effectiveness for one eel passage season; (2) monitor the effectiveness of the proposed downstream eel passage measures (i.e., annual nighttime turbine shutdowns, roller gate opening, and full-depth trash racks with 1-inch bar spacing) for passing downstream migrating silver eel for two passage seasons; and (3) implement additional operational and structural modifications and/or habitat enhancement measures to provide eel passage, if the proposed passage measures for eel are ineffective. Interior, in its fishway prescription, requires that GLHA develop upstream and downstream eel passage effectiveness plans, but provides no schedule for monitoring. Maine DMR, as part of its terms and conditions, recommends that GLHA monitor the effectiveness of the installed upstream fish passage facility for 1 year and the downstream eel passage measures for 2 years. In their comments on the draft EA, Interior states that 4 years of monitoring in the upper Penobscot River may be needed to develop an adequate predictive model of downstream migrating eel at the Mattaceunk Project, while Maine DMR recommends a 3-year radio-telemetry study for the same reason.

As discussed in section 3.3.2.2, *Eel Passage Effectiveness Studies*, upstream and downstream eel passage effectiveness studies are necessary to verify whether the eel passage measures implemented are providing safe, timely, and efficient passage. In addition, the studies would inform the need for additional monitoring or structural and/or operational modifications, which may be necessary if the project is unable to meet the upstream and downstream performance criteria.²⁵² However, neither GLHA's proposal nor Interior's prescription provide any detail as to what is to be included in the monitoring plans.

To ensure the studies are designed to accurately assess upstream passage effectiveness and downstream passage survival, GLHA would need to develop the upstream and downstream eel passage effectiveness plans required in Interior's prescription. Because the specific provisions of the plans have not been provided, we recommend that the plans include, at a minimum: (1) goals and objectives of the monitoring; (2) performance criteria for determining the success of the eel passage measures; (3) methodology used to monitor the effectiveness and efficiency of the upstream and downstream passage measures; (4) provisions to report the results of the monitoring (i.e., development of a report) and consulting with the agencies regarding the results (including an annual meeting); and (5) a provision to identify and implement (upon Commission approval): (a) additional monitoring studies, or (b) operational and structural modifications and/or habitat enhancement measures to provide eel passage, if

²⁵² Interior's fishway prescription includes a targeted upstream passage effectiveness of 90 percent and a downstream adult survival rate of 76 percent.

after 1 year of upstream monitoring and 3 years of downstream monitoring, the proposed passage measures for eel are ineffective at achieving the upstream and downstream effectiveness and survival performance criteria. We conclude that the benefits of developing plans to monitor the effectiveness of the upstream and downstream eel passage measures is worth the annual levelized cost of \$864.

With regard to how long downstream migrating eel should be monitored at the Mattaceunk Project, we evaluated the Shenandoah River model and the data collection effort that supported the model in section 3.3.2.2, *Eel Passage Effectiveness Studies*. Based on our evaluation, we found that relying on a predictive model of downstream eel migration patterns is a relatively novel approach to protecting downstream migrating silver eel, with the Shenandoah River being the only instance where a predictive model is being developed for use. Thus, there is no reason to doubt that a similar effort may be needed to develop a comparable model for the Penobscot River and the Mattaceunk Project. Therefore, we recommend that GLHA’s development of a predictive model be supported by 3 years of monitoring downstream-migrating silver eel at the project, using radio-telemetry. We conclude that the benefit of monitoring silver eel movement at the project for 3 years is worth the annual levelized cost of \$7,613.

Fish Passage Operation and Maintenance Plan

GLHA proposes to implement the existing FPOMP, which defines the: (1) operational period of the existing upstream and downstream fishways; (2) annual start-up and shutdown procedures; (3) opening-methods; (4) debris management; and (5) safety rules and procedures. Maine DMR recommends five general provisions for fish passage operations and maintenance, which are outlined in detail in section 3.3.2.2, *Environmental Effects, Fish Design, Maintenance, and Monitoring*. In summary, Maine DMR’s five provisions include: (1) implementing a “shakedown” period to ensure proper fishway operation after any modification; (2) keeping fishways in proper working order; (3) drafting and maintaining written FOPs; (4) meeting with the resource agencies annually to review fish passage operational data; and (5) maintaining and operating the fishways during the upstream and downstream migration periods for Atlantic salmon.²⁵³ To ensure proper operation of the upstream fishway, NMFS recommends that GLHA determine the specific elevation at which the upstream fishway becomes non-operational. NMFS also recommends that GLHA conduct real-time monitoring of the downstream bypass using pressure transducers to identify debris blockages. NMFS’s fishway

²⁵³ Maine DMR’s recommendation also includes maintaining and operating fishways during the upstream and downstream migration periods for eel and alosines. We discuss Maine DMR’s recommendation for general fish passage provisions as it relates to these species in section 3.3.2.2, *Eel Passage Facility Operation and Maintenance Plan*.

prescription would require GLHA to take point measurements of approach velocities immediately upstream of the project trash racks (i.e., 6 to 12 inches) after installation of full-depth trash racks with 1-inch clear bar spacing, and ensure that point measurements do not exceed 2.0 fps. Finally, Interior has a fishway prescription that would require GLHA to provide information on fish passage operations and generation upon written request from FWS.

GLHA's FPOMP includes maintenance and inspection procedures specifically for the existing upstream fishway and downstream bypass. However, the FPOMP lacks some important details that would improve GLHA's ability to properly maintain, operate, and report on the existing fishways. Maine DMR's recommendation includes several provisions that would help to ensure proper operation and maintenance of fishways at the project. However, some of the recommendations included within Maine DMR's five general provisions are already in the FPOMP for the existing facilities (see section 3.3.2.2, *Environmental Effects, Fish Design, Maintenance, and Monitoring*), and thus adding them as conditions to a new license would not provide any additional benefit to upstream or downstream migration of diadromous fish. The FPOMP does not have the following procedures, which are recommended by Maine DMR, and would ensure proper operation and maintenance of the existing fishways: (1) perform routine maintenance sufficiently before a migratory period, such that the fishways can be fully operational during the migratory periods; (2) shutdown procedures for the existing facilities; (3) procedures for emergencies and project outages; and (4) procedures for reporting annually on the operation of the existing facilities. Maine DMR also recommends a provision to provide copies of the plan to Maine DMR, FWS, and NMFS. With respect to this latter provision, copies of the FPOMP would be filed publicly with the Commission. Because all public filings are accessible to the agencies, there is no need for GLHA to provide copies of the plan directly to the agencies.

Maine DMR also recommends that GLHA meet with Maine DMR, FWS, and NMFS annually in March to review fish passage operational data from the previous year. However, Maine DMR does not identify a specific need or benefit of meeting annually, or reviewing the fish passage operational data. Further, GLHA would operate and maintain all fishways by following the proposed FPOMP (with staff modifications, discussed below). With proper operation and maintenance, there is no reason to believe that the fishways would not perform as designed. Thus, there would be no benefit to meeting annually. For the same reasons, there would also be no benefit to Interior's fishway prescriptions that would require GLHA to provide information on fish passage operations and project generation to FWS upon written request, and to provide FWS personnel access to fishways.

Maine DMR also recommends in its general provisions that annually, prior to the beginning of each fish passage season, GLHA develop a plan for fishway operations. However, the FPOMP already is an operational plan and our recommended modification

to the plan (discussed below) would be adequate to ensure proper operation of the existing fishways during each year. Further, if future modifications to the FPOMP are needed, they could be made, but would require final approval from the Commission.

The trash racks in front of the turbine intakes are designed to reduce entrainment of fish and river debris. However, some debris can accumulate on the trash racks, forcing the same volume of water to pass through a smaller area and causing the through-screen velocity between the trash rack bars to increase. As discussed in section 3.3.4.2, *Approach Velocity*, through-screen velocities are not as important as approach velocities in determining whether a fish becomes impinged or entrained. Nevertheless, with regular debris removal, the trash racks can remain mostly clear, and prevent through-screen velocities from increasing. GLHA proposes to continue implementing the FPOMP, which includes provisions for using a trash rake²⁵⁴ to clear debris from the intakes of units 3 and 4. GLHA has indicated that the intakes are cleared prior to opening the downstream bypass at the beginning of the season. The frequency of debris removal, however, is not stated in the plan.²⁵⁵ Further, there is no indication that the intakes of units 1 and 2 are also cleared of debris. To prevent through-screen velocities from increasing, GLHA would need to use the trash rake to routinely clear debris from the trash racks in front of all four intakes during the downstream migration season, and this procedure would need to be included in a modified FPOMP.

River debris can also enter into the downstream bypass pipe and cause blockages that could reduce downstream passage efficiency for smolts and kelts. In fact, operators at the Mattaceunk Project observed that the bypass was blocked with debris in 2015, subsequent to the downstream smolt passage effectiveness studies, which as discussed in section 3.3.4.2, *Environmental Effects*, appeared to cause a very low bypass efficiency (9.4 percent) for smolts during the study. GLHA does conduct daily visual inspections of the outflow from the bypass pipe in accordance with the FPOMP, which should help determine whether a blockage is preventing 140 cfs (i.e. maximum flow capability of the bypass) from flowing through and out of the bypass pipe. However, the blockage incident in 2015 indicates that visual inspections are not adequate for detecting debris blockages, which would cause decreased bypass outflow. NMFS recommends that GLHA conduct real-time monitoring of the downstream bypass using pressure transducers. The use of real-time flow monitoring would allow GLHA to quickly identify debris blockages in the bypass, and the need for additional inspection and possible debris removal. However, other less intensive and potentially less costly monitoring, such as daily visual inspection of the outflow from the bypass pipe could be

²⁵⁴ GLHA operates a trash rake that is operated by an electrical hoist on a trolley beam.

²⁵⁵ See letter filed by GLHA on July 7, 2017.

adequate. In either case, it is important that the final FPOMP include a viable strategy to ensure proper function of the downstream bypass. The existing plan does not provide details on how and when bypass monitoring data would be collected, verified, and made available to the Commission and resource agencies. Consequently, there is a need to file a modified FPOMP for Commission approval with a detailed approach to monitoring flows and clearing blockages from the bypass to ensure proper function of the downstream bypass.

Therefore, we recommend that GLHA modify the existing FPOMP to add, at a minimum, procedures to: (1) perform routine maintenance before the migration season, such that the existing fishways would be fully operational during the migratory period; (2) clear debris from the trash racks of all turbine intakes prior to the migration season, and identify, with final Commission approval, the frequency of debris clearing during the migration season; (3) monitor flows in the downstream bypass pipe, to detect debris blockages, using a method approved by the Commission; (4) clearing debris from the downstream bypass pipe when blockages are detected; (5) include procedures for filing with the Commission for informational purposes, an annual report on the operation of the existing fishways and on project generation; (6) develop and include shutdown procedures for the existing fishways; and (7) develop and include procedures for operation and maintenance of the existing fishways during emergencies and project outages. We estimate that the levelized annual cost of modifying the FPOMP would be \$259, and conclude that the benefits of the measure outweigh the cost.

Fishway “Shakedown” Period

Maine DMR recommends operating each fishway for a one-season “shakedown” period to ensure that the fishways are generally operating as designed, and if not, to make adjustments. NMFS’s fishway prescription would require a “shakedown” period during the first season after fishways are constructed. The existing upstream fishway and downstream surface bypass are currently operated and maintained using the FPOMP. With GLHA’s implementation of a modified FPOMP (discussed above), there is no reason to believe that the existing fishways would not perform as designed. Thus, there would be no benefit to operating the existing fishways for a one-season “shakedown” period.²⁵⁶

²⁵⁶ As discussed below in this same section (i.e., *Species Protection Plan for Atlantic Salmon*) passage effectiveness studies for adult Atlantic salmon, smolts, and kelts may indicate that additional measures are needed to meet the passage performance standards. The additional measures may include future modifications to the upstream fishway or downstream passage structures, which could necessitate a “shakedown” subsequent to any modifications. However, if modifications are determined to be

In contrast to the existing fishways, newly installed fishways have not been constructed and therefore there has never been an evaluation to ensure the new fishways are operating as designed. As discussed below (section 5.1.3, *Measures Not Recommended*), we do not recommend installation of an alosine fishway in year 15, but we do recommend installation of an upstream eel ladder. Thus, for the upstream eel ladder, there would be a benefit to conducting a one-season “shakedown.”

Maine DMR’s recommendation and NMFS’s fishway prescription would ensure proper eel ladder operation and design (see section 3.3.2.2, *Fish Passage Design, Operation, Maintenance, and Monitoring*). NMFS’s fishway prescription would also require “shakedowns” to occur during the first season after fishways are constructed, which would allow the “shakedowns” to occur in a timely manner without substantial delay to the operation of the fishway. To prevent interference with the fish passage season and delay in conducting fish passage effectiveness studies, the “shakedown” period, and any necessary adjustments, should also be timed so that they are completed prior to relevant fish passage seasons and pertinent effectiveness studies.

To ensure the eel ladder is operating as designed and to make minor adjustments to facilities and operations, as needed, we recommend that GLHA operate the eel ladder for a “shakedown” period that would occur prior to the relevant upstream passage season and associated effectiveness studies. 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.

Species Protection Plan for Atlantic Salmon

Measures for Upstream Passage of Adult Atlantic Salmon

To evaluate the ability of the upstream fishway to meet a performance standard of 95 percent passage effectiveness for upstream migrating adult Atlantic salmon, GLHA proposes in the SPP for Atlantic salmon to conduct up to 3 years of upstream fishway effectiveness studies for Atlantic salmon using the methods in the existing approved study plan. GLHA’s proposed study would include coordination with resource agencies to stock uniquely marked Atlantic salmon smolts upstream of the Mattaceunk Project in the first 3 years after relicensing to serve as a source of imprinted juvenile fish that can be used for studying upstream passage as returning adults. GLHA proposes in the SPP for Atlantic salmon to implement an adaptive management approach, in consultation with the resource agencies that would include additional operational, structural, and/or habitat enhancement measures, if necessary, to improve passage and/or address performance

necessary at a future date, GLHA would need to file an application to amend the license and get Commission approval prior to implementing any modifications and any “shakedowns” subsequent to modifications.

criteria for upstream and downstream migrating Atlantic salmon. Specifically, if the upstream fishway is able to meet the performance standard of 95 percent effectiveness during one year of study, GLHA proposes to evaluate upstream passage at the project once every 10 years to verify continued achievement of the performance standard. If the project does not achieve the 95 percent performance standard for upstream passage, GLHA proposes to begin an adaptive management approach to meeting the performance standard, which would include consulting with the resource agencies and the Penobscot Indian Nation to make any modifications to the upstream fishway deemed appropriate, followed by additional study.

NMFS's fishway prescription would require, and Maine DMR also recommends GLHA's proposal to conduct up to 3 years of upstream fishway effectiveness studies. In addition, NMFS's fishway prescription would require, and Maine DMR recommends, GLHA's proposal to implement additional operational and structural modifications and/or habitat enhancement measures, if necessary, to address performance standard deficiencies for upstream migrating Atlantic salmon adults. NMFS also recommends, as proposed in the SPP for Atlantic salmon, that GLHA's adaptive management for upstream passage be developed in consultation with the resource agencies.

As discussed in section 3.3.4.2, *Upstream Passage Performance Standard and Effectiveness Testing*, increasing upstream passage effectiveness from rates as low as 71 percent under existing conditions to the proposed performance standard of at least 95 percent would allow more spawning-capable salmon to reach spawning grounds upstream of the project, which could advance the recovery of the GOM DPS. GLHA's proposed effectiveness studies would be necessary to determine whether or not the 95 percent effectiveness standard was met. If the existing upstream fishway does not meet the 95 percent effectiveness standard, the proposed adaptive management and additional effectiveness studies may be needed to improve upstream passage and meet the standard. The proposed studies and adaptive management approach are supported by NMFS²⁵⁷ and Maine DMR. Nevertheless, the SPP for Atlantic salmon lacks adequate detail with respect to the study design, the number of years of study, and the need and timing of additional studies not proposed. Specifically, the upstream passage effectiveness study, which was previously developed in consultation with the resource agencies and Penobscot Indian Nation, and approved by the Commission, includes scientifically acceptable methods, such as the use of telemetry tagged adult Atlantic salmon. However,

²⁵⁷ NMFS's fishway prescription requires that all passage effectiveness studies for eel, alosines, and Atlantic salmon, begin at the start of the second migratory season after fishways are operational. However, as discussed in detail below in section 5.1.3, *Measures Not Recommended*, this requirement would not be feasible for the upstream passage effectiveness studies for adult Atlantic salmon.

because some methodology, such as the choice of telemetry tag (e.g., radio-tag, acoustic tag) has not been finalized in the existing study plan, GLHA would need to revise the study plan in consultation with the resource agencies and the Penobscot Indian Nation, and file a revised plan for final approval from the Commission. In addition, because the existing study plans are not currently included in the SPP for Atlantic salmon,²⁵⁸ the existing study plans and any revisions will need to be included as attachments to the SPP for Atlantic salmon subsequent to GLHA receiving any new license.

Regarding the number of years of study, GLHA is proposing to conduct up to 3 years of effectiveness studies. Because GLHA is proposing to stock uniquely tagged smolts during the first 3 years after relicensing (discussed in detail in section 3.3.4.2, *Upstream Passage Performance Standard and Effectiveness Testing*), GLHA could conduct an additional 1 or 2 years of upstream passage effectiveness studies to provide additional verification of effectiveness. The need for an additional 1 or 2 years of study would need to be determined in consultation with the resource agencies, with final approval from the Commission.

After the upstream fishway meets the 95 percent effectiveness standard, GLHA proposes to reevaluate its effectiveness every 10 years. However, if the upstream fishway meets the 95 percent performance standard and is properly operated and maintained by following the proposed FPOMP with staff modifications (discussed above), there is no known benefit to conducting additional effectiveness monitoring every 10 years, and thus there is no need for additional monitoring. Therefore, we do not recommend that GLHA conduct additional upstream effectiveness monitoring every 10 years.

As stated above, GLHA is proposing to conduct up to 3 years of effectiveness studies. However, GLHA does not include any additional adaptive management provisions in the SPP for Atlantic salmon if the 95 percent performance standard is not met after 3 years of study. Further, for the purposes of this study, GLHA is only proposing to stock smolts for 3 years. Thus, a fourth year of study would not be feasible under GLHA's proposal, and stocking additional smolts for the purposes of additional study may not be consistent with the restoration objectives for Atlantic salmon.

²⁵⁸ GLHA's existing study plans for upstream passage (Upstream Salmon Passage – Interim Species Protection Plan) and downstream passage (Downstream Salmon Passage – Interim Species Protection Plan) were filed on December 11, 2013, as part of GLHA's revised study plans for relicensing the Mattaceunk Project. However, modifications to the study plans were made in 2015 to accommodate a request from NMFS to study smolt mortality in the project impoundment. The methods of the revised plans are included in the 2015 Atlantic Salmon Passage Study Report, filed on March 31, 2016.

Consequently, the SPP for Atlantic salmon needs an additional provision requiring GLHA to determine the need for future effectiveness studies or measures, in consultation with the resource agencies and the Penobscot Indian Nation, and with final approval from the Commission, that could be implemented if after three years of study the upstream fishway does not meet the performance standard.

Therefore, we recommend that GLHA modify the existing SPP for Atlantic salmon to include additional provisions to: (1) revise the upstream passage effectiveness study methodology, in consultation with the resource agencies and with final approval from the Commission, to include the type of telemetry tag to be used on upstream migrating adults and the appropriate timing for stocking tagged smolts, and refile the SPP with the revised study plan; (2) include the proposed passage effectiveness study plans as attachments to the SPP; (3) 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 95 percent performance standard after the first year; and (4) determine the need for future effectiveness studies or measures, with final approval from the Commission, if after 3 years of upstream passage effectiveness studies, the upstream fishway does not meet the 95 percent performance standard.

Downstream Passage of Smolts

Because of the low effectiveness of the existing bypass in passing smolts, GLHA is proposing to open the log sluice for 3 weeks during the migration season and to install full-depth trash racks with 1-inch clear bar spacing. To determine whether these additional downstream passage measures allow smolts to pass downstream of the project with at least 96 percent survival, GLHA proposes in the SPP for Atlantic salmon to conduct a minimum of 3 years of Atlantic salmon smolt downstream passage studies to determine whether the existing and proposed downstream passage operations and facilities meet a performance standard of 96 percent survival for smolts. Maine DMR recommends and NMFS's fishway prescription would require GLHA's proposal. Penobscot Indian Nation recommends, consistent with FWS's fish passage criteria, full-depth trash racks with 1-inch clear bar spacing for passage of smolts (*see* FWS, 2017a; and Sojkowski, 2017).

As part of the SPP for Atlantic salmon, GLHA proposes, Maine DMR recommends, and NMFS's fishway prescription would require the installation of full-depth trash racks with 1-inch clear bar spacing during the downstream passage seasons for smolts, kelts, and eel. However, as discussed in section 3.3.4.2, *Trash Racks*, reducing the existing 2.63-inch bar spacing in the lower water column, to 1-inch bar spacing, would not reduce entrainment, because smolts could pass through the 1-inch bar spacing and the 2.63-inch bar spacing. Thus, for the purposes of protecting smolts from entrainment, there is no apparent benefit to installing full-depth trash racks with 1-inch clear bar spacing. However, narrowly spaced trash rack bars have the potential to deter

fish from passing between the bars, but the difference in deterrence between trash racks with 1-inch spacing compared to 2.63-inch spacing is not known. Nevertheless, GLHA could explore the potential deterrence effect of adding full-depth trash racks with 1-inch clear bar spacing, if the downstream effectiveness studies for smolts indicate that the project is unable to meet the performance standard of 96 percent survival without the full-depth trash racks with 1-inch clear bar spacing. Thus, adding trash racks with 1-inch bar spacing could be a component of GLHA's adaptive management strategy (discussed in more detail below) to protect downstream passage of smolts, if necessary. There would be no benefit to the 1-inch bar spacing for kelts, because most kelts are already protected by the existing trash rack configuration.²⁵⁹

GLHA proposes the development and implementation of adaptive management that would include additional operational, structural, and/or habitat enhancement measures determined in consultation with the resource agencies to improve passage and/or address performance criteria for downstream migrating Atlantic salmon, if such measures are needed. GLHA describes its adaptive management approach in the SPP for Atlantic salmon, which includes the implementation of phased spill measures, and we discuss the adaptive management fully in section 3.3.4.2, *Smolt Passage Performance Standard and Effectiveness Testing*. Although the overall concept of the studies and adaptive management approach proposed in the SPP for Atlantic salmon are required and recommended by NMFS and Maine DMR, respectively, the SPP needs to be updated to be consistent with GLHA's current proposal to conduct a minimum of 3 years of downstream passage studies for smolts.²⁶⁰ Three years of studies that demonstrate a downstream passage survival rate of 96 percent would engender confidence that the project can consistently pass smolts that survive at that rate, and help in the recovery of the GOM DPS of Atlantic salmon.

The SPP for Atlantic salmon also lacks adequate detail with respect to the timing of proposed measures and the need and timing of additional studies not proposed. With respect to the timing of proposed measures, GLHA proposes that if downstream passage effectiveness studies demonstrate that the downstream bypass with log sluice operations is unable to meet the performance standard of 96 percent survival for smolts, and

²⁵⁹ As discussed in section 3.3.2.2, *Environmental Effects - Downstream Eel Passage*, installing 1-inch bar spacing to the full depth of the turbine intakes during the downstream eel passage season would be protective of larger eel.

²⁶⁰ In the SPP (filed with the final license application on August 31, 2016), GLHA indicates that it would conduct up to 3 years of downstream passage studies for smolts. However, in a letter filed on July 7, 2017, GLHA stated that it would conduct a minimum of 3 years of downstream passage studies for smolts, until a total of 3 years meet the proposed performance standard of 96 percent survival.

operational or structural modifications of the bypass and log sluice are not feasible, it would move to a phased spill approach that would occur from 8:00 pm to 4:00 am for 3 weeks during the smolt out-migration period that would be determined in consultation. However, the timing of the 3-week period during out-migration is not specified. Like operation of the log sluice, the 3-week period of spill should be determined in consultation with the resource agencies and with final approval from the Commission, to maximize the likelihood of matching spill with the smolt out-migration. The SPP for Atlantic salmon also does not clearly define when the phased spill measures would or could be implemented, other than to state that spill would be implemented if the downstream fishway with log sluice operations is unable to meet the performance standard of 96 percent survival for smolts, and operational or structural modifications of the bypass and log sluice are not feasible. The timing for implementing phased spill measures would be best determined through consultation, with final approval from the Commission. To prevent the establishment of a continuous loop of study and structural and/or operational modification without a finite limit, GLHA should begin implementing the phased spill measures after a maximum of 3 years of downstream passage studies and modifications show that the 96 percent performance standard has not been achieved. It may be determined, in consultation with the resource agencies and with final approval from the Commission, that the phased spill measures should be implemented prior to reaching a maximum of 3 years. However, at least 1 year of study should be conducted prior to implementing the phased spill measures to at least determine the effectiveness of the new log sluice operations, and thus determine whether phased spill is needed.

The SPP for Atlantic salmon also requires additional measures that are not proposed by GLHA. If the downstream bypass, together with the proposed structural and operational enhancements (i.e., full-depth trash racks with 1-inch clear bar spacing, opening the log sluice for 3 weeks), meet smolt performance criteria during 3 years of study, GLHA proposes to evaluate downstream passage for smolts at the project once every 10 years thereafter to verify continued achievement of the performance standard of 96 percent survival. As discussed in section 3.3.4.2, *Smolt Passage Performance Standard and Effectiveness Testing*, the ability to meet the 96 percent performance standard during each of 3 years of study would indicate that the downstream passage structures are effective at passing smolts downstream, and if the downstream passage structures are maintained by following the proposed FPOMP with staff modifications (discussed above), GLHA should meet the 96 percent standard indefinitely. Further, if the 96 percent performance standard is met during each of 3 years of study, there is no need for reevaluating the downstream passage survival for smolts every 10 years, as proposed by GLHA, because there are no proposed or anticipated changes that would cause smolt survival to change every 10 years. Thus, we do not recommend that GLHA conduct additional monitoring every 10 years to verify that a 96 percent survival performance standard is being met for smolts.

Therefore, we recommend that GLHA modify the existing SPP for Atlantic salmon to include additional provisions to: (1) revise the number of downstream passage effectiveness studies for smolts to indicate that a minimum of 3 years of study would be conducted; (2) revise the criteria for achieving the performance standard to state that the performance standard would be considered achieved if a total 3 years of downstream passage effectiveness studies for smolts demonstrate that the downstream passage structures meet a 96 percent survival performance standard; (3) determine, with final approval from the Commission, when to begin implementation of phased spill measures for downstream passage of smolts, with the restriction that phased spill measures would be implemented after at least 1 year of conducting downstream passage effectiveness studies for smolts, but after no more than 3 years of downstream passage effectiveness studies and non-spill passage modifications; and (4) determine, with final approval from the Commission, the 3-week period during which any phased spill measures would occur for downstream passage of smolts.

Measures for Downstream Passage of Smolts Through the Impoundment

To evaluate smolt mortality in the project impoundment, GLHA proposes in the SPP for Atlantic salmon to use the existing study plan²⁶¹ with additional modifications for conducting a more rigorous evaluation of the sources of impoundment mortalities, along with any additional modifications deemed appropriate during agency consultation. Further, GLHA proposes to develop an adaptive management plan, if necessary, to address impoundment mortality. GLHA does not state in the SPP for Atlantic salmon, the number of studies it would conduct, but Maine DMR recommends that GLHA conduct up to 3 years of studies to assess the sources of impoundment mortality. NMFS did not recommend a study, but did recommend that GLHA develop a mitigation plan, in consultation with NMFS and the resource agencies, for the loss of Atlantic salmon smolts as a result of maintaining the project impoundment.

As discussed in section 3.3.4.2, *Smolt Mortality in the Impoundment*, GLHA and Stich *et al.* (2015b) estimated smolt mortality in the project impoundment. The results from those studies demonstrate that mortality in the project impoundment is not consistently higher or lower than in free-flowing sections of the Penobscot River, and provide no consistent evidence for a current project operational effect. Further, there is no information from those studies or other sources (e.g., performance standards, or

²⁶¹ GLHA's existing study plan (Downstream Salmon Passage – Interim Species Protection Plan) was originally filed on December 11, 2013, as part of GLHA's revised study plan for relicensing the Mattaceunk Project. However, modifications to the study plan were made in 2015 to accommodate a request from NMFS to study smolt mortality in the project impoundment. The methods of the revised plan are included in the 2015 Atlantic Salmon Passage Study Report, filed on March 31, 2016.

otherwise acceptable levels of mortality) to suggest that mortality in the impoundment is excessive. In addition, because there is already sufficient information to assess smolt mortality in the impoundment, there is no need for additional post-license mortality studies.

Because there is no need to conduct a post-licensing impoundment mortality study, or implementing environmental measures to reduce mortality in the project impoundment, we conclude that conducting between 1 year (as proposed by GLHA) and 3 years (as recommended by Maine DMR) of impoundment mortality studies is not worth the annual levelized cost of \$11,270 to \$25,372, respectively. Further, because available evidence provides no indication that mortality in the project impoundment is excessive, there is no basis for recommending that GLHA develop a mitigation plan for the loss of smolts in the impoundment, and conclude that the mitigation plan is not worth the annual levelized cost of \$432.

Downstream Passage of Kelts

GLHA proposes in the SPP for Atlantic salmon to conduct up to 3 years of Atlantic salmon kelt downstream passage studies, using the same returning, imprinted adult salmon that would be used during the upstream passage study (discussed above). In these studies, GLHA would determine if the proposed operations and facilities meet a performance standard of 96 percent survival for kelts. Maine DMR recommends GLHA's study proposal. GLHA also proposes to develop and implement adaptive management to address performance criteria for downstream passage, but does not provide any specific provisions to implement for passage of kelts. NMFS's fishway prescription would require and Maine DMR recommends GLHA's proposal to study passage effectiveness for kelts.

Although GLHA's proposal has support from NMFS and Maine DMR, the proposal lacks details. In particular, GLHA does not propose, nor does anyone recommend, specific provisions that would be implemented if after 1 year of study the downstream passage structures do or do not meet the 96 percent survival performance standard. Because the studies for downstream kelt passage effectiveness would require the use of the same study fish used in the upstream passage effectiveness studies and are thus confined to the same restrictions of using stocked smolts to begin the study, we conclude that the similar provisions for additional study and measures should apply after 1 year of study. Specifically, 1 year of study may be adequate if the study shows that the downstream passage structures are able to meet the 96 percent performance standard. However, because GLHA is proposing to stock uniquely tagged smolts during the first 3 years after relicensing for the purposes of the adult passage studies, GLHA could conduct an additional 1 or 2 years of downstream passage effectiveness studies to provide additional verification of effectiveness regarding kelts. The need for an additional 1 or 2

years of study would best be determined in consultation with the resource agencies, and with final Commission approval.

Evaluation of the downstream passage structure effectiveness may show that the downstream passage structures do not meet the 96 percent survival performance standard for kelts. Under this scenario, GLHA could determine the need to conduct an additional 1 or 2 years of study, in consultation with the resource agencies and Penobscot Indian Nation, with final approval from the Commission. However, if the performance measure is not met after a total of 3 years of studying downstream passage effectiveness for kelts using the salmon originally stocked as smolts, then GLHA would need to determine the need for additional effectiveness studies and/or measures, in consultation with the resource agencies and Penobscot Indian Nation, with final approval from the Commission. Use of this adaptive management approach described above would ensure that kelts would be able to pass the project with at least 96 percent survival, and help in the recovery of the GOM DPS.

Therefore, we recommend that GLHA modify the existing SPP for Atlantic salmon to include additional provisions to: (1) determine the need for an additional 1 or 2 years of downstream passage effectiveness studies for kelts, with final approval from the Commission, if the downstream fishway meets the 96 percent survival performance standard for kelts after the first year; (2) determine the need to conduct at least 1 year of additional effectiveness study, with final approval from the Commission, if the downstream fishway does not meet the 96 percent survival performance standard for kelts after the first year; and (3) determine the need for future effectiveness studies and/or downstream passage measures, with final approval from the Commission, if after 3 years of downstream passage effectiveness studies, the downstream passage structure does not meet the 96 percent survival performance standard for kelts.

GLHA proposes in the SPP for Atlantic salmon to implement an adaptive management approach, in consultation with the resource agencies that would include additional operational, structural, and/or habitat enhancement measures, if necessary, to meet the performance standards for upstream and downstream migrating Atlantic salmon. NMFS's fishway prescription would require, and Maine DMR recommends, GLHA's proposal. Implementing structural or operational modifications may be appropriate at some future date, if a need is identified.²⁶² At this time, specific structural or operational modifications have not been proposed, recommended, or prescribed, because the proposed monitoring (discussed above) has not been conducted. Thus, there is currently

²⁶² If a need for specific structural and/or operational modifications were to be identified at a future date, the licensee would have to file an amendment application with the Commission, seeking authority to alter the terms of the license.

no information to indicate a need or benefit for modifications. Because there is no identified need or benefit of implementing structural or operational modifications, there is no justification for authorizing the implementation of such measures in this proceeding. In addition, it would be inconsistent with Commission policy to authorize implementation of an unspecified measure, because such a measure is without limitations.²⁶³ Because the Commission cannot exercise its oversight authority on measures without limits, the Commission cannot approve such measures. Therefore, 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, GLHA must file an application to amend the license and get Commission approval.

We estimate that the levelized annual cost of modifying the SPP for Atlantic salmon with all of the additional provisions discussed above would be \$432, and conclude that the benefits of the measures outweigh the cost. We do not recommend that the SPP for Atlantic salmon include a provision to install full-depth trash racks with 1-inch clear bar spacing during the downstream migration season for smolts and kelts.²⁶⁴ Installing the trash racks during the downstream season for smolts and kelts would increase the levelized annual cost from \$417,212 that would be incurred by only installing the trash racks during the downstream passage season for eel, to \$873,962 for installing the trash racks during the downstream passage season for smolts, kelts, and eel. We conclude that the benefits of installing the trash racks during the downstream passage season for smolts and kelts are not worth the additional levelized annual cost of \$86,462.

Species Protection Plan for Northern Long-Eared Bat

The official FWS list of threatened and endangered species includes the northern long-eared bat as potentially occurring in the project area. Northern long-eared bat hibernacula sites are not known to occur in the project vicinity; however, no bat surveys were conducted. The project vicinity is largely forested, and should supply suitable habitat for summer roosting and foraging activities. While the applicant does not propose any additional ground disturbing or clearing activities as part of relicensing, project maintenance activities during the term of any new license could require periodic removal

²⁶³ See 116 FERC ¶ 61,270 (2006).

²⁶⁴ By not recommending the installation of full-depth trash racks with 1-inch clear bar spacing for smolts and kelts, we are recommending maintaining existing conditions for trash racks during the downstream migration season for smolts and kelts. Maintaining existing conditions would result in a normal velocity in front of the trash racks of 1.6 fps, which is less than the 2.0 fps included in the FWS (2017a) design criteria, and recommended by Penobscot Indian Nation.

of non-hazardous trees in the project boundary and ROW. If the northern long-eared bat is present in the project vicinity, tree removal may affect its habitat or food availability. Since the project is located inside the white-nose syndrome zone, in an area that may contain potential maternal roost trees, and would require the removal of hazard trees, additional protection measures are needed to avoid prohibited incidental take of northern long-eared bat.

According to the 4(d) rule, removing occupied maternity roost trees, or any trees within 150 feet of an occupied roost tree is prohibited during the northern long-eared bat pup season (i.e., June 1 – July 31). In addition, FWS’s recommendation to allow tree removal only during the northern long-eared bats’ inactive period, which is November 1 through March 31, is a discretionary conservation measure to minimize or avoid adverse effects on this species (FWS, 2016b).

Avoiding non-hazardous tree removal during the pup season and the broader active period would protect northern long-eared bats potentially using the project area and would be consistent with FWS’s determination of effects to this species. Accordingly, we recommend that GLHA develops a species protection plan for the threatened northern long-eared bat that limits non-hazardous tree removal to the period of November 1 through March 31, which is outside of the northern long-eared bat pup season (June 1 to July 31), and the broader active season (April 1 to October 31). We estimate that the levelized annual cost of developing a species protection plan would be \$432, and conclude that the benefits of the measure outweigh the cost.

5.1.3 Measures Not Recommended

Continuous Stream Temperature Monitoring

NMFS recommends that GLHA develop continuous stream temperature monitoring downstream of the dam from April 1 through October 31. NMFS argues that project operation could intensify the potential effects of climate change on stream temperature below the dam, and thus influence smolt emigration, adult immigration, and juvenile development in nursery habitats downstream of the dam. GLHA does not propose water quality monitoring.

As discussed in section 3.3.2.2, *Water Quality*, monitoring conducted in 2012 indicates that water temperature in the project impoundment and tailwaters did not deviate substantially from unimpounded waters upstream of the project impoundment. Maine’s water quality standards do not include water temperature limits, but as discussed in section 3.3.2.2, *Environmental Effects*, data collected in the impoundment in 2014 show that the impoundment does not stratify by temperature and that the impoundment has a short residence time. Together, these findings support the conclusion that there are no substantial project-related temperature issues under current and proposed operation.

In addition, NMFS does not explain a clear relationship between climate change and water temperature in the project tailrace, or how project operation would interact with a changing climate and impact smolt emigration. Further, the existing fish population within the project vicinity is diverse, self-sustaining, and healthy – suggesting that there are no project-related water quality issues (including temperature). Finally, because there is no indication that the project alters water temperature downstream of the tailrace in a way that would negatively affect aquatic resources during operation, there is no need to monitor continuously for stream temperature. Consequently, NMFS’s recommendation lacks a nexus to any project effect. Therefore, we do not recommend the measure be included in any new license issued for the Mattaceunk Project.

Finally, the Penobscot Indian Nation comments that GLHA’s temperature monitoring for about 4.5 months of 2012 does not adequately characterize the water temperature for the project. The Penobscot Indian Nation believes that a plan for monitoring for multiple years is necessary. Based on existing water quality data, as discussed in 3.3.2.2, *Environmental Effects*, data collected upstream, in the impoundment, and in the tailwater, although limited in sample size, indicate that there is no significant temperature deviation between the three habitats. Therefore, we do not recommend a plan for monitoring temperature.

Trash Rack Installation Schedule

GLHA proposes to implement downstream eel passage measures beginning the first downstream eel passage season after license issuance, which include: (1) seasonally ceasing generation from 8:00 pm to 4:00 am; (2) opening the project’s roller gate; and (3) installing full-depth trash racks with 1-inch clear bar spacing. GLHA, however, would install the trash racks within 2 years of license issuance. The proposed trash rack schedule is consistent with the schedule required by NMFS in its fishway prescription.²⁶⁵ Interior, in its fishway prescription, requires the night-time shutdowns and installation of

²⁶⁵ See NMFS’s Fishway Prescription at A-63 (Condition 7.3.2.a). Condition 7.3.5 of NMFS’s Fishway Prescription, however, requires that GLHA provide conceptual designs for the proposed full-depth trash racks with 1-inch clear bar spacing at least 6 months prior to the first downstream passage season following license issuance. Based on our interpretation, there appears to be a discrepancy between these two conditions. For example, Condition 7.3.2.a indicates that NMFS is adopting GLHA’s proposal to install the new trash racks within 2 years of license issuance, while Condition 7.3.5 requires conceptual designs to be provided at least 6 months prior to the first downstream passage season, which implies installation potentially occurring prior to the first downstream passage season. We ask that NMFS, in any modified fishway prescription filed with the Commission, clarify its schedule for installing/deploying the new, full-depth trash racks at the project.

a full-depth trash rack with 1-inch clear bar spacing, but provides no implementation schedule. Maine DMR recommends that GLHA provide downstream passage for eel beginning the first passage season following license issuance, including installing full-depth trash racks with 1-inch clear bar spacing.

GLHA proposes measures to protect out-migrating adult (silver) eel, as well as for Atlantic salmon and alosines that are generally consistent with protection measures recommended by the resources agencies. However, GLHA and the resource agencies differ as to when to initially install/deploy the new full-depth trash racks with 1-inch clear bar spacing.

The number of adult eel upstream of the project dam is unknown, though available data suggests the numbers are low. While the new upstream eel ladder, which will be installed at the project within 2 years of license issuance, is expected to improve upstream passage efficiency of juvenile eel and increase the number of eel upstream of the project, these eel will not migrate downstream as adults until at least 2030. With regard to Atlantic salmon, and as discussed above, downstream migrating smolts and kelts would not substantially benefit from full-depth trash racks with 1-inch clear bar spacing. Thus, only eel would be affected by the trash rack installation schedule.

In order for GLHA to implement the downstream passage measures in a way that meets all requirements of the resources agencies, and efficiently protects eel, the proposed measures (i.e., turbine shut-down, full-depth trash racks with 1-inch clear bar spacing, and roller gate opening) need to be implemented using a comprehensive approach. As discussed in section 3.3.2, *Aquatic Resources – Environmental Analysis*, implementing the nighttime shutdown and opening the roller gate may not provide sufficient protection to out-migrating adult eel, without the full-depth trash racks being in place. The more biologically beneficial approach to protecting downstream migrating eel at the project would be to implement the downstream eel passage measures in a coordinated and combined fashion. Therefore, we do not recommend that the proposed trash racks be installed prior to the first downstream passage season, but rather recommend that the trash racks be installed within 2 years of license issuance. This timing is consistent with the other downstream passage measures proposed and recommended for the project and represents a schedule that would most effectively and efficiently protect downstream migrating eel.

Approach Velocities

NMFS's fishway prescription would require GLHA to take point measurements of approach velocities immediately upstream of the project trash racks after installation of full-depth trash racks with 1-inch clear bar spacing, and ensure that point measurements do not exceed 2.0 fps within a 2-foot-square grid. As discussed in section 3.3.4.2, *Approach Velocity*, approach velocities can be estimated by dividing the maximum

hydraulic capacity by the total intake area of the powerhouse (EPRI, 2000). Using this approach, GLHA estimated the average approach velocities at the project to be 1.7 fps, which is lower than the burst swim speeds of smolts and kelts (table 20), and therefore reduces entrainment and impingement risk during the downstream migration. Approach velocities would not deviate substantially from 1.7 fps, because there are no proposed changes to the size of the turbine intake or the maximum hydraulic capacity. Through-screen velocities could increase with debris accumulation on the trash racks, but through implementation of the proposed FPOMP with staff recommended modifications discussed above, GLHA would regularly clear debris from the trash racks during the migration season and velocities would not increase.

Based on the information above, approach velocities at the project are already known, would not change under proposed operations, and are protective of downstream migrating fish. Further, through-screen velocities would not change with implementation of the FPOMP with staff recommended modifications. Given the existing conditions, there would be no benefit to measuring approach velocities, as required by NMFS's fishway prescription, or measuring other velocities (e.g., through-screen) near the trash racks. Therefore, we do not recommend NMFS's fishway prescription to take point measurements after installation of full-depth trash racks with 1-inch clear bar spacing, and conclude that it is not worth the levelized annual cost of \$259.

Trash Rack Design

To reduce entrainment of eel and Atlantic salmon, GLHA proposes to install full-depth trash racks with 1-inch clear bar spacing. Penobscot Indian Nation recommends that GLHA install trash racks at the project that meet FWS's fish passage design criteria (FWS, 2017a). The criteria include installing trash racks capable of maintaining a ratio of sweeping velocity to normal velocity equal to or greater than 1, and having 0.75-inch clear bar spacing and 1-inch clear bar spacing, for reducing entrainment of eel and Atlantic salmon,²⁶⁶ respectively.²⁶⁷

²⁶⁶ As discussed above in section 5.1.2, *Additional Measures Recommended by Staff*, we do not recommend GLHA's proposal for installing full-depth trash racks with 1-inch clear bar spacing for the protection of downstream migrating Atlantic salmon.

²⁶⁷ The FWS design criteria also stipulates that the normal velocity in front of the trash racks not be greater than 2 fps, and that the fish bypass flow be at least 5 percent of hydraulic capacity of the station. All proposed and recommended trash rack designs included in this EA would meet a normal velocity of 2 fps, and, thus, adherence to this criteria is not discussed further. The criteria for the fish bypass flow is discussed in a subsequent section of this EA (i.e., section 5.1.3, *Downstream Bypass Attraction Flows*).

RATIO OF SWEEPING VELOCITY TO NORMAL VELOCITY – Under existing and proposed trash rack dimensions, the sweeping velocity is 0.4 fps, which results in a ratio of sweeping velocity to normal velocity of 0.25 (i.e., 0.4:1.6), which is less than 1 (Sojkowski, 2017). To achieve a ratio of sweeping velocity to normal velocity equal to or greater than 1, Sojkowski (2017) indicates that GLHA would have to increase the angle of the trash racks relative to the face of the powerhouse or increase the incline of the trash racks relative to streambed, both of which would require extending the walls along the intake bays of all four turbine units. Trash racks designed with a ratio of sweeping velocity to normal velocity equal to or greater than 1 are intended to improve downstream passage by reducing entrainment and improving guidance toward a bypass (Sojkowski, 2017). However, trash racks meeting this criteria have not been tested at the project, and there is no certainty that if installed, such trash racks would reduce entrainment compared to GLHA’s proposal to install full-depth trash racks with 1-inch clear bar spacing, along with other proposed downstream passage measures (discussed below).

We evaluated FWS’s Region 5 design criteria, where it concerns eel and Atlantic salmon, in section 3.3.2.2, *Aquatic Resources – Environmental Effects* and section 3.3.4.2, *Threatened and Endangered Species – Environmental Effects*, respectively. We stated that trash racks designed to meet the criteria for a sweeping velocity to normal velocity equal to, or greater than, 1 are intended to enhance downstream passage by reducing entrainment and improving guidance toward a bypass (Sojkowski, 2017). However, we found that for eel and Atlantic salmon, designing trash racks to meet this criteria may not improve downstream passage at the Mattaceunk Project, because FWS (2017a) represents general design criteria that have not been tested or modeled at the project. In addition to the unproven design, installing trash racks that meet FWS’s design criteria would require substantial structural changes at the project.

GLHA proposes, and the agencies recommend, a suite of downstream passage measures that are expected to provide safe and effective downstream passage for eels and Atlantic salmon. For eel, these measures include installing full-depth trash racks with 1-inch clear bar spacing, opening the roller gate to provide a low-level passage route, and turbine shutdowns during the out-migration period. For Atlantic salmon, these measures include continued operation of the existing bypass, opening the log sluice for 3 weeks during the smolt migration season, and installing full-depth trash racks with 1-inch clear bar spacing. The Penobscot Indian Nation does not appear opposed to these measures, but recommends that GLHA install trash racks at the project that conform 100 percent to the FWS Region 5 design criteria. We concluded in section 3.3.2.2 and 3.3.4.2, that both GLHA’s proposal (also recommended by the agencies) and Penobscot Indian Nation’s recommendation would likely provide safe and effective passage for adult eel and Atlantic salmon smolts and kelts. However, the Penobscot Indian Nation has not adequately demonstrated the biological need for its recommended trash rack design, especially considering the substantial costs that GLHA would incur for the structural

changes that would need to be made at the project. The more prudent approach would be to implement the measures proposed by GLHA and recommended by the agencies, and implement downstream passage effectiveness studies for eel and Atlantic salmon to determine if the measures implemented are sufficient to achieve performance standards for the downstream passage survival of eel and Atlantic salmon. Should the monitoring show that the performance standards are not being met, additional structural changes, such as those recommended by the Penobscot Indian Nation, or other operational changes could be explored at that time.

TRASH RACK BAR SPACING – As discussed in section 3.3.2.2, *Aquatic Resources – Environmental Effects*, the protective benefit provided by a clear bar spacing of 0.75-inch versus 1-inch may be negligible for eel. Based on GLHA’s fish entrainment assessment (GLHA, 2015), a clear bar spacing of 1 inch would exclude eels 24 inches and larger, whereas a clear bar spacing of 0.75 inch would exclude eels 20 inches and larger. In comparison, the documented size of adult eels in the Penobscot River is between 24 and 30 inches, which would require a clear bar spacing of 0.9 inch. Therefore, we concluded that a trash rack with a clear bar spacing of 0.75 inch would be unnecessary, given the limited additional protective benefit. We also concluded that (a) the protective value of a clear bar spacing of 0.9 inch versus 1 inch would be negligible, and (b) a clear bar spacing of 0.75 is not likely to be substantially more protective than a clear bar spacing of 1 inch.

The downstream passage measures proposed by GLHA and recommended by the agencies include full-depth trash racks with 1-inch clear bar spacing, opening the roller gate to provide a low-level passage route, and turbine shutdowns during the out-migration period. Together, these measures are expected to significantly improve survival of downstream migrating adult eel at the project, regardless of whether the clear bar spacing is 0.75 inch or 1 inch. If these measures do not achieve the downstream passage efficiency goals prescribed by Interior, additional measures, such as a different trash rack configuration (including bar rack spacing), can be implemented to achieve the prescribed level of downstream passage efficiency for eel.

CONCLUSION – As discussed above, compared to the existing trash racks, there is no known added protective benefit to installing trash racks that meet the FWS criteria for the ratio of sweeping velocity to normal velocity and clear bar spacing of 0.75 inch for eel. Further, installing trash racks that meet these two FWS criteria would have an annual levelized cost of \$1,594,896, which is \$1,177,684 more than the cost to install 1-inch full depth trash racks during the downstream migration season for eel and maintain the existing trash racks during the downstream migration season for Atlantic salmon (i.e., annual levelized cost is \$417,212). Therefore, we do not recommend that GLHA install trash racks that meet the FWS criteria for the ratio of sweeping velocity to normal velocity and clear bar spacing for eel.

Downstream American Eel Passage Operational Period

Under existing project conditions, downstream routes for adult (silver) eel migrating through the project area include either passing over the spillway when the project spills, through the upstream fishway and log sluice when they are being used, or through the turbines during generation. However, turbine passage is the most likely downstream passage route during the adult eel migration period from August to December because GLHA generally passes all river flow through the project turbines when possible.

GLHA conducted a fish entrainment and impingement study for the Mattaceunk Project in 2014 (GLHA, 2015). The results indicate that the project has the potential to adversely affect downstream-migrating adult (silver) eel. Adult eel have a relatively high risk of entrainment at the project because of their benthic orientation when out-migrating and their likelihood to pass through the lower trash racks that have a clear bar spacing of 2.63 inches. Empirical entrainment rate information for eel suggests that rates are higher in the late summer to winter time periods, with individuals longer than 10 inches composing the majority of the eel.

GLHA proposes, and the resource agencies recommend, the same measures to protect downstream migrating adult eel (e.g., implementing night-time shutdowns, opening the project's existing roller gate to provide a low-level passage route, and installing full-depth trash racks with 1-inch clear bar spacing). However, GLHA and the resource agencies differ in regards to the operational period for the night-time turbine shutdowns. For instance, GLHA proposes to implement annual night-time shutdowns from 8:00 pm to 4:00 am, with the schedule being developed in consultation with the resource agencies and being based on a predictive model for eel movement through the project. In the interim, GLHA would implement a night-time shutdown period of up to 6 weeks (8:00 pm to 4:00 am nightly), beginning as early as the first significant rain event (1 inch or greater of rain) occurring on or after August 15. The night-time shutdown period, however, would start no later than September 15. Interior's fishway prescription would require GLHA to shut down all generation nightly (8:00 pm to 4:00 am) from August 1 through October 31. Maine DMR, similarly, recommends that GLHA institute annual night-time turbine shutdowns (8:00 pm to 4:00 am) from August 1 through October 31.

Night-time shutdowns²⁶⁸ are commonly used at hydropower projects to protect eel migrating downstream. Such nightly shutdowns would fully protect eel migrating

²⁶⁸ Shutdowns can take the form of 24-hour shutdowns for the entire eel migration season, or can be implemented nightly from dusk to dawn during the period of peak

downstream through the project area from turbine entrainment injury and mortality, though some injuries and mortalities could occur from the corresponding increased spillway passage.

As we found in section 3.3.2, *Aquatic Resources – Environmental Effects*, shutting generation down, annually, through the entire out-migrating season, or even longer, would provide the greatest level of protection for adult eel passing through the project. However, available evidence indicates that such shutdowns may not be efficient at reducing eel mortality, and would result in unnecessary turbine shutdowns with associated generation losses. For example, downstream eel migration is known to occur largely in episodic events based on environmental cues such as increased river flows following rain events, cooling temperatures, and moon phase. Thus, timing shutdowns based on site-specific eel monitoring data and environmental conditions could substantially reduce project-related eel mortality, while also reducing the cost of lost generation (Haro *et al.*, 2003). Recent studies conducted in the lower Penobscot River as well as information provided by the Maine DMR support this conclusion (*see* section 3.3.2, *Aquatic Resources – Environmental Effects*).

Consistent with the strategy to protect eel on the Shenandoah River (Smith *et al.*, 2017), in West Virginia, and FWS’s 2015 American Eel Biological Species Report Supplement, GLHA proposes to target night-time shutdowns for downstream eel passage based on a predictive model that considers environmental variables that are expected to occur in late August (beginning August 15), September, and/or October.²⁶⁹ Implementing such an approach (with the use of a cut-off probability value), along with opening the project’s roller gate and the addition of full-depth trash racks with 1-inch clear bar spacing, is expected to reduce mortality of downstream-migrating eel, as well as minimize lost power generation. GLHA’s proposed effectiveness monitoring would provide a mechanism for GLHA and the resource agencies to refine both the model and ultimately the period of time the project’s generating units are shut down to aid in downstream eel passage.

migration based on site-specific monitoring or information from upstream projects (Richkus and Whalen, 1999; Smith *et.al.*, 2017).

²⁶⁹ GLHA proposes to consult with the resource agencies in developing the predictive eel out-migration model. The cut-off probability value, as well as the environmental triggers for shutting down project operations and for restarting operations should be identified during the consultation. In addition, the mechanism for measuring the success of implementing the predictive model, both in terms of eel passage and lost generation, should be identified.

GLHA's proposal for a 6-week shutdown would result in a loss of 6,260 MWh of generation at an annual levelized cost of \$313,000, annually. In contrast, FWS's and Maine DMR's approach to shut down all generation every night (from 8:00 pm to 4:00 am) from August 1 through October 31 would result in an estimated loss of 12,520 MWh of generation, at an annual levelized cost of \$626,000, annually. The agencies' recommended 12-week shutdown, therefore, would double the amount of lost generation and annual cost associated with downstream eel passage at the project, when compared to GLHA's proposal. GLHA's proposal and the agencies' recommendation, however, are likely to protect a similar number of out-migrating eel, though the additional 6 weeks is likely to protect a small, though unknown, number of additional eel. Thus, the additional cost of the agencies' recommended measure would not be worth the benefit derived.

Based on the above discussion, we recommend GLHA's proposed schedule for ceasing generation be included in any new license issued for the Mattaceunk Project. However, Interior's prescription for nighttime shutdowns from August 1 through October 31 is mandatory, and, therefore, would be included in any new license issued for the project.

Upstream Alosine Passage

Restoration of alosines in the Penobscot River is ongoing, and in 2016 alosines were observed in the Mattaceunk pool and weir fishway for the first time since the removal of the Great Works (2012) and Veazie (2013) dams, and the installation of a fish lift at Milford (2014). Currently, alosines are unable to migrate upstream of the Mattaceunk Project because the existing pool and weir fishway is ineffective at passing alosines. GLHA proposes to install a fishway for alosines in year 15 of the license. This measure is also recommended by Maine DMR and Maine DEP and required in NMFS's fishway prescription.

As discussed in section 3.3.2.2., *Upstream Alosine Passage*, alosine spawning habitat located downstream of the Mattaceunk Project is currently underutilized (less than 3 percent of its production potential). Thus, based on available information, there would be minimal benefit to providing access to additional alosine habitat upstream of the Mattaceunk Project by installing an alosine fishway now or in the near future. In addition, many factors make it difficult to predict, with any certainty at this point in time, the run sizes of alosines in the Penobscot River in year 15 of any new license issued, and whether the number of fish seeking passage past the Mattaceunk Project would warrant the installation of an additional fishway at the dam. Given this uncertainty and associated conditional nature of this future measure, we have no basis for recommending the installation of an alosine fishway in year 15. Likewise, we have no basis for concluding that the as yet, uncertain benefits of the measure, would be worth the levelized annual cost of \$233,981.

Because we are not recommending upstream alosine passage, we also do not recommend any of the following proposed and recommended measures that are contingent on the installation of the upstream alosine fishway: (1) extending the operation season of the existing downstream fish passage facilities to accommodate alosine passage, as proposed by GLHA and recommended by NMFS and Maine DMR; (2) developing a study plan to monitor the effectiveness of alosine passage, as proposed by GLHA and recommended by NMFS and Maine DMR; (3) conducting 2 years of effectiveness monitoring of upstream and downstream passage structures for alosines, as proposed by GLHA and recommended by NMFS and Maine DMR; and (4) developing an operation and maintenance plan for the upstream alosine fishway, as recommended by Maine DMR.

As described in section 3.3.2.2, the restoration of alosines would continue through year 2032 and the term of any new license. Although requiring upstream passage for alosines at this time is not warranted, over time, data on run sizes of alosines in relation to available spawning habitat and within-river spawning distributions in the Penobscot River could provide the necessary information that would argue in favor of providing upstream passage during the term of a new license. If such monitoring data support the need for alosine passage at some point during a new license term, the licensee could file a non-capacity related amendment to propose passage, and/or NMFS could exercise its reservation of authority to require passage. Ideally, the licensee and NMFS would work together to gather the information necessary to support such a passage proposal/requirement. However, as it stands, NMFS's section 18 fishway prescription to install upstream passage in year 15 does not include an analysis, based on alosine monitoring, to inform a decision on the need for the upstream passage requirement.

Upstream Passage for Sea Lamprey

Sea lamprey are an anadromous species that currently pass upstream of the West Enfield Dam, and are potentially present immediately downstream of the project. Sea lamprey could attempt to use the existing pool and weir fishway to pass upstream, but because sea lamprey are poor swimmers, they are unlikely to successfully move through the weirs and up successive pools because the fishway was designed for strong swimmers like salmon. NMFS recommends that GLHA design the proposed upstream alosine fishway to provide sea lamprey with a safe passage route upstream of the project.

As discussed in section 3.3.2.2, *Upstream Passage for Sea Lamprey*, the need for sea lamprey to pass safely upstream of the project is not evident. Although sea lamprey were historically present upstream of the project, the relative abundance and importance of upstream habitat to the historical and existing sea lamprey population is not known. Because the abundance and importance of upstream habitat is not known, a benefit to passing sea lamprey upstream of the project cannot be identified. Therefore, we do not recommend that GLHA provide upstream passage for sea lamprey.

Impoundment Elevations and Upstream Passage Operation

As discussed in section 3.3.4.2, *Effects of Impoundment Elevation on Upstream Passage Operation*, the existing upstream fishway is operational under normal operating conditions, which could include impoundment fluctuations down to an impoundment elevation of 238.0 feet (i.e., 2 feet below the top of the flashboard elevation of 240 feet). The upstream fishway is not operational at an impoundment elevation of 236.0 feet, which occurs when the 4-foot-high flashboards are down. However, there is an unknown impoundment elevation between 236.0 feet and 238.0 feet at which the upstream fishway becomes non-operational. NMFS recommends that GLHA determine the specific elevation at which the upstream fishway becomes non-operational to inform future fishway operations and any new fishway construction. However, knowing the elevation at which the upstream fishway becomes non-operational would provide no benefit to the operation of the upstream fishway and upstream passage of Atlantic salmon, because under existing and proposed project operations, the impoundment elevations are always at or above 238.0 feet when the flashboards are in place (fishway is operational), or between 235.0 feet and 236.0 feet, when the flashboards are down (fishway is not operational). An impoundment elevation between 236.0 feet and 238.0 feet would never occur under normal operations. Therefore, because the existing upstream fishway would be operational under the proposed normal operating conditions (i.e., with the 4-foot-high flashboards in place), which are the same as existing operations, we do not recommend that GLHA identify the impoundment elevation at which the existing upstream fishway can no longer operate.

Fishway Design

GLHA is proposing to install new fishways to provide passage for eel and alosines, and to consult with the resource agencies on the design of new fishways. As-built drawings are an important component of the fishway design process, because they provide documentation that fishways are designed properly. NMFS's fishway prescription would require GLHA to provide as-built drawings to the resource agencies, for any new fishways and Maine DMR recommends that GLHA also provide as-built drawings for modified fishways, along with a licensed engineer's letter of certification. However, because it is the responsibility of the Commission to approve and ensure proper design of fishways, there would be no benefit to providing certified as-builts drawings to the resource agencies. Further, as-built drawings would be filed with the Commission and accessible to the resource agencies from the Commission. Therefore, we do not recommend requiring GLHA to provide certified copies of as-builts to the resource agencies.

Upstream Fishway Fish Trap

NMFS's fishway prescription would require GLHA to maintain the existing fish trap for counting adult Atlantic salmon as they exit the existing upstream fishway. Maine

DMR recommends that GLHA provide counts of adult Atlantic salmon that exit the upstream fishway to resource agencies, but does not specify a need to continue using the existing fish trap. GLHA proposes to monitor the upstream fishway and count the number of adult Atlantic salmon passing upstream of the project using a methodology developed in consultation with resource agencies. As discussed in section 3.3.4.2, *Environmental Effects, Counting Atlantic Salmon in the Upstream Fish Trap*, count data collected at the project can be used to help estimate Atlantic salmon population abundance. Nevertheless, there is no benefit to counting Atlantic salmon (in the fish trap or by other means), as it relates to project effects on the GOM DPS. More specifically, counting Atlantic salmon does not protect Atlantic salmon from project effects, mitigate a project effect on Atlantic salmon, or enhance the GOM DPS. Although NMFS's fishway prescription would require GLHA to count Atlantic salmon in the fish trap, for the reasons stated above, we do not recommend a license condition requiring GLHA to use the existing fish trap for counting Atlantic.

Modifications to Atlantic Salmon Passage Operating Schedules

GLHA proposes, Maine DMR recommends, and NMFS would require operation of the upstream fishway from May 1 to November 10, and the downstream bypass from April 1 to June 15 [smolts and kelts] and October 17 to December 1 [kelts]. In addition to the specified operating schedules, NMFS has a fishway prescription that would require GLHA to open the existing upstream fishway prior to May 1 if the fish lift at Milford dam begins capturing adult Atlantic salmon earlier than May 1. Maine DMR recommends including a provision in any new license to allow modification of the permanent upstream and downstream fishway operating schedules for Atlantic salmon during the term of the license. Such modification would occur in consultation with Maine DMR, FWS, and NMFS, based on new information or migration data. Maine DMR also recommends that, with approval from Maine DMR, FWS, and NMFS, GLHA have the ability to make changes in the operating schedules in any given year in response to river conditions, maintenance requirements, and annual variability in migration patterns.

Both Maine DMR and NMFS are in agreement that there should be flexibility to modify the fishway operating schedules for Atlantic salmon based on environmental or passage data. However, neither Maine DMR's recommendation nor NMFS's prescription includes limits regarding the number of days earlier or later that the fishways should be able to operate beyond the proposed schedules. In the absence of recommended or prescribed limits on operating schedule modifications, we have no information to analyze, and therefore no information to determine whether a particular schedule modification would or would not provide benefits to the GOM DPS of Atlantic salmon. More directly, we are unable to determine whether the schedule modifications would be in the public interest. Therefore, we are unable to identify any benefits to implementing unspecified modifications to the upstream fishway operating schedule.

Thus, we do not recommend a license requirement that allows GLHA to modify, without limits, the operating schedules of the upstream fishway and downstream bypass used by Atlantic salmon.²⁷⁰

Downstream Bypass Attraction Flows

As discussed in section 3.3.4.2, *Downstream Passage Operations*, the existing bypass is not effective at passing smolts downstream. To improve passage of Atlantic salmon smolts migrating downstream at the project, GLHA proposes to continue operating the downstream bypass at its maximum flow capacity of 140 cfs (2 percent of station hydraulic capacity), and to implement an added measure to provide additional safe downstream flows of 225 cfs to 690 cfs (between 3 percent and 9 percent of station hydraulic capacity) through the log sluice. Penobscot Indian Nation and Bruce Haines recommend that GLHA redesign the existing bypass to provide an attraction flow of 5 percent of hydraulic capacity, which meets the 5 percent design criteria recommended by FWS (2017a).

To be effective, safe passage routes, like the bypass or log sluice, must pass flows (i.e., attraction flows) that are capable of attracting fish to these safe routes. If the attraction flows are not discernable from competing flows (e.g., turbine intakes), fish could be attracted toward an unsafe route, such as the turbine intakes. In general, higher attraction flows are better (NMFS, 2011) and FWS (2017a) recommends a minimum attraction flow of 5 percent of station hydraulic capacity.

Increasing the bypass flows from 2 percent of hydraulic capacity under existing conditions to 5 percent of hydraulic capacity would increase attraction flows, which should be more discernable, and thereby improve attraction and passage through the bypass. Nevertheless, the existing bypass pipe has a maximum flow capacity of 2 percent of station hydraulic capacity, and cannot be increased to provide a 5 percent attraction flow without structural changes, which have not occurred and are not proposed. Consequently, the ability of a 5 percent attraction flow to improve downstream passage through the bypass has not been tested at the Mattaceunk Project. Therefore, the exact benefit of increasing attraction flow to 5 percent through the bypass is not known.

GLHA proposes, Maine DMR recommends, and NMFS requires in its fishway prescription, opening the project's log sluice (at between 3 percent and 9 percent of station hydraulic capacity, or between approximately 225 cfs and 690 cfs)²⁷¹ starting the first passage season following relicensing to facilitate downstream smolt out-migration for a 3-week period during the spring (determined in consultation with resource

²⁷⁰ See 116 FERC ¶ 61,270 (2006).

²⁷¹ The log sluice has a gated capacity of 690 cfs.

agencies). This measure represents an alternative to providing a 5 percent attraction flow through the bypass that would not require structural changes. Like Bruce Haines' recommendation, providing log sluice flows that are between 3 and 9 percent of station hydraulic capacity would increase the amount of safe passage flows above 2 percent. However, log sluice flows could increase to 9 percent of station hydraulic capacity – which is nearly double the 5 percent flows recommended by Bruce Haines and FWS (2017). Thus, operating the log sluice has the potential to be effective at increasing attraction of smolts toward a safe route, compared to existing conditions. However, the increased attraction flows through the log sluice have not been tested, and thus like Bruce Haines' recommendation, the benefits are not known.

Compared to Bruce Haines' recommendation, GLHA's proposed log sluice operations has the potential to provide equally effective attraction, yet equally unknown benefits to the downstream passage of smolts. However, the levelized cost of redesigning the bypass to provide a bypass attraction flow of 5 percent would be \$172,924.²⁷² Conversely, the levelized cost of implementing the proposed log sluice operations would be \$37,250. Because of the higher cost of providing a 5 percent attraction flow through the bypass, and the potential to be equally effective and beneficial as the log sluice operations, we do not recommend that GLHA redesign the bypass to provide an attraction flow of 5 percent.

Operating Period for the Downstream Bypass

Bruce Haines recommends operating the downstream bypass with 5 percent attraction flows, 365 days per year for Atlantic salmon smolts and kelts. However, based on existing information on the downstream migration of smolts and kelts (discussed in section 3.3.4.2, *Environmental Effects, Downstream Passage Operations*), GLHA's proposal to operate the downstream bypass from April 1 to June 15 for smolts and kelts, and from October 17 to December 1 for kelts covers the timeframe when smolts and kelts are most likely to be migrating downstream of the project. Because most smolts and kelts are not migrating outside of the proposed timeframe, providing passage outside of this timeframe would not provide a substantial benefit to the passage success of smolts or kelts. Further, the levelized annual cost of operating the bypass with 5 percent attraction flows, 365 days per year would be \$190,095. Operating the downstream bypass when

²⁷² This levelized cost only includes the cost to redesign the bypass to provide a 5 percent attraction flow, and does not include additional costs to operate and maintain a bypass that is capable of providing 5 percent attraction flows. Bruce Haines recommends operating the bypass with 5 percent attraction flows, 365 days per year. The levelized cost of operating the bypass with 5 percent attraction flows, 365 days per year would be \$190,095. We discuss this specific component of Bruce Haines' recommendation below in the section title, *Operating Period for the Downstream Bypass*.

most smolts and kelts are likely to be migrating would be \$25,000. Because there is no substantial benefit to operating the bypass 365 days per year, and because the levelized annual cost is \$165,095 greater than the cost of GLHA's proposed bypass operations, we do not recommend that GLHA operate the downstream bypass year-round.

Timing of Atlantic Salmon Passage Effectiveness Studies

NMFS's fishway prescription would require that all passage effectiveness studies for eel, alosines, and Atlantic salmon, begin at the start of the second migratory season after fishways are operational. The existing upstream fishway and downstream bypass are currently operational, and thus the effectiveness studies for the Atlantic salmon that use those fishways could, in theory, be conducted during the start of the first migratory season. However, as discussed in detail in section 3.3.4.2, *Upstream Passage Performance Standard and Effectiveness Testing* and *Kelt Passage Performance Standard and Effectiveness Testing*, the studies on upstream migrating adult Atlantic salmon and downstream migrating kelts would require salmon that are imprinted to habitats upstream of the project, and thus motivated to migrate upstream of the Mattaceunk Project. This requirement necessitates stocking smolts upstream of the project, which would be imprinted to those habitats, migrate out to sea, and return on average, 2 years later to be telemetry tagged and used in the effectiveness studies. If smolts are stocked in the first year after any new license is issued, adults would not likely return until at least the third year after any new license is issued. Thus, effectiveness studies for upstream migrating adult Atlantic salmon and downstream migrating kelts could not occur within the time constraints of NMFS's prescription. Consequently, NMFS's prescription lacks substantial evidence as to its need. Therefore, we do not recommend that there be a requirement in any new license to begin the upstream adult or downstream kelt effectiveness studies at the start of the second migratory season after the fishways are operational.

Time Standard for Downstream Passage of Atlantic Salmon

As discussed in section 3.3.4.2, *Smolt Passage Performance Standard and Effectiveness Testing* and section 3.3.4.2, *Kelt Passage Performance Standard and Effectiveness Testing*, GLHA proposes to conduct studies to evaluate downstream passage survival for smolts and kelts. NMFS states in its fishway prescription that during the downstream passage survival studies, smolts and kelts must pass the project forebay area within 24 hours to be considered as a successful passage attempt that can be applied toward calculation of downstream passage survival. To support the 24-hour passage criteria for smolts, NMFS cites Stich *et al.* (2015a). NMFS states that the results from Stich *et al.* (2015a) indicate that downstream passage delay of more than 24 hours at each dam in freshwater habitat of the Penobscot River causes increased mortality in the Penobscot River estuary. As discussed in detail in section 3.3.4.2, *Smolt Passage Performance Standard and Effectiveness Testing*, there is evidence that delays at dams

can reduce survival of smolts (but not kelts). However, there is no evidence attributing a specific duration of delay to excessive smolt or kelt mortality, and thus there is no evidence to indicate that smolts or kelts that do not pass a dam within 24-hours will experience excessive mortality. Based on the evidence available, there would be no benefit to including a 24-hour passage criteria in the study designs used to estimate downstream passage survival of smolts and kelts. Therefore, we do not recommend including a requirement, in any new license, for smolts or kelts to pass downstream of the project within a specific 24 hour threshold to be considered as a successful passage attempt.

Portage Plan

GLHA operates and maintains an existing portage around Weldon Dam. Interior recommends that GLHA consult with the Penobscot Indian Nation to develop a plan for the canoe portage around the project. Interior states that there is no good way for boaters to portage through the woods around the dam. However, Interior does not explain why the existing portage trail is not a feasible route for portaging canoes around the dam, and no clarity is provided about whether improvements to the existing trail are needed because of the existing portage's condition or some other factor.

As discussed in section 3.3.5, *Land Use and Recreation*, the portage is located on the west bank of the river, and follows a 9-foot-wide gravel road that is periodically used by GLHA for maintenance. GLHA inspects and maintains the signage associated with the trail, including signs at the take-out, put-in, and directional signs along the route. Photos provided by GLHA of the canoe portage indicate that it is clear and maintained, and no other comments have been filed indicating issues with the existing route. Therefore, we do not recommend inclusion of a portage plan for the project as a license requirement.

5.1.4 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 Mattaceunk Project, as proposed by GLHA with the additional staff-recommended measures, would be best adapted to a plan for improving the Penobscot River Basin.

5.2 UNAVOIDABLE ADVERSE IMPACTS

Some entrainment mortality is likely unavoidable for Atlantic salmon and adult eel migrating downstream even with upstream and downstream passage for these species. Entrainment also is likely unavoidable for some resident fish species like smallmouth bass and white sucker. Most adult fish could avoid involuntary entrainment, but entrainment of some small fish could still occur. Additionally, some dewatering of

shallow water nests is likely unavoidable for species that spawn in shallow water, such as smallmouth bass, when the 4-foot-high flashboards are not in place.

5.3 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 March 24, 2017, 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 May 23, 2017, NMFS filed eight section 10(j) recommendations on May 23, 2017, and Maine DMR filed 39 section 10(j) recommendations on May 22, 2017.

In the draft EA, we determined that Interior's recommendation filed pursuant to section 10(j) was within the scope of section 10(j). We also determined that four of the eight recommendations filed by NMFS pursuant to section 10(j) on May 23, 2017, were within the scope of section 10(j). Of the four recommendations that were considered to be within the scope of section 10(j), we determined that one recommendation may be inconsistent with the purpose and requirements of the FPA or other applicable law. Finally, we determined that 22 of the 39 recommendations filed by Maine DMR pursuant to section 10(j) on May 22, 2017, were within the scope of section 10(j). Of the 22 recommendations that were considered to be within the scope of section 10(j), we determined that four recommendations may be inconsistent with the purpose and requirements of the FPA or other applicable law. We sent letters to NMFS and Maine DMR on March 15, 2018 informing them of the inconsistencies.

On April 27, 2018, NMFS requested a meeting to discuss the one recommendation that we determined may be inconsistent with the purpose and requirements of the FPA or other applicable law. To try to resolve the inconsistency, Commission staff conducted a 10(j) meeting via teleconference with NMFS on June 7, 2018. During the 10(j) meeting, we discussed NMFS's recommendation to develop a flow monitoring plan, in consultation with the resource agencies and USGS that includes measures to install flow monitoring equipment in the project tailrace to confirm that minimum flow requirements are being met.

In the draft EA, we did not recommend NMFS's recommendation because GLHA does not propose any changes in minimum flows, has an existing system that is fully

capable of monitoring minimum flows, and has operated the project without any evidence of deviating from the required minimum flows. In addition, because GLHA would continue to provide resource agencies with flow monitoring data upon request and make flow data available on the National Waterline website, we determined that there was no benefit to making the flow data available in another format (e.g., USGS format). Therefore, we concluded that NMFS's recommendation was not worth the leveled annual cost of \$719, and made a preliminary determination that NMFS's recommendation may be inconsistent with the comprehensive planning standard of section 10(a) of the FPA and the equal consideration provision of section 4(e) of the FPA.

At the 10(j) meeting, NMFS stated that it was concerned about the uncertainty of the monitoring system GLHA uses to monitor flows, and requested that GLHA discuss how flows are monitored. GLHA described the curves that it uses to monitor flows that pass through the turbines (i.e., kilowatts of generation versus flow), and how flows that pass through the dam gate or over the flashboards (i.e., gate setting versus flow) are monitored. NMFS questioned whether the curves are still accurate, and added that turbine efficiency changes over time, which causes the relationship between generation and flow to change. GLHA indicated that the curves have not been verified in nearly 14 years since the turbines were installed. NMFS stated that the only way to confirm that the curves are accurate is to gauge the flows.

Staff asked whether a reasonable alternative would be to include, as part of an operation compliance monitoring plan, a provision to verify the accuracy of the curves using in-stream field measurements within a short time period after license issuance, and every 10 years thereafter. GLHA was agreeable to the overall approach, but was concerned that verification every 10 years might not be necessary. Instead, GLHA proposed the idea of developing an appropriate verification schedule based on discussions with Alden (i.e., fluid dynamics consultants) and the turbine vendor. NMFS indicated that it was agreeable to this approach, but would want to review and comment on any proposed plan. GLHA agreed to file an operation compliance monitoring plan that included the methods and schedule for verifying the accuracy of the curves.²⁷³ No other 10(j) issues were raised.

In a June 28, 2018 filing, subsequent to the 10(j) meeting, NMFS recommended that GLHA develop a flow monitoring plan, in consultation with the resource agencies that would include conducting a study, within 1 year of any new license issued, to verify the accuracy of the curves used to estimate minimum flows, and making near-real time data and historical flow data electronically available on the internet within 1 year of any new license issued. NMFS's recommendation is generally consistent with the approach

²⁷³ GLHA filed an operation compliance monitoring plan on September 14, 2018. We will address the merits of the plan in the license order.

discussed by Commission staff, GLHA, and NMFS at the 10(j) meeting. However, during the 10(j) meeting we did not discuss, and in section 5.1.2, *Additional Measures Recommended by Staff*, we do not recommend, making historical flow data electronically available on the internet within 1 year of any new license issued.

As discussed in section 5.1.2, *Additional Measures Recommended by Staff*, to ensure compliance with the minimum flow requirements of any new license issued, we recommend, consistent with the approach discussed at the 10(j) meeting, that GLHA develop an operation compliance monitoring plan with measures to: (1) monitor minimum flows and impoundment elevation levels using the existing system; (2) document compliance with project operation; (3) verify the accuracy of the curves used to estimate minimum flows within 1 year of any new license issued, and recalibrate as necessary; (4) verify and recalibrate the curves subsequent to the first verification event, as needed, during the term of the new license; (5) report operational data and deviations;²⁷⁴ and (6) facilitate administration of the license.

Table 25 lists the recommendations filed pursuant to section 10(j), and indicates whether the recommendations are included under the staff alternative. 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 and in section 5.1, *Comprehensive Development and Recommended Alternative*.

²⁷⁴ In section 5.1.2, *Additional Measures Recommended by Staff*, we recommend that GLHA continue to make project flow data available on the internet in near-real time, and that historical flow data be made available to the public upon request.

Table 25. Analysis of fish and wildlife agency recommendations for the Mattaceunk Project.

Recommendation	Agency	Within scope of section 10(j)?	Levelized Annual Cost	Recommend Adopting?
<p>Operate in a run-of-river mode, such that outflow approximately equals inflow, and impoundment water levels are maintained within 1.0 foot of the top of flashboard crest elevation (240.0 feet) during normal operations, and within 2.0 feet of the flashboard crest elevation (240.0 feet) for irregular circumstances (i.e., to allow adequate margin for debris loads, ice loads, or sudden pool increases that might cause flashboard failure), and up to 1.0 foot of the crest of dam elevation (236.0 feet) when replacing the flashboards.</p>	<p>NMFS, Interior, Maine DMR</p>	<p>Yes.</p>	<p>\$0</p>	<p>Yes.</p>
<p>Develop plans to monitor impoundment water levels. The applicant shall consult with the resource agencies and USGS in developing these plans, and shall respond to agency comments and include their correspondence in future filings with the Commission. The applicant shall provide the resource agencies a minimum of 30 days to respond to draft plans before filing for Commission approval.</p>	<p>NMFS</p>	<p>Yes.</p>	<p>\$432</p>	<p>Yes. Staff recommend the development of an operations monitoring plan, which would include plans to monitor impoundment water levels.</p>

Recommendation	Agency	Within scope of section 10(j)?	Levelized Annual Cost	Recommend Adopting?
Continue to provide a year-round continuous minimum base flow of 1,674 cfs or inflow, whichever is less. Continue to provide a daily average minimum flow of 2,392 cfs from July 1 through September 30 and 2,000 cfs from October 1 through June 30, or average inflow, whichever is less.	NMFS, Maine DMR	Yes.	\$0	Yes.
<p>Develop a flow monitoring plan, in consultation with the resource agencies.</p> <p>Conduct a study, within 1 year of any new license issued, to verify the accuracy of the curves used to estimate minimum flows.</p> <p>Make near-real time and historical flow data electronically available on the internet within 1 year of any new license issued.</p>	NMFS	<p>Yes.</p> <p>Yes.</p> <p>No.^a</p>	<p>\$2,332</p> <p>\$546</p>	No. Staff recommend the development of an operations monitoring plan, which would include monitoring for minimum flows and impoundment water levels, verifying the accuracy of the existing flow monitoring system, recalibrating the curves used to estimate flows, and making historical flow data available upon request.
Conduct continuous stream temperature monitoring between April 1 and October 31 to assure that the dam and its operations do not intensify the effects of climate change that can affect smolt emigration, adult immigration, and juvenile development in nursery habitats downstream of the dam.	NMFS	No. ^b	\$200	No. No nexus.

Recommendation	Agency	Within scope of section 10(j)?	Levelized Annual Cost	Recommend Adopting?
<p>Operate each fishway for a “shakedown” period subsequent to any new fishway construction, or operational or structural modifications to existing fishways, and prior to the relevant fish passage season and pertinent effectiveness studies to ensure it is operating as designed and to make minor adjustments to facilities and operations, as needed.</p> <p>Have a licensed engineer certify that fishways are constructed and operating as designed at the end of each “shakedown” period.</p>	Maine DMR	<p>Yes (for the upstream eel ladder); No (for “shakedowns” following operational or structural modifications to existing fishways).^c</p> <p>No.^{a,c}</p>	<p>\$0</p> <p>\$0</p>	<p>No. We recommend a “shakedown” period only subsequent to the installation of the upstream eel ladder.</p> <p>No.</p>
Provide the Maine DMR, FWS, and NMFS with a copy of the as-built fishway drawings for any new or modified fishways as submitted to the Commission, along with the licensed engineer's letter of certification.	Maine DMR	No. ^a	\$0	No.

Recommendation	Agency	Within scope of section 10(j)?	Levelized Annual Cost	Recommend Adopting?
<p>The applicant shall, consistent with safe working practices, keep the fishways in proper working order and shall maintain fishway areas clear of trash, logs, and material that would hinder passage.</p> <p>Routine maintenance shall be performed sufficiently before a migratory period such that fishways can be tested and inspected, and will be operational during the migratory periods.</p>	Maine DMR	<p>Yes.</p> <p>Yes.</p>	<p>\$10,259 (This is the cost to modify the FPOMP. Both measures would be included in the modified FPOMP.)</p>	<p>Yes. Included in our recommended modifications to the FPOMP.</p> <p>Yes. Included in our recommended modifications to the FPOMP.</p>
<p>In consultation with the Maine DMR, FWS, and NMFS, the applicant shall draft and maintain written Fishway Operating Procedures (FOPs) for the Mattaceunk Project. These FOPs will include general schedules of routine maintenance, procedures for routine operation, procedures for monitoring and reporting on the operation of each fish passage facility or measure, and schedules for procedures for annual start-up and shutdown, and procedures for emergencies and project outages significantly affecting fishway operations.</p> <p>Copies of these FOPs, and any revisions made during the term of the license, will be sent to the Maine DMR, FWS, and NMFS.</p>	Maine DMR	<p>Yes.</p> <p>No.^a</p>	<p>\$10,259 (This is the cost to modify the FPOMP. Both measures are covered by the modified FPOMP.)</p>	<p>Yes. This measure is consistent with our recommendation to modify the FPOMP.</p> <p>No. The modified FPOMP would be filed with the</p>

Recommendation	Agency	Within scope of section 10(j)?	Levelized Annual Cost	Recommend Adopting?
				Commission and made available to the public.
<p>Meet annually in March with the resource agencies to review fish passage operations data.</p> <p>Draft an annual report to include the number of fish passed daily (by species), daily water temperature, air temperature, and any other related fishway operational information.</p> <p>Draft a fishway operations plan for all fishways each year following the annual meeting to review fish passage operations.</p>	Maine DMR	<p>No.^a</p> <p>No.^a</p> <p>No.^d</p>	<p>\$0</p> <p>\$259</p> <p>\$3,000</p>	<p>No, regarding Maine DMR's recommendation to meet annually in March.</p> <p>No, regarding Maine DMR's recommendation to count the number of fish passed daily for all species.</p> <p>No. Fish passage operations and maintenance plans would be modified for the existing fishways, or developed for any new fishways. Once modified or developed, those plans can be modified in consultation, but new plans are not needed annually.</p>
Once installed, applicant shall maintain and operate permanent fishways during the upstream and downstream migration periods for: (1) Atlantic salmon;	Maine DMR	Yes.	\$25,000 (for existing upstream passage for Atlantic salmon);	Yes.

Recommendation	Agency	Within scope of section 10(j)?	Levelized Annual Cost	Recommend Adopting?
<p>(2) American shad, blueback herring, alewife; and</p> <p>(3) American eel.²⁷⁵</p>		<p>No.^e</p> <p>Yes.</p>	<p>\$25,000 (for downstream passage for Atlantic salmon)</p> <p>\$233,981 (for new upstream fishway for alosines)</p> <p>\$14,323 (for upstream eel ladder); \$626,000 (for downstream passage)</p>	<p>No. Installation of the alosine fishway is not recommended for reasons explained in section 5.1.3.</p> <p>Yes.</p>

²⁷⁵ The specific migration periods recommended by Maine DMR are discussed in section 3.3.1.2, *Aquatic Resources, Environmental Effects* for eel and alosines, and in section 3.3.3.2, *Threatened and Endangered Species, Environmental Effects* for Atlantic salmon.

Recommendation	Agency	Within scope of section 10(j)?	Levelized Annual Cost	Recommend Adopting?
			operations for eel)	
Modify the fishway operating schedules during the term of the license based on migration data, new information, and in consultation with the Maine DMR, FWS, and NMFS. Upon request of licensee, the actual dates of operation may be varied in any given year in response to river conditions, maintenance requirements, or annual variability in fish migration patterns, with the approval of Maine DMR, FWS, and NMFS, as appropriate.	Maine DMR	No. ^f	\$0	No.
Design, install and maintain, in consultation with NMFS and FWS, a seasonal upstream eel ramp within 2 years of the effective date of the new license to provide upstream passage for eel. The upstream eel passage facility shall be designed in consultation with the resource agencies, and resource agencies shall review the 30 percent, 60 percent and 90 percent drawings.	Maine DMR	Yes.	\$14,323	Yes.
Monitor the seasonal upstream eel ramp for use and effectiveness during one eel passage season.	Maine DMR	Yes.	\$1,297	Yes.

Recommendation	Agency	Within scope of section 10(j)?	Levelized Annual Cost	Recommend Adopting?
Install an upstream fishway for alosines in year 15 of the new license, and operate the structure in year 16 of the new license.	Maine DMR	No. ^e	\$233,981	No. Installation of the alosine fishway is not recommended for reasons explained in section 5.1.3.
Monitor the upstream fishway for alosines for two years, following the completion of construction.	Maine DMR	No. ^e	\$5,967	No.
The new upstream fishway proposed by the applicant should be designed to ensure safe passage for sea lamprey.	NMFS	No. ^e	\$0	No.
Implement additional operational and structural modifications and/or habitat enhancement measures, if necessary, to provide eel and alosine passage (passage criteria for eel and alosines shall be based on a review of the performance of comparable fish passage measures in New England).	Maine DMR	No. ^g		No. ^h
Beginning in the first passage season following license issuance, the licensee shall institute annual nighttime turbine shutdowns (from 8 PM to 4 AM) in combination with installation of the 1-inch clear spacing full-depth trash racks and opening the project's	Maine DMR	Yes.	\$626,000	No. Recommend nighttime shutdowns that begin within 2 years of license issuance.

Recommendation	Agency	Within scope of section 10(j)?	Levelized Annual Cost	Recommend Adopting?
<p>roller gate in support of downstream migrating eel.</p> <p>Provide downstream passage for eel for 12 weeks from August 1 through October 31 each year.</p>		Yes.		No. Recommend providing downstream passage for up to 6 weeks each year.
<p>The licensee shall conduct 3 years of studies to determine the effectiveness of the nighttime shutdowns, coupled with installation of the full-depth trash racks with 1-inch clear spacing and water releases from the roller gate for passing eel downstream in a safe, timely, and effective manner.</p>	Maine DMR	Yes.	\$7,613	Yes. Recommend 3 years of monitoring studies.
<p>Install full-depth trash racks with 1-inch clear bar spacing, and would be installed seasonally during the downstream migration seasons for eel, alosines, and Atlantic salmon.</p> <p>Begin installing the seasonal full-depth trash racks with 1-inch clear bar spacing during the first passage season for Atlantic salmon and eel.</p>	Maine DMR	Yes.	\$101,462	Yes, for eel. No, for alosines and Atlantic salmon.
<p>Begin installing the seasonal full-depth trash racks with 1-inch clear bar spacing during the first passage season for Atlantic salmon and eel.</p>		Yes.	\$0	No. Recommend installing full-depth trash racks with 1-inch clear bar spacing within 2 years of license issuance.

Recommendation	Agency	Within scope of section 10(j)?	Levelized Annual Cost	Recommend Adopting?
Provide downstream passage for alosines after the upstream fishway for alosines is operational (expected in year 16), by: (1) operating the downstream fishway continuously from April 1 to December 1; and (2) by opening the sluice gate (between 3 percent [225 cfs] and 9 percent [690 cfs] of station hydraulic capacity) for a 3 week period between April 1 and June 15 (exact schedule determined in consultation with resource agencies and based on environmental factors), and between June 1 and November 30, as needed based on monitoring results.	Maine DMR	No. ^e	\$342,000	No.
<p>Continue to maintain and operate the existing upstream pool and weir fishway annually from May 1 to November 10 to provide passage for adult Atlantic salmon to spawning habitats upstream of Weldon Dam.</p> <p>Continue to provide counts of adult Atlantic salmon that exit the existing upstream fishway and enter the impoundment to resource agencies.</p>	Maine DMR	Yes.	\$25,000	Yes.
		No. ^a	\$0	No.

Recommendation	Agency	Within scope of section 10(j)?	Levelized Annual Cost	Recommend Adopting?
Continue to provide auxiliary attraction water to the existing upstream fishway entrance of 7 cfs via a gravity fed pipe.	Maine DMR	Yes.	\$0 – costs are accounted for in the item immediately above.	Yes.
Coordinate with resource agencies to stock uniquely marked Atlantic salmon smolts upstream of Weldon Dam in the first three years after relicensing to serve as a source of imprinted adult fish (i.e., fish homing to areas upstream of Weldon Dam) used for studying upstream passage of adults and downstream passage of kelts.	Maine DMR	Yes.	\$7,063	Yes.
Conduct up to 3 years of upstream fishway effectiveness testing and up to 3 years of downstream kelt studies using the returning imprinted adult fish.	Maine DMR	Yes.	\$14,705	Yes.
Implement additional operational and structural modifications and/or habitat enhancement measures, if necessary, to address performance standard deficiencies for upstream migrating Atlantic salmon adults.	Maine DMR	No. ^g	\$0 – costs would be included as part of the effectiveness monitoring for upstream and downstream	No.

Recommendation	Agency	Within scope of section 10(j)?	Levelized Annual Cost	Recommend Adopting?
			passage (see table 24)	
Continue to maintain and operate the downstream fish passage facility to provide downstream passage for Atlantic salmon smolts (juveniles) and kelts (post-spawning adults) from April 1 to June 15 and Atlantic salmon kelts from October 17 to December 1.	Maine DMR	Yes.	\$25,000	Yes.
Open the project's log sluice (between 3 percent and 9 percent of station hydraulic capacity, or between approximately 225 cfs and 690 cfs) starting the first passage season following relicensing in support of downstream Atlantic salmon smolt out-migration for a 3 week period during the spring that would be determined in consultation with resource agencies.	Maine DMR	Yes.	\$37,250	Yes.
Conduct a minimum of 3 years of Atlantic salmon smolt downstream passage survival monitoring for existing fish passage operations, coupled with operation of the log sluice and implementation of the 1-inch clear spacing full-depth trash racks.	Maine DMR	Yes.	\$25,372	Yes.

Recommendation	Agency	Within scope of section 10(j)?	Levelized Annual Cost	Recommend Adopting?
Conduct up to 3 years of studies to assess the sources of impoundment mortality for Atlantic salmon smolts.		No. ^a	\$0	No.
Implement an adaptive management plan to address performance criteria for downstream passage of Atlantic salmon, should the proposed measures be inadequate.	Maine DMR	No. ^g	\$0 – costs would be included as part of the effectiveness monitoring for upstream and downstream passage (see table 24)	No. Staff recommends the SPP for Atlantic salmon, which includes a proposal to implement adaptive management.
Implement additional operational and structural modifications and/or habitat enhancement measures, if necessary, to address outmigrating Atlantic salmon smolts and kelts.	Maine DMR	No. ^g	\$0 – costs would be included as part of the effectiveness monitoring for upstream and downstream passage (see table 24)	No.

Recommendation	Agency	Within scope of section 10(j)?	Levelized Annual Cost	Recommend Adopting?
Develop a mitigation plan, in consultation with NMFS and resource agencies, for the loss of Atlantic salmon smolts as a result of maintaining the project impoundment.	NMFS	No. ⁱ	\$432	No. A project effect on smolt mortality in the impoundment has not been identified, thus there is currently no nexus.

- ^a Not a specific fish and wildlife measure. Measure that does not specifically provide for the protection, mitigation, or enhancement of fish and wildlife resources.
- ^b Monitoring by itself would not provide any evidence intensifying the effects of climate change, and NMFS did not provide or recommend methodology for identifying potential temperature changes that would indicate an intensification exclusive of the effects of climate change. Therefore, the recommendation is unrelated to the proposed action.
- ^c There is no reserved authority under section 10(j) for measures related to uncertain, future actions. The effectiveness of the existing fishways can be tested prior to license issuance. Therefore, the recommendation does not fall within the scope of section 10(j).
- ^d This is not a specific fish and wildlife measure. The plans have yet to be developed, and the plans' provisions are generic and uncertain. In addition, there is no reserved authority under section 10(j) for future, uncertain actions.
- ^e Maine DMR's justification for the recommendation is based on conditions that do not warrant passage at the project at this time, and the expectation that conditions will be favorable in the future. Measures instituted at a time conditioned on future events (i.e., presence of alosines) that might never occur, are outside the scope of section 10(j).
- ^f 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.
- ^g Not a specific fish and wildlife measure. Further, there is no reserved authority under section 10(j) for measures related to uncertain, future actions.
- ^h This is a measure that would be included in the effectiveness monitoring plans for eel passage and the SPP for Atlantic salmon. However, any future operational or structural modifications would require Commission approval prior to implementation.

- ⁱ Measure that does not specifically provide for the protection, mitigation, or enhancement of fish and wildlife resources. This is a measure that cannot be defined at the present time, because the need for mitigation has not been identified. Stipulations that there should be beneficial measures without mention of the specific measures to be implemented are outside the scope of section 10(j), as are measures that cannot be defined until the occurrence of future events (e.g., excessive smolt mortality in the project impoundment).

5.4 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 24 comprehensive plans that are applicable to the Mattaceunk 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 Mattaceunk 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 resources, 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 Mattaceunk 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 Draft Environmental Assessment

Commission staff issued its draft environmental assessment (EA) for the licensing of the Mattaceunk Hydroelectric Project (Mattaceunk Project) on March 15, 2018. Staff requested comments on the draft EA be filed within 45 days from the issuance date. The following entities filed comments pertaining to the draft EA.

<u>Commenting Entity</u>	<u>Date Filed</u>
National Marine Fisheries Service (NMFS)	April 12, 2018
Bureau of Indian Affairs (BIA)	April 23, 2018
Great Lakes Hydro America, LLC (GLHA)	April 27, 2018
Maine Department of Marine Resources (Maine DMR)	April 27, 2018
NMFS	April 27, 2018
Penobscot Indian Nation	April 30, 2018
U.S. Department of the Interior (Interior)	April 30, 2018

Below, we summarize the substantive comments, provide responses to those comments, and explain how we modified the text of the draft EA, as appropriate, to address the comments. The comments are grouped by topic for convenience.

General Comments

Comment: The Penobscot Indian Nation comments that the Commission’s draft EA makes no mention of the human environment, as required under the National Environmental Policy Act (NEPA) and conducts no assessment of the project effects on the human environment.

Response: The Penobscot Indian Nation does not state what it believes is specifically missing from the discussion of the human environment. Contrary to the Penobscot Indian Nation’s general claim, the draft and final EA specifically analyzes the potential effects of the proposal to issue a new license on six types of resources in the project area—geology and soil resources, aquatic resources, terrestrial resources, threatened and endangered species, land use and recreation, and cultural resources—that together encompass the “human environment” defined by CEQ as “the natural and physical environment and the relationship of people with that environment.” Further, we conduct these analyses of the potential effects of the project proposal on the human environment under five alternative scenarios assuming various operational and environment measures.

Federal Lands

Comment: Penobscot Indian Nation comments that there are federal tribal reservation lands currently submerged underneath the project impoundment.

BIA provides a study (Roy, 2014) that described research into the land surveys authorized by Massachusetts and Maine in relation to the 1796, 1818, and 1820 Treaties with the Penobscot Indian Nation. BIA alleges that the study concludes that the Penobscot Indian Nation never ceded the bed of the Penobscot River to the State of Maine.

Response: BIA's comments were filed in relation to the Commission's July 17, 2017, request for clarification of the specific lands to which the Interior's May 23, 2017, request to reserve authority under section 4(e) of the Federal Power Act (FPA) applies. We have modified section 1.3.1.2, *Section 4(e) Conditions*, to reflect BIA's filing and include the Penobscot Indian Nation's position on the matter of the presence of federal tribal reservation lands at the project.

Analysis of Alternatives

Comment: In a letter filed on April 12, 2018, NMFS commented that it is unclear if we are requesting consultation on the staff alternative or the staff alternative with mandatory conditions. NMFS also comments that the draft EA cannot substitute for a biological assessment (BA) because it lacks clarity as it relates to the proposed federal action on which we are requesting Endangered Species Act (ESA) consultation.

In a letter filed on April 27, 2018, NMFS comments that the draft EA is unconventional with respect to NEPA practice, because it does not present a separate analysis of each alternative considered. Consequently, NMFS requests that we issue a revised draft EA that presents a separate analysis of each alternative considered.

Penobscot Indian Nation provides comments that it would like to see a revised draft EA or a draft environmental impact statement (EIS) prepared as described above by NMFS.

Response: The proposed federal action on which we are requesting ESA consultation is the staff alternative with mandatory conditions. In section 2.5, *Staff Alternative with Mandatory Conditions*, we describe the staff alternative with mandatory conditions.

With regard to the need for a stand-alone document containing our BA of the effects of the proposed action on ESA-listed species or designated critical habitat, our BA is already incorporated into the draft EA and final EA, which includes, among other things: (1) a description of the proposed action; (2) descriptions of all listed species or

critical habitat that may be affected by the proposed action; (3) a description of the area that may be affected by the proposed action; and (4) a description of how the proposed action may affect listed species or critical habitat. Therefore, there is no need for a separate, stand-alone document with our BA of the effects of the proposed action on ESA-listed species or designated critical habitat.

With respect to NMFS's request to revise the draft EA to present a separate analysis of each alternative, NEPA and the implementing regulations do not require that an EA provide a separated review of each reasonable alternative. This is true even for an EIS. An EIS "must rigorously explore and objectively evaluate all reasonable alternatives",²⁷⁶ and devote "substantial treatment" to each.²⁷⁷ The Council on Environmental Quality (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."²⁷⁸

None of the considered alternatives, including the no action alternative, entail new construction or modification of project facilities or changes to existing operations, except for fish passage facilities. The considered alternatives do 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 33-198; final at 36-213) provides a level of treatment for each of the considered alternatives that enables a reviewer to evaluate and compare these alternatives. A separated analysis of the action alternatives would be needlessly duplicative. Thus, this final EA serves as our final NEPA document for the proposed project. We will not issue a revised draft EA or a draft EIS that presents a separate analysis of each alternative considered.

Comment: In a letter filed on April 12, 2018, NMFS comments that the staff alternative conflicts with and/or eliminates some of the mandatory conditions contained in its section 18 fishway prescriptions. In a separate letter filed on April 27, 2018, NMFS also comments that the rejection of mandatory conditions is disagreeable and such modifications should not be considered in the draft EA analysis.

²⁷⁶ 40 C.F.R. § 1502.14(a)

²⁷⁷ 40 C.F.R. § 1502.14(b)

²⁷⁸ Forty Most Asked Questions Concerning CEQ's National Environmental Policy Act Regulations, 46 Fed. Reg. 18,026, 18,028 (Mar. 23, 1981).

Response: We are required to consider and independently evaluate measures for fish and wildlife resources, including section 18 fishway prescriptions.²⁷⁹ The draft EA, issued on March 15, 2018, includes our independent evaluation of the need for fishway measures. In the draft EA, we did not recommend some of the fishway prescription measures because we were unable to identify information sufficient to support those respective measures. Nevertheless, as stated in the draft EA and final EA 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 issued for the project. Therefore, the staff alternative with mandatory conditions includes all the measures included in the staff alternative with the addition of the section 18 fishway prescriptions not included in the staff alternative, as discussed above in section 2.4, *Staff Alternative*.” Thus, any section 18 fishway prescriptions that were excluded from the staff alternative are included in the staff alternative with mandatory conditions and would be required in any license issued.

Comment: The Penobscot Indian Nation states that the discussions in the draft EA, section 4.1, *Power and Economic Benefits of the Project* and section 4.2, *Comparison of Alternatives*, would seem to support the idea of project decommissioning and removal. The Penobscot Indian Nation is confused as to why its interpretation of the analysis is not factored into the analysis of the need for this project.

Response: Economics is only one of the many public interest factors the Commission considers in determining whether or not, and under what conditions, to issue a license. Although our analysis shows that the project would cost more to operate than our estimated cost of alternative power, regardless of the source, it is the applicant who must decide whether to accept this license and any financial risk that it entails.

Purpose and Need/Project Retirement

Comment: The Penobscot Indian Nation states that the need for power analysis in the draft EA is inadequate and should take into account wind power as a replacement for the project’s power. The Penobscot Indian Nation requests that we review information presented on a website about wind power in Maine to better understand the wind power situation in Maine. Also, the Penobscot Indian Nation does not agree with the statement that power lost by retiring the plant would need to be replaced, given that the project’s power “has already been replaced many times over” by Maine’s increased wind and solar generation in the past decade. For these reasons, the Penobscot Indian Nation supports project decommissioning.

²⁷⁹ *Steamboaters v. FERC*, 759 F.2d 1382 (9th Cir. 1985).

Response: The Mattaceunk Project currently generates power and sells that power on the state (Maine) and regional grid. The existing project serves a role in the state and region’s clean, renewable electric power portfolio by displacing the operation of, and reliance on, combustible fueled power plants (emissions producing power plants), which exist in the region. The Penobscot Indian Nation’s contention that this source of power is currently being, or in the future would be, replaced by other sources of generation such that the project would no longer generate, is speculative and not supported with evidence.

More specifically, the fact that incremental demand for electricity in Maine has been satisfied by increasing solar and wind generation in the past decade does not support a conclusion that existing generators, like the Mattaceunk Project, are obsolete or have been replaced. At this time, a substantial amount of electricity generated in Maine and in New England comes from hydroelectric plants (29.7 and 6.8 percent, respectively) and from natural-gas-fired plants (18.8 and 46.7 percent, respectively). These figures are based on data from the Energy Information Administration (EIA) about net generation in 2017.²⁸⁰ The Commission cannot simply assume that the demand currently satisfied by the Mattaceunk Project’s 19.2 MW of capacity would cease at some future point or be satisfied entirely by solar or wind generation if the project was retired, given the mixed state and regional generation portfolios.

We have updated section 2.6.3, *Retiring the Project*, to indicate that Penobscot Indian Nation recommends project retirement. However, as we stated in section 2.6.3, under the Commission’s project retirement policy²⁸¹ we do not recommend project retirement when viable options to removal exist and the licensee is not proposing it.

Aquatic Resources

Comment: The Penobscot Indian Nation comments that it does not agree with our use of the word “unimpeded” in reference to upstream and downstream passage at the West Enfield and Milford projects.²⁸² In support of this position, the Penobscot Indian

²⁸⁰ The figures cited are based on data from the EIA’s “Electricity Data Browser” webpage, using the “Net generation” data set, and flipping back and forth between pre-generated reports: “1.3, Net generation by state by sector;” “1.7, Net generation from natural gas by state by sector;” and “1.10, Net generation from hydroelectric (conventional) power by state by sector.”

²⁸¹ See generally *Project Decommissioning at Relicensing; Policy Statement*, FERC Stats. & Regs., Regulations Preambles (1991-1996), ¶ 31,011 (1994).

²⁸² See draft EA at 60.

Nation states that upstream passage at the West Enfield and Milford projects has never been tested for American eels, American shad, alewife, blueback herring, or sea lamprey.

Response: By definition, the term “unimpeded” means not slowed (hindered), blocked (obstructed), or interfered with. Using this definition, we would agree that the term “unimpeded” is not the correct term to use when describing fish passage at a dam. To clarify this, we have modified the text in the final EA to say that the fish passage facilities at the Milford and West Enfield Projects “provide” American eel, alosines, and sea lamprey access to the Mattaceunk Project.

Comment: Interior indicates that it supports the development of a site-specific predictive model for eel migration timing, as outlined in FWS’s fishway prescription. Interior states that any model that informs the timing of seasonal turbine shutdowns at the Mattaceunk Project must be based on eel behavior and migration timing in the upper Penobscot River. In addition, Interior states that it is incumbent on GLHA to not only develop an appropriate model, but also to collect the necessary empirical data on the timing and behavior of migrating silver eels at the project.²⁸³

Response: Our recommendation largely comports with Interior’s request. In section 5.1.1, *Comprehensive Development – Measures Proposed by GLHA*, we recommend GLHA develop a predictive model for downstream eel passage at the Mattaceunk Project, consistent with Interior’s fishway prescription. The model would rely on the behavior and migration timing of eel in the upper Penobscot River, and the data collected would be used to inform decisions regarding the timing of seasonal turbine shutdowns at the Mattaceunk Project.

Comment: Interior and Maine DMR indicate that use of a predictive model for establishing the seasonal timing for turbine shutdowns is a novel approach, with the Shenandoah model being the only example. Both agencies, however, support the use of such a model at the Mattaceunk Project. The agencies state that the Shenandoah model was informed by an extensive telemetry study that included radio-tagging 145 eels over a 4-year period, as well as monitoring the eels at five run-of-river dams in a 122-mile stretch of the Shenandoah River.²⁸⁴ Thus, to develop an appropriate model for the

²⁸³ Interior’s fishway prescription identifies radio-telemetry as the best method for collecting empirical data on silver eel migratory behavior. Such data would include: (1) searching and delay; (2) migratory timing in relation to freshets and water temperature; (3) route of downstream passage; (4) immediate survival; and (5) latent survival passing Mattaceunk Dam.

²⁸⁴ Interior also states that, while the means and methods used to develop the Shenandoah model are relevant to a study on the Penobscot River, the actual results of

Mattaceunk Project, Interior indicates that 4 years of monitoring in the upper Penobscot River may be needed, and Maine DMR recommends a 3-year radio-telemetry study, using a similar number of tagged eel to that used in the Shenandoah study.

With regard to the nighttime shutdowns, Interior contends that the 3-month window required by FWS's fishway prescription is needed to protect out-migrating eel at the project, until GLHA has developed a model to refine turbine operation and protect downstream migrating eel. Maine DMR states that turbine shutdowns from August 1 through October 30, along with the 3-year telemetry study, is needed to develop an accurate predictive model. GLHA does not agree with the 3-month window, arguing that: (1) nighttime shutdowns from August 1 through October 31 is not consistent with shutdown periods at other projects in Maine (*e.g.*, Shawmut on the Kennebec River and Cataract on the Saco River); and (2) its proposal to develop a seasonal operating schedule based on a predictive model of eel movement is consistent with the FWS's 2015 American Eel Biological Species Report.

Response: The use of a predictive model for establishing the turbine shutdown period is a relatively new approach. We are aware of only one such instance (*i.e.*, Shenandoah River in Virginia) where a predictive model is being developed. We have modified our description of the predictive modeling approach accordingly. We continue to recommend the development of such a model for the Mattaceunk Project, and respond, below, to the specific comments regarding the eel monitoring and turbine shutdown periods.

Out-migration eel monitoring – We evaluated the Shenandoah River model and the data collection effort that supported the model (*i.e.*, Eyler *et al.*, 2016; Smith *et al.*, 2017). We believe that development of a predictive model should be supported by at least 3 years of monitoring, using radio-telemetry, downstream-migrating silver eels at the project. We have modified section 3.3.2.2, *Aquatic Resources – Environmental Effects*, accordingly.

Turbine shutdown period – As we indicated in the draft EA,²⁸⁵ shutting down generation at the Mattaceunk Project for a full 3-month period, from August 1 through October 31, is but one, albeit conservative, nighttime shutdown approach that has been implemented at hydropower projects in New England and the mid-Atlantic to enhance downstream silver eel passage. The other approach involves shutting down the turbines from dawn to dusk during the period of peak migration, based on site-specific monitoring or

the Shenandoah model are not likely applicable to silver eels migrating from the Penobscot River due to differences in (a) eel migration timing, (b) water temperature, (c) seasonal flow patterns, and (d) oceanic migration distance.

²⁸⁵ See draft EA at 86.

information from other projects in the basin. The latter approach has been used successfully at projects on the Saco and Kennebec Rivers in Maine.

Downstream migration data from projects on the Penobscot River indicate that the majority of downstream migrating eel in the Penobscot River move during a 6- to 8-week period from late August through mid-October, and that silver eel tend to move during high flow events. GLHA's proposal to institute nighttime shutdowns for a 6-week period, triggered by the first highflow event that occurs after August 15, is consistent with both of these environmental variables. For the small percentage of silver eel that migrate outside of the nighttime shutdown period, the full-depth trash rack with 1-inch clear bar spacing and the downstream passage route associated with the open roller gate would offer some level of protection.

While many of the means and methods used to develop the Shenandoah River model are relevant to the Mattaceunk Project, there is nothing in Eyler *et al.* (2016) and Smith *et al.* (2017) to imply that nighttime shutdowns would need to occur during the entire migration period to provide the data necessary to develop an effective predictive model. In fact, Eyler *et al.* (2016) collected downstream migration data during normal turbine operation, as well as during the nighttime shutdown events. Neither Interior, nor Maine DMR, provided any new information that would cause us to modify our recommendation for nighttime shutdowns at the project. Thus, we continue to recommend GLHA's proposal for implementing nighttime shutdowns at the Mattaceunk Project. However, Interior's prescription for nighttime shutdowns from August 1 through October 31 is mandatory, and, therefore, would be included in any new license issued for the project.

Comment: The Penobscot Indian Nation states that the draft EA, on page 87, recognized the Eyler *et al.* (2016) study as valid and pertinent to the Mattaceunk Project, where it concerns silver eel migration timing. The Penobscot Indian Nation also states that, in contrast, the draft EA, on pages 88-89, recognizes the Eyler *et al.* study as not being pertinent to silver eel run timing at the Mattaceunk Project. The Penobscot Indian Nation seeks clarification of this perceived inconsistency.

Response: In the first instance, on page 87 of the draft EA, our statement is intended to convey information on the seasonality of downstream silver eel migration, and how implementing nighttime shutdowns, every night across the entire downstream passage season, may be inefficient at reducing eel mortality while also leading to unnecessary generation losses. In the second instance, on pages 88 and 89 of the draft EA, our reference to the Shenandoah River study is intended to convey that, while the general concept of the predictive model developed for the Shenandoah River is pertinent, the outcome of the modeling effort is not likely valid because of differences in silver eel migration timing, water temperature, seasonal flow patterns, oceanic migration distance,

etc. We have modified the pertinent text in section 3.3.2.2, *Aquatic Resources – Environmental Effects*, accordingly.

Comment: The Penobscot Indian Nation seeks clarification as to what studies we relied on in reaching the conclusion that nearly 93 percent of the out-migrating eel in Maine rivers occurs in the months of August and September.

Response: In our discussion of downstream American eel passage we cite to Maine DMR data collected at 19 commercial weir sites in Maine from 1987 to 2000 that showed 80.7 percent of silver eel in Maine migrate downstream in September and October, with an additional 11.6 percent migrating downstream in the last two weeks of August, for a total of 92.3 percent (or just shy of 93 percent). We also reference a 2015 study conducted at the downstream Stillwater Project (BBHP, 2016) which showed that 86 percent of the downstream eel migration occurred between September 27 and October 3, with 97 percent of those eels passing in a 5-hour period on September 30 during a rain event. We added text to the discussion to make it clear that we relied on this information in our discussion of run-timing at the Mattaceunk Project and on the Penobscot River.

Comment: The Penobscot Indian Nation states that downstream fish passage facilities at the Mattaceunk Project should conform to FWS Region 5 Criteria for downstream fish passage. The Penobscot Indian Nation also states that: (1) it fully supports FWS’s assessment (Sojkowski (2017)) for fish passage at the Mattaceunk Project; and (2) downstream passage should be installed immediately upon relicensing to protect downstream migrants, including American eel, and Atlantic salmon smolts and kelts.

Response: We reviewed FWS’s Region 5 fish passage design criteria,²⁸⁶ as well as the assessment prepared by FWS – Engineering Section, Region 5 for the Mattaceunk Project (Sojkowski, 2017).²⁸⁷

Sojkowski (2017) identified four of the FWS’s Region 5 fish passage design criteria as “paramount” to providing safe, timely, and effective downstream passage, including: (1) hydraulic capacity (bypass flows of at least 5 percent of the station’s

²⁸⁶ FWS. 2017. Fish Passage Engineering Design Criteria. USFWS, Northeast Region 5, Hadley, Massachusetts.

²⁸⁷ Sojkowski, B. 2017. Memorandum – Downstream Passage Design Alternatives for the Mattaceunk Hydroelectric Project (FERC No. 2520). 9 pages, plus Appendices.

hydraulic capacity); (2) normal velocity²⁸⁸ (not greater than 2 fps in front of the trash racks); (3) sweeping²⁸⁹ to normal velocity ratio (equal to, or greater than, 1); and (4) bar rack spacing to prevent fish from being entrained (i.e., 0.75-inch spacing for American eel; and less than, or equal to, 1 inch for Atlantic salmon smolts). Our updated analysis in section 3.3.2., *Aquatic Resources*, and section 3.3.4, *Threatened and Endangered Species*, shows: (1) GLHA's proposed and the agencies' recommended alternatives for downstream fish passage considered in this final EA would meet the design criteria for bypass flows and normal velocity;²⁹⁰ and (2) no fish passage alternative considered in this final EA would meet the criteria for the ratio of sweeping velocity to normal velocity and clear bar spacing for eel.²⁹¹ We have updated the EA to include our recommendations regarding the four design criteria in section 5, *Comprehensive Development and Recommended Alternative*.

With regard to the installation schedule, Interior and NMFS, in their respective fishway prescriptions, require fish passage be operational no later than 2 years after license issuance. This time period allows for final design, construction, and testing, before the facilities become operational. Our analysis in section 3.3.2, *Aquatic Resources*, shows that 2 years is an appropriate time frame to design, construct, and test fish passage facilities at the Mattaceunk Project.

Comment: NMFS, Maine DMR, and GLHA comment that they disagree with our conclusion in the draft EA that upstream passage efficiency through the vertical slot

²⁸⁸ Normal velocity is the component of velocity in front of the trash racks that is perpendicular to the trash rack bars.

²⁸⁹ Sweeping velocity is the component of velocity in front of the trash racks that is parallel to the trash rack bars.

²⁹⁰ Use of the surface bypass (2 percent of hydraulic capacity) and log sluice (3 to 9 percent of hydraulic capacity) would provide a fish bypass flow that represents 5 to 11 percent of the station's hydraulic capacity. Opening the roller gate to provide a low-level bypass route for eel would provide an additional, though unquantified, amount of flow for downstream passage at the project. The normal velocity for all trash rack designs assessed by Sojkowski (2017), and considered in this final EA, would not exceed 1.6 fps.

²⁹¹ None of the downstream fish passage designs that are proposed, prescribed, or recommended by us in this final EA would have a sweeping to normal velocity ratio of 0.25. Moreover, no fish passage designs proposed, prescribed, or recommended by us in this final EA include trash racks with a clear bar spacing of 0.75 inch for eel. However, our recommendation to not require 1-inch clear bar spacing to the full depth of the turbine intakes for salmon smolts and kelts would meet the FWS's design criteria to meet a normal velocity not greater than 2.0 fps.

fishway at the West Enfield Project is low for alosines and may represent a bottleneck for adults migrating upstream to spawn. NMFS, Maine DMR, and GLHA add that there is no formal, quantitative, passage effectiveness study (e.g., a telemetry study) to support our conclusion.

Response: On further review, there appears to be insufficient information at this time to conclude that upstream passage efficiency through the vertical slot fishway at the West Enfield Project is low for alosines. Therefore, in the final EA, we revised section 3.3.2.2, *Upstream Alosine Passage* by deleting the paragraph that included our analysis of upstream passage efficiency at the West Enfield fishway (pages 94-95 of the draft EA). These revisions do not change our staff recommendation that we have no basis for recommending the installation of an upstream alosine fishway at the Mattaceunk Project in year 15, as explained in section 5.1.3 of this final EA.

Comment: NMFS comments that the timeframe to install fish passage to support American shad, blueback herring, and alewife was carefully constructed, and it does not agree with our apparent modifications to its fishway prescription requiring upstream passage for alosines in year 15 of a license. NMFS further states that its requirement to install upstream alosine passage at the Mattaceunk Project in year 15 of a license provides certainty to both the resource agencies and the applicant as to when mitigation measures will be implemented. Lastly, NMFS notes that our recommendation in the draft EA to base the need for installing fish passage on a re-assessment of population trends 14 years post-license issuance creates uncertainty.

Maine DMR states that our recommendation to base the need for alosine passage at the Mattaceunk Project on a re-assessment of alosine populations in the Penobscot River 14 years post-license is questionable because our: (1) environmental analysis lacks sufficient data; and (2) our recommendation does not describe the methods that would be used to re-assess alosine populations in the Penobscot River or an outcome that would lead to specific fish passage measures for alosines.

Response: As indicated in section 2.5, *Staff Alternative with Mandatory Conditions*, we recognize that the Commission is required to include all final section 18 fishway prescriptions in any license issued for the project. Thus, any new license issued for the Mattaceunk Project would already require the licensee to install an alosine fishway at the project in year 15, thereby negating the need for a future re-assessment in year 14. For this reason, the measure to re-assess the need for alosine passage is no longer included in the staff alternative in this final EA, nor is it part of the staff alternative with mandatory conditions. We have made revisions to make this point clearer in the final EA.

Comment: NMFS states that our analysis of the entrainment potential of juvenile alosines omits the concept that behavioral avoidance/deterrence of the intake might be enhanced by the full-depth 1-inch trash racks based on the results a 2014 study (filed with the Commission on March 24, 2015 [Accession number: 20150324-5214]). That study evaluated downstream passage effectiveness and survival of out-migrating Atlantic salmon smolts at the Orono Project (FERC No. 2710).

Response: Our analysis on pages 98-99 of the draft EA provides an estimate of entrainment potential that is likely high. Entrainment would not be higher than our estimate because it does not account for any deterrence of juvenile alosines from the proposed full-depth trash racks with 1-inch clear bar spacing. Fish behaviors are often difficult to predict (i.e., whether smaller trash rack spacing along the bottom portion of the trash racks would actually deter juvenile alosines). Moreover, the 2014 study at the Orono Project that NMFS references was based on Atlantic salmon smolts, the behavior of which may differ from, and therefore not apply to, outmigrating juvenile alosines. Further, the 2014 study does not provide any evidence of improved passage effectiveness for smolts after installing full-depth trash racks with 1-inch clear bar spacing.²⁹² Therefore, we made no changes to the EA concerning the entrainment potential of juvenile alosines.

Comment: Maine DMR comments that the staff alternative does not include a re-assessment of the need for downstream passage of alosines that mirrors re-assessing the need for upstream passage in year 14 of the license. Maine DMR states that re-assessing the need for downstream passage is important because the draft EA indicates that full-depth trash racks with 1-inch clear spacing would reduce the entrainment of adult alosines during their post-spawning migration to the ocean.

Response: As indicated above, any new license issued for the project would require NMFS's fishway prescriptions. Several of these prescriptions (*see* Appendix D)

²⁹² The 2014 study does provide an estimate of downstream passage effectiveness when full-depth trash racks with 1-inch clear bar spacing was in place, but the study does not include a comparison to passage effectiveness prior to the full-depth trash racks being installed. The next most recent study that could be used as a comparison occurred in 2010 (results filed on February 15, 2011). However, in the time between the 2010 and 2014 studies, the Orono Project has undergone major modifications that include construction of a new powerhouse, a new intake [including 1-inch full-depth trash racks], and a new downstream fish passage facility. Thus, even if passage effectiveness improved between 2010 and 2014, the improved effectiveness could be a result of more than one modification that occurred at the project, and cannot be solely attributed to installation full-depth trash racks with 1-inch clear bar spacing.

involve measures that would accommodate the downstream passage of alosines once the new upstream alosine fishway is constructed—including the installation of full-depth trash racks with 1-inch clear spacing during the alosine out-migration season.

Comment: NMFS comments that our analysis and conclusions throughout the draft EA suggest the applicant’s proposed new upstream fishway at the Mattaceunk Project is only intended for American shad, which is not accurate as the upstream fishway is intended to pass multiple species.

Response: In the draft EA, the terms “shad” or “shads” were used to collectively refer to American shad, blueback herring, and alewife. This distinction was made in several locations throughout the draft EA.²⁹³ Nevertheless, this term may have led to some confusion (e.g., a “shad fishway” could be misinterpreted as meaning a fishway that is designed to pass only a single species, American shad). Therefore, throughout the final EA, we changed the term “shad” or “shads” to “alosesines” to more clearly describe this group of species—American shad, blueback herring, and alewife.

Comment: The Penobscot Indian Nation believes the statement on page 66 of the draft EA (footnote 79) that “American shad and blueback herring are not currently stocked in the Penobscot River, but alewives are stocked” is incorrect.

Response: To clarify, we updated this footnote in the final EA (page 69, footnote 83) to note that alewife are the only alosine species currently *targeted* for stocking in the Penobscot River, as indicated in Maine DMR’s 10(j) letter filed with the Commission on May 22, 2017. As indicated in the updated footnote, the source of alewife adults for stocking purposes is the fish trap at the Milford Project; however, some blueback herring are incidentally collected and stocked as part of these efforts because they are nearly indistinguishable from alewife.

Comment: The Penobscot Indian Nation specified its recommended timeframe for the installation of the upstream alosine fishway is the second year of the new license.

Response: On page 102 of the final EA, we updated the Penobscot Indian Nation’s recommendation that the upstream alosine fishway be installed during the second year of a new license. Because this recommendation (i.e., immediate construction of the fishway upon license issuance) was already analyzed and discussed in the draft EA (see pages 95, 234-235), no changes were made to our analysis in the final EA.

Comment: NMFS comments that it disagrees with our recommendation not to require GLHA to file with the agencies, final as-built fishway drawings for new or modified fishways. NMFS states that prior to fishway designs being filed with the

²⁹³ See draft EA at ix, 2, 22, and 55.

Commission for final approval, engineers from NMFS and FWS work closely with FERC licensees on all aspects of fishway planning and design. NMFS also states that without as-built drawings, NMFS's ability to work with licensees and to be responsive to licensing requirements would be severely restricted.

Response: As discussed in the draft EA, section 5.1.3, *Measures Not Recommended by Staff*, final as-built drawings, which are not filed until after the fishways are constructed, would be accessible to the resource agencies from the Commission. Resource agencies would be able to access the final as-built drawings using the Commission's eLibrary system. The filing of final as-built drawings with the Commission does not prevent the resource agencies from working with a licensee on fishway planning and design prior to the final as-builts being filed with the Commission. Further, because the resource agencies would have access to the final as-built drawings and any new license issued, there would be no restrictions on the agencies' ability to work with the licensee and be responsive to the licensing requirements. Thus, our recommendation is unchanged, and we do not recommend requiring GLHA to provide copies of as-builts to the resource agencies. Nevertheless, NMFS's modified fishway prescriptions would require GLHA to file final as-built drawings with NMFS and FWS after a new fishway is constructed.

Threatened and Endangered Species

Comment: NMFS comments that to proceed with formal ESA consultation it needs to receive an analysis of the project effects to the Gulf of Maine Distinct Population Segment (GOM DPS) of Atlantic salmon and their critical habitat that is consistent with the proposed action.

Response: As indicated above, we are consulting on the staff alternative with mandatory conditions. All proposed, recommended, and required measures included in the staff alternative with mandatory conditions have been fully analyzed in the EA, including section 3.3.4.2, *Environmental Effects, Atlantic Salmon*, where we analyze the effects on the GOM DPS of Atlantic salmon (including critical habitat). Therefore, no additional analysis is needed.

Comment: NMFS comments that the in draft EA we do not establish the baseline environmental conditions for Atlantic salmon (including existing project effects) and that we evaluate the "cumulative effects" of the project under a definition applicable to the NEPA, but not under the ESA definition.

Response: Regarding baseline environmental conditions, in the draft EA at 31 and final EA at 34 we state that, "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.” In addition, existing conditions as they relate to Atlantic salmon are discussed in detail in section 3.3.4.1, *Affected Environment*.

Regarding cumulative effects, the ESA definition of cumulative effects includes only the effects of future state or private activities, not involving Federal activities that are reasonably certain to occur within the action area of the Federal action subject to consultation (i.e., the Mattaceunk Project area).²⁹⁴ We have addressed all of the reasonably foreseeable future actions in the direct effects analysis of section 3.3.4.2, *Environmental Effects*, and we know of no other reasonably foreseeable actions.

Comment: NMFS comments on our analysis in section 3.3.4.2, *Atlantic Salmon Critical Habitat*, where we state that submerged aquatic vegetation along shallow water areas in the impoundment can serve as temporary holding and resting areas during the upstream migration of adult Atlantic salmon. NMFS states that adult Atlantic salmon hold in deep, cold-water pools during the upstream migration, and not in shallow water areas with submerged vegetation (Fay *et al.*, 2006).²⁹⁵

Response: In defining the physical and biological features of the spawning and rearing primary constituent elements for Atlantic salmon, NMFS (2009)²⁹⁶ indicates on page 19 that for returning salmon, large boulders or rocks, over-hanging trees, logs, woody debris, *submerged vegetation* and undercut banks provide shade, reduce velocities allowing for resting, and offer protection from predators. NMFS (2009) adds, that these features are essential to the conservation of the species to help ensure the survival and successful spawning of adult salmon. Thus, our analysis in section 3.3.4.2, *Atlantic Salmon Critical Habitat* is unchanged with respect to submerged aquatic vegetation.

Comment: In the letter filed on April 12, 2018, NMFS comments that the staff alternative rejects many measures proposed by the applicant in the Species Protection Plan (SPP) for Atlantic salmon and supporting BA that were designed specifically to avoid jeopardizing the continued existence of the GOM DPS of Atlantic salmon. In the letter filed on April 27, 2018, NMFS comments it is not clear why FERC staff have

²⁹⁴ 50 CFR §402.02.

²⁹⁵ Fay, C. , M. Bartron, S. D. Craig, A. Hecht, J. Pruden, R. Saunders, T. F. Sheehan, and J. G. Trial. 2006. Status review for anadromous Atlantic salmon (*Salmo salar*) in the United States. Report to the National Marine Fisheries Service and U.S. Fish and Wildlife Service.

²⁹⁶ NMFS. 2009. Biological valuation of Atlantic salmon habitat within the Gulf of Maine Distinct Population Segment. Gloucester, MA.

disregarded the applicant's BA and SPP, particularly as these documents were developed in careful coordination with NMFS, and were designed to minimize the effects to Atlantic salmon and their critical habitat. NMFS adds that the staff alternative included in the draft EA recommends 15 different, non-biologically supported modifications that may render the applicant's SPP inadequate to avoid jeopardizing the continued existence of the GOM DPS of Atlantic salmon.

Response: Sections 4(e) and 10(a) of the FPA require us to consider and independently evaluate proposed and recommended measures for fish and wildlife resources, including those in the proposed SPP. The majority of our modifications to the SPP were intended to provide clarification. Only three provisions (i.e., provisions 1, 13, and 14 of our recommended revised SPP) removed measures proposed by GLHA. Below we discuss the basis for all 15 of the additional provisions we recommended in the modified SPP.

Provision 1 of our modified SPP: remove the provision to seasonally install full-depth trash racks with 1-inch clear bar spacing for the purpose of protecting smolts and kelts.

In the EA (draft EA at 162-164; final EA at 173-175) we provide our analysis in which we identified no benefit to installing full-depth trash racks with 1-inch clear bar spacing for the purpose of protecting downstream migrating smolts and kelts. Therefore, in the EA, we recommend the removal of GLHA's proposed measure to seasonally install full-depth trash racks with 1-inch clear bar spacing for the purpose of protecting smolts and kelts. As discussed above, NMFS comments that full-depth trash racks with 1-inch clear bar spacing were installed at the Orono Project, and studies conducted at the Orono Project in 2014 provide evidence of improved use of the downstream fishway for Atlantic salmon smolts when compared to prior conditions when 1-inch bar spacing did not extend to the full-depth of the intake. However, as discussed above in response to NMFS's comment on the need for full-depth trash racks with 1-inch clear bar spacing for alosines, the 2014 studies provide no evidence of improved passage. Therefore, we still find no evidence that installing full-depth trash racks with 1-inch clear bar spacing would provide a protective benefit for smolts and kelts. We recommend deleting this measure under the staff alternative.

Provision 2 of our modified SPP: revise, with final approval from the Commission, the upstream passage effectiveness study methodology to include the type of telemetry tag to be used on upstream migrating adults and the appropriate timing for stocking tagged smolts.

We recommended provision 2 to provide clarity on the methodology that would be used to study upstream passage effectiveness for Atlantic salmon. This information is

necessary for us to independently evaluate the appropriateness of the study and would be needed prior to Commission approval of the SPP. The addition of this provision to the SPP does not change the intended protective benefits of the plan, but is needed to clarify GLHA's proposed SPP.

Provision 3 of our modified SPP: *refile the SPP with the revised study plan and include the proposed passage effectiveness study plans as attachments to the SPP.*

In the SPP, GLHA proposes to conduct passage effectiveness studies, but the passage effectiveness study plans were not included with the SPP. Because the studies are proposed measures within the SPP, the study plans need to be included as attachments to the SPP subsequent to GLHA receiving any new license. Thus, provision 3 is a recommendation for an administrative provision that does not change the intended protective benefits of the SPP.

Provision 4 of our modified SPP: *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 95 percent performance standard after the first year.*

Provision 10 of our modified SPP: *determine the need for an additional 1 or 2 years of downstream passage effectiveness studies for kelts, with final approval from the Commission, if the downstream passage structures meet the 96 percent survival performance standard for kelts after the first year.*

In the SPP, GLHA proposes to conduct up to 3 years of fishway effectiveness studies for both the upstream passage of adult Atlantic salmon and the downstream passage of kelts. NMFS's fishway prescription would require GLHA to implement the proposed studies. The language in GLHA's proposal and NMFS's fishway prescription to conduct *up to 3 years* (emphasis added to language used by GLHA and NMFS) suggests that only 1 year of study is certain to occur, and an additional 1 or 2 years of study would be optional. In the EA, we agree that only 1 year of study may be necessary if the fishway effectiveness studies show that the upstream fishway and downstream passage structures are effective at passing adult Atlantic salmon and kelts, respectively. Neither GLHA's proposal nor NMFS's fishway prescription provide a mechanism or the criteria for determining whether an additional 1 or 2 years of study would be needed after the first year of study. Thus, we recommend adding provisions 4 and 10 to provide clarity that if the fishways meet the performance standard after the first year of study, then the need for additional study would be determined in consultation with the resource agencies, and with final approval from the Commission. We also clarify that provisions 4 and 10 do not alter GLHA's ability to conduct up to 3 years of study. Therefore, provisions 4 and 10 are complementary to NMFS's fishway prescription requiring GLHA

to conduct up to 3 years of fishway effectiveness studies for upstream migrating adults and downstream migrating kelts.

Provision 5 of our modified SPP: *determine the need for future effectiveness studies or measures, with final approval from the Commission, if after 3 years of upstream passage effectiveness studies, the upstream fishway does not meet the 95 percent effectiveness performance standard.*

Provision 12 of our modified SPP: *determine the need for future effectiveness studies, and/or downstream passage measures, with final approval from the Commission, if after 3 years of downstream passage effectiveness studies, the downstream passage structures do not meet the 96 percent survival performance standard for kelts.*

As discussed above, GLHA proposes to conduct up to 3 years of fishway effectiveness studies for upstream passage of adult Atlantic salmon and downstream passage of kelts, and NMFS's fishway prescription would require GLHA to implement the proposed studies. However, GLHA's proposal and NMFS's fishway prescription do not describe the steps to be taken if after 3 years of effectiveness studies, the upstream fishway and downstream passage structures do not meet the performance standards. Thus, we recommended adding provisions 5 and 12 to clarify the need for additional study or measures developed in consultation with the resource agencies, and with final approval from the Commission.

Provisions 5 and 12 were intended to be complementary to NMFS's fishway prescription which would require GLHA to conduct up to 3 years of effectiveness studies for upstream migrating adults and downstream migrating kelts. Provision 5 and 12 also were intended to be complementary to NMFS's fishway prescription to implement additional operational, structural, and/or habitat enhancement measures, if necessary, to improve passage and/or address performance criteria for upstream migrating adults and downstream migrating kelts. The addition of provisions 5 and 12 simply provides clarification on the steps to be taken if after 3 years of effectiveness studies, the upstream fishway and downstream passage structures do not meet the performance standard. Provisions 5 and 12 do not conflict with the fishway prescriptions and do not alter the protective benefits of GLHA's proposed SPP.

Provision 6 of our modified SPP: *revise the number of downstream passage effectiveness studies for smolts to indicate that a minimum of 3 years of study would be conducted.*

Provision 7 of our modified SPP: *revise the criteria for achieving the downstream performance standard for smolts to state that the standard would be*

considered achieved if a total 3 years of effectiveness studies for smolts demonstrate that the downstream passage structures meet a 96 percent survival performance standard.

In the SPP, GLHA proposed to conduct up to 3 years of downstream passage effectiveness studies for smolts. In GLHA's response to comments on the final license application (filed July 7, 2017), GLHA clarified that it "proposes to conduct a minimum of 3 years of study, until a total of 3 years meet the performance standard." GLHA was responding to comments filed by NMFS on May 23, 2017, in which NMFS stated, "The Draft BA identified 3 years of studies to be conducted to determine whether the project is attaining downstream survival standards for Atlantic salmon smolts. The standard must be achieved for all three years." Thus, our recommendation for the addition of provisions 6 and 7 is consistent with GLHA's proposal and NMFS's comments filed on May 23, 2017. Further, provision 6 is consistent with NMFS's fishway prescription requiring GLHA to conduct *up to 3 years* of downstream passage effectiveness studies for smolts.

NMFS's fishway prescription did not specifically include a requirement to meet a 96 percent survival performance standard, as indicated in provision 7, but NMFS does indicate in its letter filed on May 23, 2017 that a 96 percent standard is consistent with other projects in the Penobscot River. To date, the addition of provisions 6 and 7 is consistent with GLHA's proposal, NMFS's May 23, 2017 comment letter, and NMFS's fishway prescription.

Provision 8 of our modified SPP: determine, with final approval from the Commission, when to begin implementation of phased spill measures for downstream passage of smolts, with the restriction that phased spill measures would be implemented after a minimum of 1 year and a maximum of 3 years of conducting downstream passage survival studies for smolts, and non-spill passage measures.

In the SPP, GLHA proposes to implement phased spill measures to enhance downstream passage of smolts if the project is unable to meet the downstream performance standard, and if structural or operational modifications to downstream passage facilities are determined to be unfeasible. However, GLHA's proposal does not define when the phased spill measures would or could be implemented. NMFS's fishway prescription also is not clear as to when phased spill measures would be necessary. As discussed in the EA, we added this provision in order to establish when phased spill measures could begin (i.e., after 1 year of study shows that implementing the proposed log sluice operations with the new full-depth trash racks does not meet the performance standard for smolts). We also intend to prevent a continuous loop of study followed by

structural and/or operational modification, without spill measures being implemented. Therefore, we recommended that implementation of the phased spill measures would need to begin, after a maximum of 3 years of downstream passage studies and modifications that show non-achievement of meeting the 96 percent performance standard. The intent of provision 8 is to establish temporal limits on when phased spill measures could begin. Thus, the addition of this provision provides clarity and does not conflict with the fishway prescriptions or alter the protective benefits of GLHA's proposed SPP.

Provision 9 of our modified SPP: *determine, with final approval from the Commission, the 3-week period during which any log sluice or phased spill measures would occur for downstream passage of smolts.*

In the SPP, GLHA proposes to operate the log sluice and implement the phased spill measures, if necessary, during the peak 3 weeks of out-migration. GLHA indicates that the timing and duration of the log sluice operations and spill measures would likely be based on water temperature, but the timing would ultimately be determined in consultation and could be altered for any reason in consultation with NMFS. We recommend adding provision 9 because the log sluice operations and phased spill measures are proposed to occur on a schedule that is not specifically defined and could be altered. Thus the log sluice and spill measures could occur on a schedule without limits on when the 3-week period could occur. Therefore, we recommend that GLHA identify when the 3 week period of spill measures would occur (e.g., a specific water temperature window), in consultation with the resource agencies and with final approval from the Commission.

Provision 11 of our modified SPP: *determine the need to conduct at least 1 year of additional effectiveness study, with final approval from the Commission, if the downstream passage structures do not meet the 96 percent survival performance standard for kelts after the first year.*

In the SPP, GLHA proposes to conduct up to 3 years of fishway effectiveness studies for downstream passage of kelts, and NMFS's fishway prescription would require GLHA to implement the proposed studies. However, GLHA does not propose, nor does anyone recommend, specific provisions that would be implemented if, after 1 year of study, the downstream passage structures do not meet the performance standard. Thus, we recommend adding provision 11 to provide clarity on the steps to be taken in the event that the performance standard for kelts is not met after the first year of study. Further, provision 11 is intended to be complementary to GLHA's proposal and NMFS's prescription to conduct up to 3 years of effectiveness study.

Provision 13 of our modified SPP: *remove the provision to conduct a study to evaluate smolt mortality in the project impoundment.*

Our justification for recommending provision 13 is included in the draft EA (at 180-182 and 245-246). The EA has been updated to include a revised analysis of smolt mortality in the project impoundment in section 3.3.4.2, *Smolt Mortality in the Impoundment*. In section 5.1.2, *Additional Measures Recommended by Staff*, we present our justification for keeping provision 13 and not recommending studies to evaluate smolt mortality in the project impoundment.

Provision 14 of our modified SPP: *remove the provisions requiring reevaluation of upstream and downstream passage effectiveness every 10 years.*

Our justification for adding provision 14 is included in the EA (at 255-260) and is unchanged from the draft EA.

Provision 15 of our modified SPP: *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.*

Our justification for adding provision 15 is fully addressed in the EA (at 263-264) and our recommendation to add this provision to the SPP is unchanged.

Comment: NMFS comments that it is unclear whether the Commission would require compliance with the SPP for Atlantic salmon in a license article, and whether the SPP that would be required would be the one proposed by GLHA or a modified SPP.

Response: The staff alternative with mandatory conditions alternative includes staff's recommended SPP for Atlantic salmon. If any license issued for the project requires staff's recommended SPP, GLHA will be required to comply with it.

Comment: NMFS comments that contrary to footnote 169 of the draft EA, it does support a minimum attraction flow of 5 percent of station hydraulic capacity for upstream fishways as an engineering criteria. NMFS clarifies, however, that it does not typically require modifications to existing fishways that provide attraction flows less than 5 percent, because of the extensive modifications that are typically needed. Thus, NMFS states that it does not recommend changing the existing attraction flow (i.e., 7 cfs) unless studies indicate significant delay of upstream migrating Atlantic salmon.

Response: As indicated in footnote 169 of the draft EA, NMFS includes a comment in Attachment B to the preliminary fishway prescription filed on May 23, 2017, which states that NMFS currently recommends a minimum attraction flow of 5 percent of

station capacity. However, NMFS's fishway prescription does not include this language, and instead indicates that they support GLHA's proposal to continue to maintain the existing upstream fishway, which includes a 7 cfs attraction flow. Because of this conflict, we defaulted to analyzing the fishway prescription (i.e., 7 cfs attraction flow), rather than the recommendation included in the comments (i.e., 5 percent of station capacity). Thus, we correctly assumed in the draft EA that NMFS is requiring a 7 cfs attraction flow for the upstream fishway. Because NMFS has clarified that they do support an attraction flow of 5 percent of station capacity as a general engineering criteria, we have removed the referenced footnote from the EA.

Comment: NMFS comments that although footnote 4 of the draft EA states that the Long Island Sound and Central New England populations of Atlantic salmon are not federally listed, the footnote also should have indicated that the populations are not listed because they are extirpated.

Response: Footnote 4 pertains to section 1.3.3 of the draft EA, which explains the status of the Commission's compliance with the ESA. Because the noted populations are not federally listed, they are irrelevant to a discussion of ESA compliance. Therefore, the footnote has been deleted in the final EA.

Comment: NMFS comments that it disagrees with our conclusion in section 3.3.4.2, *Approach Velocity*, that in-river approach velocities in front of the powerhouse intakes would not deviate substantially from the approach velocity (i.e., 1.7 feet per second [fps]) calculated by GLHA, because there are no proposed changes to the size of the turbine intake or the maximum hydraulic capacity. NMFS states that the approach velocity calculated by GLHA is an average approach velocity and is not the approach velocity that fish would encounter and have to overcome to avoid entrainment or impingement. NMFS adds that fish will encounter point velocities that are higher and lower than the calculated approach velocity of 1.7 fps. NMFS states that without taking point measurements of approach velocities there would be no data to determine whether the licensee is meeting the requirement of NMFS's fishway prescription to maintain approach velocities of 2.0 fps or less.

GLHA comments on NMFS's preliminary fishway prescription that would require GLHA to measure approach velocities annually using point measurements upstream of the project trash racks, and ensure that approach velocities do not exceed 2.0 fps. GLHA states that it agrees with our conclusion in the draft EA, section 3.3.4.2, *Approach Velocity* that approach velocities at the project are already known, and therefore, there would be no benefit to measuring approach velocities, or measuring other velocities (e.g., through-screen) near the trash racks.

Response: Our recommendation under the staff alternative to not require GLHA to take point measurements of approach velocities in front of the project intakes is unchanged in the EA. We are aware that there can be some minor variability in the approach velocities in front of the intakes, but as discussed in section 3.3.4.2, *Approach Velocity*, we have no basis for concluding that approach velocities at various points in front of the intake in this instance would be expected to deviate substantially from the estimated average approach velocity of 1.7 fps (which is less than the prescribed 2.0 fps). Other than providing general statements that point velocities would likely be higher and lower than the estimated average approach velocity depending on the measurement location, NMFS provides no project-specific reasoning to support a conclusion that the variance in the intake velocity would be expected to be substantial in this case such that point measurements are necessary.

With respect to GLHA's comment, NMFS's modified fishway prescription filed on June 28, 2018, would no longer require GLHA to measure approach velocities annually, but would still require GLHA to take point measurements of approach velocities after installation of the full-depth trash racks with 1-inch clear bar spacing. Our analysis has been updated to include NMFS's modified fishway prescription in the staff alternative with mandatory conditions alternative.

Comment: NMFS states that it has a fishway prescription that would require real-time monitoring of the downstream fishway to ensure safe and effective operation. NMFS also states we make a recommendation to use "less sophisticated" methods such as monitoring flows at the end of the bypass pipe to identify debris blockages in the pipe and ensure proper function in section 3.3.4.2, *Real-time Monitoring of the Downstream Fishway*. NMFS states that monitoring outflow at the downstream bypass pipe would be inadequate, because some blockages may have little effect on flow. NMFS adds that monitoring pressure loss across the outflow pipe would provide better data to ensure the downstream fishway is operating as designed. Thus, NMFS recommends that GLHA use pressure transducers to identify blockages in the bypass pipe, and shut down and clean the bypass if a blockage is detected.

Response: In a letter filed on May 23, 2017, NMFS provided recommendations and preliminary fishway prescriptions, and on June 28, 2018, NMFS filed its modified fishway prescriptions. None of the fishway prescriptions filed with the Commission required real-time monitoring of the downstream fishway to ensure safe and effective operation. However, real-time monitoring was included as a recommendation in Attachment C (i.e., comments on the draft biological assessment) of the letter filed on May 23, 2017. Thus, in the EA we do not identify NMFS's recommendation for real-time monitoring of the downstream fishway as a fishway prescription.

In section 3.3.4.2, *Real-time Monitoring of the Downstream Fishway*, and in section 5.1.2, *Additional Measures Recommended by Staff* we did not recommend that GLHA monitor flows at the end of the bypass pipe or similar means to evaluate the effectiveness of the downstream fishway. In section 3.3.4.2, *Real-time Monitoring of the Downstream Fishway*, we indicated that less intensive methods than real-time monitoring²⁹⁷ may suffice to ensure optimal bypass function, but we also stated that during modification of the Fish Passage Operations and Maintenance Plan (FPOMP), and through consultation with the resource agencies, it may be determined that real-time monitoring is a better approach. In section 5.1.2, *Additional Measures Recommended by Staff*, we recommended that GLHA modify the FPOMP and file it for Commission approval after consultation with NMFS, FWS, Maine DMR, and the Penobscot Nation to add procedures to monitor outflows from the downstream bypass pipe and to detect debris blockages.

The EA has been updated in section 3.3.4.2, *Real-time Monitoring of the Downstream Fishway*, to include an analysis of NMFS's recommendation for GLHA to use pressure transducers to identify blockages in the bypass pipe, and shut down and clean the bypass if a blockage is detected. In section 5.1.2, *Additional Measures Recommended by Staff*, we present our justification for not specifically recommending pressure transducers.

Comment: NMFS comments that in section 3.3.4.2, *Upstream Passage Performance Standard and Effectiveness Testing*, we stated that NMFS's requirement for 75 percent and 20 percent of adult Atlantic salmon to pass upstream of the project within a specific 48-hour or 96-hour threshold, respectively, was without scientific justification. NMFS comments that sound scientific justification to support the 48-hour and 96-hour thresholds was provided in its letter filed on May 23, 2017.

Response: We are still unable to identify to what "scientific justification" NMFS points in its letter in support of a specific 48-hour or 96-hour threshold. Further, no new supporting information was provided in the modified fishway prescriptions filed by NMFS on June 28, 2018. Therefore, our analysis in section 3.3.4.2, *Upstream Passage Performance Standard and Effectiveness Testing* and recommendation is unchanged.

Comment: NMFS comments on our analysis in section 3.3.4.2, *Upstream Passage Performance Standard and Effectiveness Testing*, in which we state, "Although dams are

²⁹⁷ In a letter filed on May 23, 2017, NMFS recommended real-time monitoring of the downstream fishway to ensure safe and effective operation for downstream migrating fish. This recommendation did not include NMFS's recommendation to use pressure transducers during real-time monitoring.

known to delay upstream passage of salmonids (Caudill *et al.*, 2007), a 48-hour and 96-hour passage requirement implicitly assumes that delay is exclusively caused by the dam or ineffective upstream passage.” In reference to our statement, NMFS comments that its upstream and downstream performance standards have been specifically designed to measure delay only caused by dams (i.e., the standards only apply to salmon that reach within 100 meters [about 328 feet] of a dam).

Response: In our analysis in section 3.3.4.2, *Upstream Passage Performance Standard and Effectiveness Testing*, we discuss the factors, other than the dam that could delay upstream migration, including extreme high or low temperatures and river flow. These factors can delay upstream migration, even within 100 meters of a dam. Consequently, the quoted statement above is accurate.

Comment: NMFS comments on our analysis on page 160 of the draft EA, in which we state that smolts can pass the project under existing conditions at close to 96 percent survival. NMFS states that data collected at the project since 2005 (i.e., Stich *et al.*, 2014;²⁹⁸ Stich *et al.*, 2015a;²⁹⁹ GLHA, 2016³⁰⁰) demonstrate that smolt survival past the project dam can range from 84 percent to 95 percent under different environmental conditions at the project.

Response: We have updated the EA to include the estimates of survival provided by Stich *et al.* (2015a), and retain the estimates from GLHA (2016) that were in the draft EA. We did not add any estimates of survival associated with Stich *et al.* (2014) because no specific estimates of survival were included in that publication.

NMFS’s comment also indicates that data on smolt survival have been collected at the project since 2005, but we are unable to locate data preceding 2010. Stich *et al.* (2015a) estimated survival at the project dam between 2010 and 2014, and none of the sources cited by NMFS included survival estimates at the project dam that were estimated earlier than 2010.

²⁹⁸ Stich, D., M. Bailey, and J. D. Zydlewski. 2014. Survival of Atlantic salmon *Salmo salar* smolts through a hydropower complex. *Journal of Fish Biology*, 85:1074-1096.

²⁹⁹ Stich, D. S., M. M. Bailey, C. M. Holbrook, M. T. Kinnison, J. D. Zydlewski. 2015a. Catchment-wide survival of wild- and hatchery-reared Atlantic salmon smolts in a changing system. *Canadian Journal of Fisheries and Aquatic Sciences*. 72(9):1352-1365.

³⁰⁰ GLHA (Great Lakes Hydro America, LLC). 2016. Final License Application for Mattaceunk Hydroelectric Project. August 2016. FERC Project Number 2520.

Comment: NMFS comments on our analysis in section 3.3.4.2, *Downstream Passage Operations*, in which we state that based on a 1993 study, kelts are able to pass the project with close to 96 percent survival under existing conditions. NMFS states that the 1993 study was conducted under spill conditions, which only occur about 60 percent of the time. NMFS states that based on this information, we cannot conclude that survival of kelts approaches 96 percent under existing conditions.

Response: In the draft EA, we clearly stated that the 1993 study was conducted under spill conditions. However, we have updated the EA to clarify that existing information indicates that kelts are able to pass the project dam with 96 percent survival when the project is spilling.

Comment: NMFS provides comments regarding the fishway prescription that would require that a smolt pass downstream of the project within a specific 24-hour threshold to be considered as a successful passage attempt during downstream passage effectiveness studies (i.e., 24-hour passage criteria). NMFS comments that in the draft EA, we misinterpreted the smolt movement rates provided by Stich *et al.* (2015b)³⁰¹ to be based on movement through freshwater (as opposed to the estuary), and then used our incorrect interpretation to support our recommendation not to include a requirement for a 24-hour passage criteria. NMFS also comments that the Stich *et al.* (2015b) study results (i.e., the relationship between smolt gill NKA activity³⁰² and estuary survival) demonstrate that the “speed of traverse” through freshwater is important for survival through the estuary. NMFS also provides additional unpublished results from a model that was based on data presented in Stich *et al.* (2015b). NMFS states that the unpublished results indicate that when smolts experience 24-hour passage delay, or 48-hour passage delay at each dam (i.e., Mattaceunk, West Enfield, and Milford) on the mainstem of the Penobscot River, the probability of survival in the Penobscot River estuary is reduced by 1 percent and 8 percent, respectively.³⁰³

³⁰¹ Stich, D. S., G. B. Zydlewski, J. F. Kocik, and J. D. Zydlewski. 2015b. Linking behavior, physiology, and survival of Atlantic salmon smolts during estuary migration. *Marine and Coastal Fisheries: Dynamics, Management, and Ecosystem Science* 7:68-86.

³⁰² Gill NKA (Na⁺, K⁺-ATPase) activity in Atlantic Salmon is one enzyme measurement that has been found to be a useful indicator of smolt development and preparedness for saltwater entry.

³⁰³ Similar unpublished results were also provided in NMFS’s May 23, 2017 filing that included preliminary fishway prescriptions.

In a letter filed on June 28, 2018, which includes modified fishway prescriptions, NMFS also indicates that the best available scientific information to support the 24-hour passage criteria is provided in the filing with accession number: 20170929-5272.³⁰⁴

GLHA comments that they agree with our analysis and conclusion in the draft EA there is no benefit to including a 24-hour passage criteria for evaluating downstream passage survival of smolts and kelts.

Response: NMFS is correct regarding our misinterpretation of the movement rate results in Stich *et al.* (2015b). The movement rate estimated by Stich *et al.* (2015b) was based on movement through the Penobscot River estuary only (where no dams are present), and not through the estuary and riverine sections (where dams are present), as we interpreted it. Accordingly, in section 3.3.4.2, *Downstream Smolt Passage Performance Standard and Effectiveness Testing with Adaptive Management*, we have removed any reference to the movement rate discussed in Stich *et al.* (2015b), as it is irrelevant to NMFS's 24-hour passage criteria because it is based on movement through the estuary and not movement through sections of the river that include dams.

NMFS indicates that the Stich *et al.* (2015b) results, specifically the relationship between gill NKA activity and smolt survival, provide support for the 24-hour passage criteria by demonstrating that "speed of traverse" (or movement rate) through freshwater is important to survival in the estuary. We do not interpret the Stich *et al.* (2015b) results in the same manner. Stich *et al.* (2015b) did demonstrate that gill NKA activity was positively related to survival in the estuary, which as discussed by Stich *et al.* (2015b), indicates that smolts that are more physiologically prepared for the saline environment display better survival. However, Stich *et al.* (2015b) did not demonstrate any relationship between gill NKA activity and movement rate through freshwater. Further, Stich *et al.* (2015b) did not present any results that would indicate that smolts with higher gill NKA activity moved through freshwater more quickly or experienced reduced delay at dams. Stich *et al.* (2015b) did demonstrate that gill NKA activity was related nonlinearly to estuarine arrival date, but arrival date is a measure of timing, not movement rate. Further, and as noted by NMFS, Stich *et al.* (2015b) did not evaluate movement rate through freshwater, which would be needed to evaluate the effect of passage delay on smolt survival. More importantly, Stich *et al.* (2015b) did not evaluate the relationship between hours of delay at dams and survival past those dams, or survival

³⁰⁴ NMFS did not identify the contents of the filing with accession number 20170929-5272, but the filing is for the Conowingo Hydroelectric Project (P-405) Initial Fishway Operation and Maintenance Plan.

in the estuary. Thus, the Stich *et al.* (2015b) study provides no specific justification that would support NMFS's requirement for a 24-hour passage criteria.

NMFS states that the unpublished results indicate that when smolts experience 24-hour passage delay, or 48-hour passage delay at each dam (i.e., Mattaceunk, West Enfield, and Milford) on the mainstem of the Penobscot River, the probability of survival in the Penobscot River estuary is reduced by 1 percent and 8 percent, respectively. Although the results suggest that 24-hour passage delay may affect smolt survival, there is no accompanying description of the study methodology; therefore, we are unable to conduct a full and independent evaluation of the results and include them in our analysis.

In NMFS's modified fishway prescriptions filed on June 28, 2018, they indicate that the "best available scientific information" to support the 24-hour passage criteria is provided in the filing with accession number: 20170929-5272. However, the filing with accession number 20170929-5272 is the Conowingo Hydroelectric Project (P-405) Initial Fishway Operation and Maintenance Plan, which does not include any information relating to a 24-hour passage criteria for smolts.

For the reasons discussed above, we maintain our recommendation under the staff alternative to not include a requirement, in any new license, for smolts to pass downstream of the project within a specific 24 hour threshold to be considered as a successful passage attempt.

Comment: NMFS disagrees with our conclusion in the draft EA that if the 96 percent performance standard for smolts is met during each of 3 years of study conducted after relicensing, there would be no justification for reevaluating downstream passage survival for smolts every 10 years, as proposed by GLHA, because there are no proposed or anticipated changes that would cause smolt survival to change every 10 years. NMFS states, "This conclusion ignores the anticipated impact of climate change on fish in the Northeast United States. According to [a] climate science forecast (IPCC, 2007)³⁰⁵, a warming of about 0.2°C (0.4°F) per decade is projected for the next two decades over a range of emission scenarios. This temperature increase will very likely be associated with more extreme precipitation and faster evaporation of water, leading to greater frequency of very wet and very dry conditions. These changes will directly affect smolt survival at the project and will need to be monitored to ensure the project is not having any additional impacts to the species over the course of a 30-40 [year] license issued by the Commission."

³⁰⁵ Intergovernmental Panel on Climate Change (IPCC). 2007. Climate Change 2007: Synthesis Report. Contribution of Working Groups I, II and III to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change [Core Writing Team, R.K. Pachauri and A. Reisinger (eds.)]. IPCC, Geneva, Switzerland, 104 pp.

Response:

NMFS cites to the IPCC (2007) climate change forecast to support the need for downstream passage effectiveness studies every 10 years at the Mattaceunk Project. However, the IPCC (2007) report includes air temperature and precipitation predictions at continental and global geographic scales, and does not include any downscaled air temperature and precipitation predictions to local regions, such as the Penobscot River Basin, or other small geographic regions that would include the Mattaceunk Project. Thus, the forecasted effects of climate change at the project are speculative at best, and are an insufficient basis for justifying an upfront requirement for conducting effectiveness evaluations every 10 years of a license term.

Should conditions change during the license term, Standard Article 15 of any Commission issued license provides that a fish and wildlife agency may petition the Commission to reopen the license, after opportunity for comment and hearing, to consider the need for additional or modified measures for protecting fish and wildlife resources. For these reasons, our recommendation under the staff alternative is unchanged.

Comment: NMFS restates its view, expressed in a letter filed on March 10, 2015, that the results from the 2014 study to evaluate downstream passage survival of smolts are biased and invalid and should not be used in the EA. NMFS discusses three general issues with the 2014 study that could have introduced bias in the survival estimate. First, NMFS states that mortality of smolts in the free-flowing reach downstream of the dam was high compared to estimates in other studies in the Penobscot and Kennebec rivers, and concludes that the cause of much of the mortality was attributable to poor handling prior to release, radio-tag failure (e.g., battery failure), or missed detections (e.g., smolts swam past a radio telemetry receiver alive, but were not detected because of tag loss), and not because of conditions in the free-flowing reach. Second, NMFS suggests that the sample size used in the study was small,³⁰⁶ which when using a paired-release study design, tends to inflate survival estimates. Third, NMFS states that the 2014 study did not meet the assumptions of a paired-release design that the difference between distance

³⁰⁶ The 2014 study included a total of 118 smolts (69 released upstream of the dam, 49 released downstream of the dam). GLHA released 151 smolts, but 33 of the 102 smolts released about 3.4 miles upstream of the dam were never detected in the dam forebay. Thus, only 69 smolts released upstream of the dam were included in the study. NMFS suggests that many hundreds of smolts would be necessary to minimize the likelihood of overestimating survival.

traveled by smolts released upstream of the dam and the distance traveled by smolts released downstream of the dam must be negligible.³⁰⁷

Response: We are aware of NMFS's concern with the results of the 2014 study. With respect to NMFS's concern that poor handling, tag failure, and missed detection biased the 2014 study results, GLHA conducted a laboratory study concurrent with the 2014 field study, and found no indication that handling effects, tag failure, or tag loss caused excessive mortality during the 2014 field study.³⁰⁸ NMFS provided no other information to demonstrate bias in handling.

NMFS approved GLHA's methodology for conducting the 2014 study and only after reviewing the results, did NMFS conclude that the sample size and difference in distance traveled between the upstream and downstream released smolts was not negligible and therefore could cause bias.

Based on a recommendation from NMFS, GLHA modified the design of the 2015 study to release all smolts upstream of the dam, rather than releasing some upstream and downstream of the dam, as done in the 2014 paired-release study. The estimated total survival past the dam in 2015 was 95.9 percent, and consistent with the 2014 estimate of

³⁰⁷ During the 2014 study, the smolts released upstream of the dam had to travel from a location 200 meters (656 feet) upstream of the dam to 4.6 kilometers (2.86 miles or 15,092 feet) downstream of the dam (i.e. location of telemetry receiver), or a total of about 15,748 feet (i.e., 15,092 feet + 656 feet). The smolts released downstream of the dam were released 300 meters (984 feet) downstream of the dam and traveled to 4.6 kilometers downstream of the dam, or a total of 14,108 feet (i.e., 15,092 feet – 984 feet). NMFS comment suggests that the difference in distance (i.e., 1,640 feet) traveled by smolts released upstream of the dam and those released downstream of the dam is not negligible relative to the total distance traveled by smolts released upstream of the dam (i.e., 15,748 feet). The difference represents about 10 percent of the total distance traveled by smolts released upstream of the dam.

³⁰⁸ GLHA tagged 40 smolts (10 with live tags, 30 with dummy tags) and held them in holding tanks for 7-10 days to determine whether there was evidence of tag failure, tag loss, or mortality caused by handling. During the duration of the study, the tags remained operational, all tags were retained within the smolts, and all smolts survived. One smolt died after about 2 weeks, which was beyond the 7-10 day duration of the study. The smolt that died had a lesion on its nose, which GLHA suggested was caused by the smolt trying to escape the tank. During the 2014 field study, all smolts had traversed the entire length of the study reach within 4 days indicating that the 7-10 day duration of the laboratory study was representative of time period over which tag failure, tag loss, or handling mortality would be expected to occur in the field.

95.8 percent. For the reasons discussed above, the 2014 results are retained in our analysis in the final EA.

Comment: NMFS comments on our analysis in section 3.3.4.2, *Smolt Mortality in the Impoundment*. Specifically, in comments provided to them by Dr. Joseph Zydlewski (United States Geological Survey [USGS]), NMFS states that reliance on the impoundment mortality study conducted by GLHA in 2015 is poorly founded, because the results indicate that mortality was higher in a free-flowing reach (3.8 percent per mile) than in the project impoundment (1.8 percent per mile).

Response: NMFS approved the methodology used by GLHA to conduct the 2015 study to evaluate mortality through the project impoundment. Further, in comments filed on March 7, 2016, NMFS stated that GLHA should explain why mortality in the impoundment was lower than in the free-flowing reach downstream of the project dam, but NMFS did not refute the results of the study.

An updated analysis in section 3.3.4.2, *Smolt Mortality in the Impoundment* provided us no reason to disregard the results of the 2015 study. We updated our analysis to include revised mortality calculations (as discussed in our response to the subsequent comment below), and information provided in Table 1 of the letter NMFS filed on April 27, 2018, which is based on the results of Stich *et al.* (2015a). Our revised analysis using the Stich *et al.* (2015a) data indicates that for wild smolts the average mortality in the project impoundment is slightly lower than in free-flowing reaches downstream of the project. Thus, GLHA's 2015 study results, which indicate lower mortality in the project impoundment compared to a free-flowing reach downstream, do not appear to be anomalous. Therefore, our analysis of smolt mortality in the EA includes GLHA's 2015 (and 2014) study results.

Comment: NMFS, in comments provided to them by Dr. Joseph Zydlewski (USGS), states that our conversion of smolt mortality estimates from mortality per kilometer (based on survival per kilometer provided in Stich *et al.*, 2015a) to mortality per mile, appears to be incorrect (i.e., draft EA section 3.3.4.1, *Downstream Passage*).

Response: We reviewed our calculations provided in the draft EA, and in the final EA we added table 18, which includes our calculations for estimating mortality per mile based on the survival per kilometer estimates in Stich *et al.* (2015a). In the draft EA, we presented average per mile mortality estimates of 2.7 percent and 1.6 percent in the project impoundment for hatchery smolts and wild smolts, respectively. In table 18 of the final EA, we show that the average per mile mortality estimates in the project impoundment are the same as those in the draft EA. In the draft EA, we also presented average per mile mortality estimates in free-flowing reaches of 0.64 percent and 1.34 percent for hatchery smolts and wild smolts, respectively. These average per mile mortality estimates were based on six survival rates presented in Stich *et al.* (2015a) that

we identified as being from free-flowing reaches of the Penobscot River (i.e., the supplemental material provided by Stich *et al.* (2015a)³⁰⁹). In table 18, we revised our per mile mortality estimates to be based on survival estimates from just three free-flowing reaches, which were the same free-flowing reaches included in Table 1 of the letter filed by NMFS on April 27, 2018.³¹⁰ Despite our revisions to the per mile mortality estimates in free-flowing reaches, our estimates in the draft EA and the final EA were calculated with the correct conversions (see table 18). Rather, we attribute the differences between our calculations in the draft EA and NMFS's (or Dr. Zydlewski's) calculations to the different number of free-flowing reaches used (as discussed above), and not to incorrect conversions as suggested in comments from NMFS.

Comment: NMFS, in comments provided to them by Dr. Joseph Zydlewski (USGS), states that “The impact of the survival assessments both past the project and through the project impoundment are not presented in a manner which highlights the influence of the dam and its associated headpond. It is important to highlight the difference between estimations of mortality as a per distance rate and interval mortality. Mortality rate is standardized per distance to make reach comparisons possible. To calculate loss over distance, however, one needs to consider the interval over which the estimate was made. For example, a 95% per kilometer (km) survival estimate made over a 3 km reach would mean that 85.7% of the fish would survive (based on $S = 0.95 \times 0.95 \times 0.95$) and thus 14.3 % would die ($1 - 0.95 \times 0.95 \times 0.95$).”

Response: We fully understand the points made. Our primary reason for using estimates calculated over a standard unit of 1 mile was to be able to make standardized comparisons of mortality in the impoundment relative to free-flowing reaches (or “open river”, as described by NMFS). Comparing mortality in the impoundment to free-flowing reaches can help determine whether mortality in the two types of river reaches is different. However, to make appropriate comparisons, the mortality estimates must be standardized by reach length. Thus, we made comparisons of mortality in the impoundment and free-flowing reaches using mortality per mile estimates.

³⁰⁹ Stich *et al.* (2015a) provide estimates of smolt mortality in table S2 of the supplementary material provided with the article (<http://nrcresearchpress.com/doi/suppl/10.1139/cjfas-2014-0573>). In the draft EA, we used the survival estimates from six free-flowing reaches identified by Stich *et al.* (2015b) with the parameters: \hat{S}_5^A , \hat{S}_6^A , \hat{S}_7^A , \hat{S}_{10}^A , \hat{S}_{11}^A , and \hat{S}_{12}^A . Thus, there were six free-flowing reaches with a survival estimate in each reach for both hatchery and wild smolts.

³¹⁰ The survival estimates in the three free-flowing reaches were also identified by Stich *et al.* (2015a) with the parameters: \hat{S}_5^A , \hat{S}_6^A , \hat{S}_7^A .

We are also aware that the total loss of smolts would increase as the reach length is increased. For example, in the draft EA at section 3.3.4.2, *Cumulative Effects*, we calculated the cumulative loss of smolts that could occur, under existing and proposed operations, as smolts migrate past the Mattaceunk Project, the West Enfield Project, and the Milford Project. However, to address NMFS's concern regarding cumulative loss in the project impoundment, in table 18 of the final EA, we provide estimates of total survival of hatchery and wild smolts over an 8.5 mile stretch of river (i.e., equivalent to the length of the project impoundment).

Comment: NMFS, in comments provided to them by Dr. Joseph Zydlewski (USGS), states that based on estimates provided in Table 1 of their letter filed on April 27, 2018, mortality past the project (including the impoundment and dam) is estimated to be 17 percent and 21 percent for wild and hatchery smolts, respectively. NMFS also comments that such estimates deviate markedly from the assertion in the draft EA that there is no indication that smolt mortality in the impoundment is "excessive" and that there is no means to determine whether smolt mortality is excessive. NMFS adds that compared to system wide estimates (Stich *et al.*, 2015a) and in river survival estimates (Holbrook *et al.*, 2011),³¹¹ these mortalities indicate that the river reach containing the Mattaceunk Project dam and impoundment is one of the most dangerous reaches for a smolt to traverse in the entire Penobscot River watershed.

NMFS also states that the data from Stich *et al.* (2015a) supports the need for post-licensing studies to evaluate smolt mortality in the project impoundment.

Response: NMFS provides mortality estimates of 17 percent and 21 percent for wild and hatchery smolts, respectively. These estimates represent mortality as smolts move through the impoundment *and* past the project dam, and are not representative of mortality in the impoundment alone. In section 3.3.4.1, *Smolt Survival Through the Impoundment*, we present valid estimates of smolt mortality in the project impoundment, and in section 3.3.4.2, *Smolt Mortality in the Impoundment*, we find no evidence that mortality in the project impoundment is excessive. In addition, because the record contains valid smolt mortality estimates for the impoundment, which are included and discussed in this EA, there is no need for post-license evaluations of smolt mortality.

Comment: NMFS comments that the EA should be revised to include the information provided to them by Dr. Zydlewski (i.e., the comments discussed above).

³¹¹ Holbrook, C. M., M. T. Kinnison and J. Zydlewski. 2011. Survival of Migrating Atlantic Salmon Smolts through the Penobscot River, Maine: a Prerestoration Assessment. *Transactions of the American Fisheries Society* 140(5): 1255-1268.

Response: In our response to comments above, we have addressed the comments that Dr. Zydlewski provided to NMFS. Any revisions to the EA are noted in our responses.

Comment: NMFS comments that we use the term “excessive” in describing Atlantic salmon mortality throughout the draft EA. NMFS requests that we define what is considered “excessive” mortality for critically endangered Atlantic salmon.

Response: In the draft EA and in the final EA (section 3.3.4.2, *Smolt Mortality in the Impoundment*), we conclude that smolt mortality in the project impoundment is not excessive because there is no indication that smolt mortality in the impoundment is consistently greater than smolt mortality in free-flowing reaches. There also are no specific performance standards, or otherwise acceptable levels of impoundment mortality that would suggest that mortality in the impoundment is excessive.

Comment: NMFS comments that in section 3.3.4.2, *Smolt Mortality in the Impoundment*, the citations to McCormick *et al.* (1998) and Larsson *et al.* (2011) should be removed because they refer to smolt parasites and feeding in the marine environment and not freshwater.

Response: We have removed the citations because they are not relevant to the freshwater environment in the project impoundment.

Comment: GLHA comments that it agrees with our conclusion in section 3.3.4.2, *Upstream Passage Performance Standard and Effectiveness Testing* that NMFS’s potential requirement for adult salmon to pass upstream of the project within a specific 48-hour or 96-hour threshold is without scientific justification. GLHA also comments that the basis and support for the specified 48 hours (or 96 hours) in terms of determining passage success or failure has not been demonstrated, as none of the studies cited by NMFS actually quantify a delay risk.

Response: GLHA’s comment is consistent with our analysis in section 3.3.4.2, *Upstream Passage Performance Standard and Effectiveness Testing*; therefore, our analysis is unchanged.

Comment: GLHA comments that in the SPP for Atlantic salmon it proposed to cease trapping operations³¹² of the upstream fishway in order to minimize the possibility of potential injury or delay to trapped Atlantic salmon. GLHA adds that although it proposed to continue monitoring Atlantic salmon’s use of the fishway by other means as needed in support of passage studies, it agrees with our conclusion in section 3.3.4.2,

³¹² GLHA currently using a trap at the exit of the upstream fishway to count upstream migrating Atlantic salmon.

Counting Atlantic Salmon in the Upstream Fish Trap that there is no benefit to counting fish species that pass through fishways at the project.

Response: In the final license application, GLHA proposed to continue operating the upstream fishway and provide resource managers with spawning escapement tallies (i.e. counts) of adult Atlantic salmon, but it would do so by means other than using the fish trap (e.g., passive integrated transponder [PIT]³¹³ tagging, or video). In section 3.3.4.2, *Counting Atlantic Salmon in the Upstream Fish Trap*, we determined that there was no project-related benefit to counting fish that pass through the upstream fishway. Although GLHA's comment indicates that it agrees with us that there is no project-related benefit to counting fish species that pass through the upstream fishway, GLHA does not specifically retract its proposal to continue counting adult Atlantic salmon that pass through the upstream fishway. Thus, the EA does not include any changes in GLHA's proposal regarding counting upstream migrating Atlantic salmon.

Comment: GLHA comments on NMFS's preliminary fishway prescription in which it states that during the downstream passage studies, smolts must pass the project forebay within 24 hours to be considered a successful passage attempt. In the preliminary fishway prescription, NMFS defines the forebay as the area within 200 meters (656 feet) upstream of the trash racks to approximately 1 mile downstream of the powerhouse. GLHA comments that NMFS's definition is not consistent with smolt studies associated with other projects on the Penobscot River.

Response: In the modified fishway prescriptions filed on June 28, 2018, NMFS states that it agrees with GLHA's comments and revised their prescription. NMFS's modified prescription would require smolts or kelts approaching within 200 meters of the project dam to pass within 24 hours to be considered a successful passage attempt. Accordingly, we have updated the EA to include NMFS's revised definition of the project forebay to be the area within 200 meters upstream of the project dam.

Comment: GLHA comments that although it proposed to conduct a study to evaluate smolt mortality in the project impoundment, it agrees with our conclusion in section 3.3.4.2, *Smolt Mortality in the Impoundment* that there is no justification for conducting a post-licensing impoundment mortality study.

GLHA comments on NMFS's recommendation to develop a mitigation plan for the loss of Atlantic salmon smolts as a result of maintaining the project impoundment. GLHA states that it has agreed to an adaptive management strategy that may include a mitigation plan to address impoundment mortality. However, GLHA adds that it agrees

³¹³ The PIT tag is an electronic tag measuring 0.5 inches long and less than 1/8 inches in diameter. Fish injected with this tag can be automatically recognized by detecting/recording devices located within collection facilities at hydroelectric dams.

with our conclusion in the draft EA, section 5.1.2, *Additional Measures Recommended by Staff* that because available evidence provides no indication that mortality in the project impoundment is excessive, there is no need for GLHA develop a mitigation plan for the loss of smolts in the impoundment.

Response: GLHA's comments are noted. In the final EA, our conclusion with respect to the need for impoundment mortality studies and mitigation is unchanged and therefore we continue to not recommend that GLHA conduct the studies or develop a mitigation plan. Although GLHA agrees with our conclusion, we continue to interpret their current proposal to be to conduct studies to evaluate smolt mortality in the project impoundment and develop an adaptive management plan, if necessary, to address impoundment mortality.

Comment: GLHA comments that it does not agree with NMFS's May 23, 2017 filing, in which NMFS made a 10(j) recommendation for GLHA to develop a flow monitoring plan that would include installing flow monitoring equipment in the project tailrace to confirm that minimum flow requirements are being met, and making flow data electronically accessible and consistent with USGS website format. GLHA states that it proposes to continue monitoring minimum flow releases consistent with existing practices of using gate settings and turbine operations. Consequently, GLHA agrees with our recommendation that GLHA not install additional flow monitoring equipment in the project tailrace.

Response: In the draft EA, we preliminarily determined that NMFS's recommended flow monitoring plan was inconsistent with the FPA or other applicable law. On June 7, 2017, we held a 10(j) meeting to try and resolve the inconsistency. The outcome of the 10(j) meeting is discussed in final EA, section 5.3, *Summary of Section 10(j) Recommendations*. In section 5.3, we also discuss our recommendation for GLHA to develop an operation compliance monitoring plan that includes provisions for verifying the accuracy of the existing flow monitoring system, and recalibrating as necessary. Our recommendation to not require GLHA to develop a flow monitoring plan that would include installing flow monitoring equipment in the project tailrace is unchanged in the EA.

Comment: GLHA comments on NMFS's recommendation for GLHA to conduct continuous stream temperature monitoring from April 1 to October 31 to assure that operations do not intensify the effects of climate change. GLHA agrees with our conclusion in section 3.3.2.2, *Water Quality* that because existing conditions provide good water quality that supports aquatic life, and because GLHA does not propose any changes to project operation, there would be no benefit to monitoring water temperature continuously.

Response: GLHA's comment is noted, and our conclusions and recommendation with respect to stream temperature monitoring is unchanged in the EA.

Tribal Resources

Comment: The Penobscot Indian Nation comments that the draft EA gives little to no mention or analysis of the Penobscot Indian Nation's past, current, or future relationship with the project area. The Penobscot Indian Nation also comments that the draft EA gives little to no consideration to Tribal history, culture, cultural activities, sustenance fishing rights, gathering of culturally important medicines and materials, traditional fishing locations, submerged reservation islands, or other Tribal issues besides archaeological resources.

Response: NEPA requires that the Commission take a hard look at how a proposed action and reasonable alternatives may affect the human environment. The proposal for a new license for the Mattaceunk Project would not materially alter the project's operation and would require new monitoring and mitigation for environmental impacts. The proposed action has no potential to affect the other tribal issues cited by the Penobscot Indian Nation.

The EA does consider the cultural history of Maine from the Pre-Contact Period beginning 11,500 years ago through the Post-Contact Period of the past few centuries to present, including information about where and how the Penobscot and other tribal groups lived.³¹⁴ The EA acknowledges that the Penobscot Indian Nation has asserted its interest in the Penobscot River Basin as both their ancestral home as well as a sustenance fishery for current tribal members.³¹⁵ The EA also notes that the boundaries of the Penobscot Reservation and the Penobscot Indian Nation's hunting, fishing, and gathering rights in the waters of the Penobscot River are currently the subject of federal court litigation.³¹⁶ Gathering of indigenous plants by members of Native American tribes within the project boundary was also specifically discussed.³¹⁷ The Penobscot Indian Nation is not specific as to what other information it would like to see in the final EA. No modifications have been made in the final EA to address these comments.

³¹⁴ Draft EA at 190-193.

³¹⁵ *Id.* at 196.

³¹⁶ *Id.* at 196, n.223.

³¹⁷ *Id.* at 198.

Other

Comment: Penobscot Indian Nation comments that in the draft EA, section 5.4, *Consistency with Comprehensive Plans*, we omitted the 2008 Strategic Plan for the Restoration of Diadromous Fishes to the Penobscot River³¹⁸ and the 2009 Operational Plan for the Restoration of Diadromous Fishes to the Penobscot River.³¹⁹

Response: Although we inadvertently omitted the two plans from section 5.4, we reviewed both plans and referenced them in multiple places in the draft EA and final EA. We have updated section 5.4 of the EA to include the plans identified by Penobscot Indian Nation.

³¹⁸ Maine DMR and Maine DIFW (Maine Department of Marine Resources and Maine Department of Inland Fisheries and Wildlife). 2008. Strategic plan for the restoration of diadromous fishes to the Penobscot River. March 2008. 108 pp.

³¹⁹ Maine DMR and Maine DIFW. 2009. Operational plan for the restoration of diadromous fishes to the Penobscot River. July 2009. 129 pp.

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 19.2 megawatts.

Draft Article 202. *Exhibit Drawings.* Within 45 days of the effective date of this license, as directed below, the 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-2520-1001 through P-2520-10XX) 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 Infrastructure Information (CEII) material under 18 C.F.R. § 388.113(c)**. 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-2520-1001, 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-2520, 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-2520, project boundary metadata, MM-DD-YYYY.TXT].

Draft Article 203. 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 205. *As-built Exhibits.* Within 90 days of completion of construction of the facilities authorized by this license, including a new upstream eelway and a new upstream alosine fishway, the licensee must file for Commission approval, revised Exhibits A, F, and G, as applicable, to describe and show those project facilities as built. A courtesy copy must be filed with the Commission's Division of Dam Safety and Inspections (D2SI) – New York Regional Engineer, the Director, D2SI, and the Director, Division of Hydropower Administration and Compliance.

Draft Article 301. *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 – 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 302. *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 must 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 303. *Cofferdam and Deep Excavation Construction Drawings.* Should construction require cofferdams or deep excavations, the licensee must:

(1) 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 4XX. Commission Approval, Filing Reports, Notification, and Filing of Amendments.

(a) Resource Plan Requirements

Conditions found in Appendices X and X of this license require the licensee to prepare: (1) upstream and downstream American eel passage design plans (U.S. Fish and Wildlife Service [FWS] Condition 12.1); (2) a fish passage operation and maintenance plan for American eel passage (FWS Condition 12.5.2) in consultation with FWS and the Maine Department of Marine Resources (Maine DMR); and (3) upstream and downstream American eel passage effectiveness plans (FWS Conditions 12.6.1 and 12.6.2). In addition, the National Marine Fisheries Service (NMFS) requires the licensee to: (1) construct upstream passage facilities for alosines in year 15 of the license, which would be operational in year 16 (NMFS Condition 7.3.1.c); (2) install full-depth trash racks with 1-inch clear bar spacing, as well as operate the existing downstream fish passage measure(s) and open the log sluice on a schedule determined in consultation with the resource agencies (NMFS Conditions 7.3.2.a and 7.3.2.b); and (3) monitor the effectiveness of the upstream and downstream anadromous fish passage facilities (NMFS Conditions 7.3.1.d, 7.3.2.c, and 7.3.4). The conditions either do not provide for Commission approval, do not specify when the plan(s) would be filed with the Commission for approval, or do not specifically require design plans for the required fish passage facilities. Therefore, the due date for filing each plan with the Commission is as specified below:

NMFS Fishway Prescription Condition No.	FWS Fishway Prescription Condition No.	Plan Name	Due Date for Filing the Plan(s) with the Commission
	12.1	Upstream American eel fishway design plan	Within 6 months of license issuance
	12.1	Downstream American eel fishway design plan (includes new full-depth	Within 6 months of license issuance

NMFS Fishway Prescription Condition No.	FWS Fishway Prescription Condition No.	Plan Name	Due Date for Filing the Plan(s) with the Commission
		trash rack with 1-inch clear bar spacing)	
	12.5.2	Fishway operation and maintenance plan for upstream and downstream American eel passage	Within 6 months of license issuance
7.3.1.c		Upstream alosine fish passage design plan	December 31, 2032
7.3.2.a & 7.3.2.b		Downstream anadromous fish passage design plan (includes new full-depth trash rack with 1-inch clear bar spacing)	Within 6 months of license issuance
7.3.1.d & 7.3.4	12.6.1	Upstream diadromous fishway <u>effectiveness study plan(s) for:</u> ➤ Atlantic salmon & American eel ➤ Alosines	➤ Within 6 months of license issuance ➤ December 31, 2032
7.3.2.c & 7.3.4	12.6.2	Downstream diadromous fishway <u>effectiveness study plan(s) for:</u> ➤ Atlantic salmon & American eel ➤ Alosines	➤ Within 6 months of license issuance ➤ December 31, 2032

The licensee must include with each plan filed with the Commission documentation that the licensee developed the plan after consultation with FWS and Maine DMR, and received approval from FWS. 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

One FWS fishway prescription condition in Appendix X and one NMFS fishway prescription condition in Appendix X would allow the licensee to modify the timing of seasonal American eel, Atlantic salmon, and alosine fishway operations based on empirical passage timing 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 FWS, NMFS, Maine DMR, and the Penobscot Indian Nation. 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.

NMFS Fishway Prescription Condition No.	FWS Fishway Prescription Condition No.	License Requirement
7.3.3	12.5.1	Timing of seasonal fishway operation

(c) Requirement to File Amendment Applications

Certain conditions of NMFS’s fishway prescription in Appendix X and FWS’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.*, Conditions 7.3.1 and 7.3.2 of NMFS’s fishway prescription, and Condition 12.6.2 of FWS’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.

Draft Article 4XX. Operation Compliance Monitoring Plan. Within 90 days of license issuance, the licensee must file with the Commission, for approval, a final operation compliance monitoring plan that is based on the existing monitoring system approved by the Commission (55 FERC ¶ 62,259 (1991)). The accuracy of the existing monitoring system must be verified within 1 year of license issuance, and recalibrated as necessary. The accuracy of the existing monitoring system must also be verified and recalibrated, as necessary, through the term of the license. The plan must include, but not necessarily be limited to:

- (1) a detailed description of how the licensee will operate the project to comply with the requirements specified in Draft Article 4XX, *Project Operation*, 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, *Project Operation*, including descriptions of the mechanisms and structures (*i.e.*, type and exact locations of all flow and impoundment elevation monitoring equipment and gauges) used;
- (3) a detailed description of how the licensee will monitor compliance with the minimum flow requirements specified in Draft Article 4XX, *Minimum Flow Requirements*;
- (4) a detailed description of the methods for verifying the accuracy of the existing monitoring system used for monitoring minimum flows, and recalibrating as necessary, through the term of the license;
- (5) the methods and frequency for reporting monitoring data to the Commission, Maine Department of Environmental Protection (Maine DEP), Maine Department of Marine Resources (Maine DMR), Maine Department of Inland Fisheries and Wildlife, (Maine DIFW), National Marine Fisheries Service (NMFS), U.S. Fish and Wildlife Service (FWS), and U.S. Geological Survey (USGS), including making recent flow data available on the internet in near-real time and making historic flow data available to the public upon request; and
- (6) an implementation schedule.

The licensee must include with the plan, documentation of consultation with Maine DEP, Maine DMR, Maine DIFW, NMFS, FWS, and USGS; 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, FWS, and USGS 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. Project Operation. The licensee must operate the Mattaceunk Project in a run-of-river mode with year round use of the 4-foot-high flashboards such that average daily outflow approximately equals average daily inflow. The impoundment fluctuation limits must maintain the following impoundment surface elevation of:

- (1) Within 1.0 foot of the top of the flashboards crest elevation of 240.0 feet (U.S. Geological Survey [USGS] datum) during normal operations;
- (2) No lower than 2.0 feet below the flashboard crest elevation of 240.0 feet (USGS datum) when needed to allow an adequate margin for debris loads, ice loads, or sudden pool increases that might cause flashboard failure; and
- (3) Within 1.0 foot of the top of the dam crest elevation of 236.0 feet when flashboards are not in place (i.e., during flashboard replacement).

Water surface elevations may be temporarily modified if required by operating emergencies beyond the control of the licensee, or for short periods upon agreement among the licensee, the Maine Department of Environmental Protection (Maine DEP), the Maine Department of Marine Resources (Maine DMR), the National Marine Fisheries Service (NMFS), and the U.S. Fish and Wildlife Service (FWS). If water surface elevations or minimum flow releases 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. Minimum Flow Requirements. To protect the water quality and aquatic resources of the Penobscot River, the licensee must discharge from the Mattaceunk Project into the Penobscot River a continuous minimum outflow of 1,674 cubic feet per second (cfs), or inflow, whichever is less, throughout the year and maintain a daily average minimum outflow of 2,392 cfs from July 1 through September 30 and 2,000 cfs from October 1 through June 30, unless daily average inflow is less than the stated daily average minimum outflows, in which case daily average outflow from the project must approximate daily average inflow to the project.

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 and the Maine Department of Environmental Protection (Maine DEP), Maine Department of Marine Resources (Maine DMR), National Marine Fisheries Service (NMFS), and the U.S. Fish and Wildlife Service (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. *American Eel Upstream and Downstream Passage Monitoring Plans.* In accordance with section 12.6 of the U.S. Department of the Interior's Fishway Prescription filed May 23, 2017, and attached to this license as Appendix C, the licensee must develop fish passage effectiveness monitoring plans for upstream American eel passage (section 12.6.1) and downstream American eel passage (section 12.6.2). In addition to the provisions included in the section 12.6 of the prescription, the licensee must include, with the effectiveness monitoring plan(s):

- (1) goals and objectives of the monitoring;
- (2) performance criteria for determining the success of the eel passage measures;
- (3) methodology used to monitor the effectiveness and efficiency of the upstream and downstream passage measures;
- (4) provisions to report the results of the monitoring (i.e., development of a report) and consulting with the agencies regarding the results (to include an annual meeting); and
- (5) a provision to identify and implement (upon Commission approval)
 - (a) additional monitoring studies, or
 - (b) operational and structural modifications and/or habitat enhancement measures to provide eel passage, if, after 1 year of upstream monitoring and 3 years of downstream monitoring, the proposed passage measures for eel are ineffective at achieving the upstream and downstream effectiveness and survival performance criteria.

Draft Article 4XX. *Fish Passage Operations and Maintenance.* The licensee must operate and maintain, or provide for the operation and maintenance of all existing, and any new or modified upstream or downstream fish fishways.

Within 90 days 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 final Fish Passage Operations and Maintenance Plan, filed on August 31, 2016, with the following modifications:

The modifications to the Fish Passage Operations and Maintenance Plan include adding provisions to:

- (1) Perform routine maintenance before the migration season, such that the existing fishways would be fully operational during the migratory period;
- (2) Clear debris from the trash racks of all turbine intakes prior to the migration season, and determine the frequency of debris clearing during the migration season with final approval from the Commission;
- (3) Monitor flows in the downstream surface bypass pipe, using a method approved by the Commission, to detect debris blockages during the fish passage season;
- (4) Clear debris from the downstream bypass pipe when blockages are detected;
- (5) Include procedures for filing with the Commission for informational purposes, an annual report on the operation of the existing fishways and project generation;
- (6) Develop and include shutdown procedures for the existing fishways; and
- (7) Develop and include procedures for operation and maintenance of the existing fishways during emergencies and project outages.

All revisions to the Fish Passage Operations and Maintenance Plan must be developed after consultation with the National Marine Fisheries Service (NMFS), U.S. Fish and Wildlife Service (FWS), Maine Department of Marine Resources (Maine DMR), and Penobscot Indian Nation (PIN). 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.

Updates to the plan must be developed after consultation with NMFS, FWS, Maine DMR, and the PIN. The licensee must include with the updated plan, documentation of consultation, copies of recommendations on the completed report after it has been prepared and provided to the entities above, and specific descriptions of how the entities' comments are accommodated in the updated plan. The licensee must allow a minimum of 30 days for the entities to comment and to make recommendations prior to

filing the updated 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 reasons. The Commission reserves the right to require changes to the Fish Passage Operations and Maintenance Plan based on the updates. Updates to the plan must not begin until the licensee is notified by the Commission that the updates are approved. Upon Commission approval, the licensee must implement the updates to the plan, including any change required by the Commission.

The licensee must draft an annual report subsequent to the fish passage seasons for all fishways. The report must include periods of fishway operation, periods of fishway shutdowns, including unscheduled shutdowns, fishway maintenance. The licensee must provide the report to the NMFS, FWS, Maine DMR, and PIN and the Commission.

The licensee must operate the upstream eel fishway for a "shakedown" period subsequent to construction. The "shakedown" period must occur prior to the relevant fish passage season and pertinent effectiveness studies.

Draft Article 4XX. *Atlantic Salmon Species Protection Plan.* Within 90 days of license issuance, the licensee must file, with the Commission for approval, a revised Atlantic Salmon Species Protection Plan to mitigate project effects on the federally listed Atlantic salmon (*Salmo salar*). The plan must be based on, and include the provisions of, the final Atlantic Salmon Species Protection Plan, filed on August 31, 2016, as Attachment A of Volume V of the Final License Application, with the following modifications:

- (1) Remove the provision to seasonally install trash racks with 1-inch clear bar spacing to the full depth of the turbine intakes for the purpose of protecting smolts and kelts;
- (2) Revise the upstream passage effectiveness study methodology to include the type of telemetry tag to be used on upstream migrating adults and the appropriate timing for stocking tagged smolts, and refile the Atlantic Salmon Species Protection Plan with the revised study plan;
- (3) Include the proposed passage effectiveness study plans as attachments to the Atlantic Salmon 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 95 percent performance standard after the first year;
- (5) Determine the need for future effectiveness studies, and/or fishway modifications, with final approval from the Commission, if after 3 years of upstream passage effectiveness studies, the upstream fishway does not meet the 95 percent effectiveness performance standard;

- (6) Revise the number of downstream passage effectiveness studies for smolts to indicate that a minimum of 3 years of study would be conducted;
- (7) Revise the criteria for achieving the performance standard to state that the performance standard would be considered achieved, if a total 3 years of downstream passage effectiveness studies for smolts demonstrate that the downstream passage facilities meet a 96 percent survival performance standard;
- (8) Determine, with final approval from the Commission, when to begin implementation of phased spill measures for downstream passage of smolts, with the restriction that phased spill measures would be implemented after a minimum of 1 year and a maximum of 3 years of conducting downstream passage effectiveness studies for smolts, and non-spill passage measures;
- (9) Determine, with final approval from the Commission, the 3 week period during which any log sluice or phased spill measures would occur for downstream passage of smolts;
- (10) Determine the need for an additional 1- or 2-years of downstream passage effectiveness studies for kelts, with final approval from the Commission, if the downstream fishway meets the 96 percent survival performance standard for kelts after the first year;
- (11) Determine the need to conduct at least one year of additional effectiveness study, with final approval from the Commission, if the downstream fishway does not meet the 96 percent survival performance standard for kelts after the first year;
- (12) Determine the need for future effectiveness studies, and/or fishway modifications, with final approval from the Commission, if after 3 years of downstream passage effectiveness studies, the downstream fishway does not meet the 96 percent survival performance standard for kelts;
- (13) Remove the provision to conduct a study to evaluate smolt mortality in the project impoundment;
- (14) Remove the provisions requiring reevaluation of upstream and downstream passage effectiveness every 10 years; and
- (15) 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 Atlantic Salmon Species Protection Plan must be developed after consultation with the National Marine Fisheries Service (NMFS), U.S. Fish and

Wildlife Service (FWS), Maine Department of Marine Resources (Maine DMR), and Penobscot Indian Nation (PIN). 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.

Updates to the Atlantic Salmon Species Protection Plan must be developed after consultation with the NMFS, FWS, Maine DMR, and PIN. The licensee must include with the updated plan documentation of consultation, copies of recommendations on the updated plan after it has been prepared and provided to the entities above, and specific descriptions of how the entities' comments are accommodated in the updated plan. The licensee must allow a minimum of 30 days for the entities to comment and to make recommendations prior to filing the updated 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 reasons. The Commission reserves the right to require changes to the Atlantic Salmon Species Protection Plan based on the updated plan.

Draft Article 4XX. *Northern Long-Eared Bat Species Protection Plan.* Within 90 days of license issuance, the licensee must file, with the Commission for approval, a Northern Long-Eared Bat Species Protection Plan to mitigate project effects on the federally listed northern long-eared bat (*Myotis septentrionalis*), and their associated habitat in the project boundary.

The plan must include, at a minimum, limiting non-hazardous tree removal to November 1 through March 31, which is outside of the northern long-eared bat pup season (June 1 to July 31), and the broader active season (April 1 to October 31). Tree-removal is defined herein as cutting down, harvesting, destroying, trimming, or manipulating in any other way the non-hazardous trees, saplings, snags, or any other form of woody vegetation likely to be used by northern long-eared bats.

The licensee must prepare the plan after consultation with the U.S. Fish and Wildlife Service, and the Maine Department of Inland Fisheries and Wildlife. The licensee must include with the plan documentation of consultation, 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.

The Commission reserves the right to require changes to the plan. Land-disturbing or land-clearing activities 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. *Downstream Angler Access Area Improvements.* Within three years of the effective date of this license, the licensee must complete installation of the following improvements at the Downstream Angler Access Area: (1) a pulley system to assist boaters with moving car top boats and other small watercraft up and down the existing stairs; and (2) a ramp adjacent to the existing recreation pavilion to provide wheel chair access to the pavilion and its associated picnic table. Within 90 days of completion, the licensee must file with the Commission a report documenting the completed recreation improvements. The documentation may include photographs, aerial photographs, as-built drawings, or other means, provided that the documentation clearly demonstrates the recreation improvements have been constructed in substantial conformity as approved.

Draft Article 4XX. *Recreational Facilities.* The licensee must operate and maintain the following recreational facilities for the term of the license: (1) the existing canoe portage located on the western side of the impoundment with a take-out about 650 feet upstream from the dam and put-in below the dam; and (2) the Downstream Angler Access Area, located on the east bank of the Penobscot River which includes angler access via stairs from the parking area to the river, a covered picnic area adjacent to the parking area, and parking for six to eight vehicles.

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 State Historic Preservation Officer for Managing Historic Properties that may be affected by Issuing a License to Great Lakes Hydro America, LLC for the Operation of the Mattaceunk Hydroelectric Project in Aroostook and Penobscot Counties, Maine," executed on _____ by the Maine State Historic Preservation Officer (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 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 and the Penobscot Indian Nation Tribal Historic Preservation Officer (THPO) 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 THE INTERIOR'S SECTION 18 FINAL FISHWAY PRESCRIPTIONS³²⁰

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 Mattaceunk Hydroelectric Project.

FINAL 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 the Licensee. To ensure the immediate and timely contribution to the restoration and enhancement of American eel in the Penobscot River upstream of the Mattaceunk Project, the following are included and shall be incorporated by the Licensee 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 Penobscot River watershed and at the Mattaceunk Project and would benefit from immediate implementation of safe, timely, and effective upstream and downstream passage. The Commission will need to include

³²⁰ On June 27, 2018, the U.S. Fish and Wildlife (FWS) Service filed a letter indicating that no entity requested a hearing, and no comments were filed, on its Preliminary Fishway Prescription filed May 23, 2017. Thus, FWS states that the May 23 Preliminary Fishway Prescription should be incorporated, unchanged and unmodified, as the final prescription for fishways under the new license.

appropriate license articles requiring preparation of detailed design plans, installation schedules and 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 resources 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

The Licensee 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 American eels reaching the Projects depends on a number of factors, including the overall efficiency and cumulative losses of eels attempting to migrate upstream at the Milford, Orono, Stillwater, and West Enfield dams. The Service does not have a precise estimate of the number of eels that would be expected to use upstream fish passage at the Project. Given the cumulative effect from the dams below the Project and the presence of eel at the Project, fish passage will enhance 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

The Licensee 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 in the future when additional information about eel abundance and movement in the vicinity of the Project becomes available. Once eels have entered an eel ramp, 90 percent must 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).

The Licensee shall operate the Project to exceed the minimum downstream survival efficiency criterion of 76 percent of the adult (i.e. silver) American eel moving downstream past the Project. This performance standard is based upon Sweka et al. (2014) which indicates that cumulative silver eel survival passing three to four dams—in this case, Mattaceunk, West Enfield dams followed by either Milford dam for eels passing down the main stem, or the Stillwater and Orono dams for eels passing down the Stillwater Branch of the river – must exceed a minimum of 76 percent at each dam, and must be higher to rebuild the American eel population.

12.3 UPSTREAM EEL PASSAGE

Within two years of License issuance, the Licensee shall design and construct an eel upstream passage ramp at the west abutment of the spillway. The exact location of this eel fishway and other design criteria to be determined by the U.S. Fish and Wildlife Service following consultation with the licensee 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

Licensee shall shutdown all generation nightly (8 pm to 4 am) from August 1 through October 31 annually to provide out-migrating American eels safe and timely downstream passage. Licensee shall install full depth one inch trash racks, as either permanent structures or seasonal overlays, during the downstream eel passage operations.

12.5 FISHWAY OPERATION AND MAINTENANCE

12.5.1 OPERATING DATES

The Licensee shall operate the upstream eel fishway during the months of June through August. The Licensee shall operate the downstream eel fishway during the months of August through October. 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 and/or a predictive model for eel movement through the Project waters.

12.5.2 FISHWAY OPERATION AND MAINTENANCE PLAN

Within 12 months of license issuance, Licensee will develop a Fishway Operation and Maintenance Plan (FOMP) covering all operations and maintenance of the upstream and downstream fish passage facilities provided for American eel. The FOMP shall be submitted to the Service for review and approval. Thereafter, Licensee 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, Licensee 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 Licensee will require approval by the Service prior to implementation. Licensee 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, and 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

The Licensee 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 Presumpscot 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, a criterion developed by MDMR and used to assess all of the eel ramps installed at dams on the Kennebec and Presumpscot Rivers, and at other projects.

12.6.2 DOWNSTREAM AMERICAN EEL EFFECTIVENESS MONITORING

The Licensee 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 meets the criterion in Section 12.2.2. If this passage rate is not met, then Licensee and the Service will assess passage enhancements including, but not limited to, an extended passage season, 0.75 inch trash rack spacing, a deep bypass gate, or new downstream eel passage facilities based upon angled trash racks (Sojkowski 2017, entire). Licensee will implement the solution selected by the Service.

The Service recommends that silver eel passage effectiveness monitoring be conducted with radio telemetry methods in order to determine migratory delay, route of downstream passage (i.e. via the two surface bypasses, the roll gate, spill, turbines, or spillway), immediate survival, and latent survival passing Mattaceunk Dam.

12.7 FISHWAY INSPECTIONS

The Licensee 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.

APPENDIX D

NMFS'S SECTION 18 MODIFIED FISHWAY PRESCRIPTIONS

7.3 Section 18 Modified Fishway Prescription

We hereby submit the following modified 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 USFWS 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 # 20170530-0009).

7.3.1 Upstream Fish Passage – Anadromous Species

The Licensee shall construct, operate and maintain upstream fish passage facilities that pass anadromous fish species in a safe, timely and effective manner consistent with the performance standards described in Section 7.3.4. Based on the fish passage alternative report filed in the FLA, and the best scientific information available at this time, we believe that any one of the following fishways could be satisfy the standard of safe, timely and effective: a nature-like fishway, fish lift, or vertical slot fishway for alosines and Atlantic salmon in conjunction with the existing pool and weir fishway for Atlantic salmon. We also consider ice harbor fishways to be an acceptable design for passing alosines because they are successful at passing American shad at projects on the

U.S. West Coast. However, because the fishway will not be built for another 15 years, and because new studies and testing will occur during this interim time period, the specific performance criteria by which safe, timely and effective passage will ultimately be determined pursuant to the process identified in section 7.3.5.

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.

The Licensee proposed the following actions to increase survival of upstream migrating anadromous fish:

- a. Maintain the existing pool and weir fishway for Atlantic salmon.
- b. Additional operational and structural modifications and/or habitat enhancement measures, if necessary, to address performance standard deficiencies for upstream migrating Atlantic salmon adults.
- c. Installation of an effective upstream passage structure for alosine species in year 15 of the new license, to be operational year 16.
- d. Conduct up to three years of upstream passage monitoring for Atlantic salmon and two years of upstream passage monitoring of alosines.
- e. Additional operational and structural modifications and/or habitat enhancement measures, if necessary, to provide alosine passage (passage criteria for alosine shall be based on a review of the performance of comparable fish passage measures in New England).

We incorporate by reference the GLHA proposed measures in this prescription and further require the following:

- Maintain the trap associated with the existing pool and weir fishway for Atlantic salmon.
- Additional protective measures or alternative actions (e.g., additional fishway entrances, increased attraction flows) may be necessary based on monitoring, and as determined by the resource agencies, to address performance standard deficiencies for upstream migrating Atlantic salmon and alosines.

Additional protective measures or alternative actions (e.g., spillage, turbine shutdowns) 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.

7.3.2 Downstream Fish Passage – Anadromous

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 described in Section 7.3.5. The downstream passage facility shall be comprised of a protective barrier leading to a bypass system. The bypass system shall be comprised of (1) a surface entrance leading to a pipe or sluice to convey fish around the project and discharge to flowing water below the project such as the tailrace with sufficient depth (at least 4 ft.) to avoid injury (USFWS 2017) and (2) increased spill through an opening (e.g., log sluice) adjacent to the powerhouse discharging to flowing water below the project with sufficient depth (at least 4 ft.) to avoid injury. Downstream passage facilities shall be operational within two years after the issuance of a new license. 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.

The Licensee proposed the following actions to improve survival of downstream migrating anadromous fish:

- a. Installation of trash racks having 1-inch clear spacing to the full depth of all turbine intakes within two years of license issuance. The trash racks would be deployed during the fish passage season.
- b. Beginning in the first passage season following license issuance, operate existing downstream fishway plus open the log sluice (between 3% and 9% of station capacity or between 225 cfs and 690 cfs) for three weeks. The schedule will be determined in consultation with agencies and based on environmental factors including river temperatures and flows.
- c. Conduct up to three years of downstream passage monitoring for Atlantic salmon and two years of downstream passage monitoring of alosines.
- d. Annual extended seasonal operation of the downstream fishway and log sluice operation (~225 cfs and 690 cfs) from June 1 to December 1, as necessary based on smolt and alosine study results, once upstream passage for alosines (American shad and river herring) is operational (expected year 16 of a new license term).

- e. Implement an adaptive management plan to address performance criteria for downstream passage should the proposed measures be inadequate.
- f. Additional operational and structural modifications such as spill and/or habitat enhancement measures, if necessary, to address performance standard deficiencies for outmigrating Atlantic salmon smolts and kelts, and alosines.

We incorporate by reference GLHA proposed measures in this prescription and prescribe the following additional measures:

- Additional protective measures or alternative actions such as additional spill or intakes screening sufficient to attain performance standards for outmigrating Atlantic salmon smolts and kelts, and alosines. Additional protective measures for Atlantic salmon will be determined during the section 7 consultation with FERC regarding the issuance of a new license for the Project.
- Point measurements of approach velocities immediately upstream of the intakes and trash racks shall not exceed 2.0 feet per second (fps) within a 2-foot square grid as measured within 6 to 12 inches upstream of the racks.

The proposed actions, including the modifications identified above, provide a reasonable approach for mitigating project impacts on downstream migrating anadromous fish. Additional measures, such as increasing the amount of spill, 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.

7.3.3 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. These dates may change based on new information and agency consultation. 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 Penobscot River watershed specific data, approved fish passage protective measures shall be operational during the follow migration windows:

- a. Upstream alosine (once construction of the new fishway is complete): May 1 to July 31
- b. Upstream Atlantic salmon: May 1 – Nov 10 unless the Milford fishways begins capturing fish earlier in the calendar year in which case the fishway will open prior to May 1

- c. Downstream alosine (once construction of the new fishway is complete):
June 1 –November 30
- d. Downstream kelt: April 1 to June 15 and October 17 – December 1 or ice in.
- e. Downstream smolt: April 1 to June 15

7.3.4 Passage Performance Standards and Monitoring

The degree to which fish passage facilities are considered safe, timely and effective will be evaluated based on performance criteria. Fishways (upstream and downstream) must operate in a way that complies with any Incidental Take Statement issued as part of the anticipated Biological Opinion. A performance standard of 95% for adult Atlantic salmon upstream passage and 96% for downstream passage of Atlantic salmon smolts and kelts is identified in GLHA’s proposed Species Protection Plan. This proposal is consistent with requirements for other projects in the Penobscot River. We note that the upstream and/or downstream passage standards may be modified by the Incidental Take Statement in any Biological Opinion issued by us for this project. When analyzing telemetry test data, individual salmon (smolt or kelt) approaching within 200 meters of the dam structure must pass within 24 hours in order for it to be considered a successful passage attempt that can be applied towards the downstream passage performance standard (i.e., if a fish takes longer than 24 hours it will not be considered to have passed successfully). When analyzing telemetry test data, we anticipate the upstream passage performance standard of 95% will be considered achieved if: 1) 75% of adult test fish pass the project area within 48 hours of approaching the dam; and 2) the remaining 20% of test fish pass the project within 96 hours. The project area is defined as 200 meters downstream of the project dam/powerhouse to the upstream fishway exit. In the event that monitoring results indicate that fishways at the project do not meet the performance criteria for Atlantic salmon, additional operational and structural modifications (e.g., spill) and/or habitat enhancement measures shall be required as determined by the resource agencies and as specified in the adaptive management steps contained in the Atlantic salmon Species Protection Plan or as modified by the Incidental Take Statement in any Biological Opinion issued by NMFS for this project.

Preliminary modelling results from Stich et al. (*in review*) indicate that once passage is provided at a dam, high upstream and downstream passage survival of American shad is necessary, including at the Mattaceunk Project, to reach and maintain population management goals. Fishways that are able to pass shad are able to pass alosines given similarities in swimming performances and behavior (USFWS 2017); accordingly, we have prescribed a fishway that can pass shad in a safe, timely and effective manner. To achieve stated recovery goals for alosines upstream of the Mattaceunk Project, we will require that the Licensee meet fish passage performance standards for American shad and river herring. Because we are not requiring

construction of the new fishway until 2034, and the performance standards need to be based on the best available information at that time, we will delay establishing the performance standards until we can determine what is safe, timely and effective upstream and downstream passage for alosines. Based on currently available information (Stich et al. *in review*), we anticipate that safe, timely and effective passage for shad and river herring is likely to mean that 90% of alosine must pass upstream of the project within 24 hours (and survive the passage attempt) and that 95% of alosines must pass downstream of the project (and survive the passage attempt). This, however may change in the next several years. In the event that monitoring results indicate that fishways at the project do not meet the established performance criteria for American shad or river herring, additional operational and structural modifications (as described above) shall be required as determined by the resource agencies in consultation with the Licensee.

The Licensee shall monitor the ability of Atlantic salmon, American shad, blueback herring and alewife to use the upstream and downstream fish passage facilities. Monitoring for all fish passage facilities is required to ensure they function as designed and intended for providing safe, timely and effective passage. This includes pre-season inspection and maintenance consistent with measures described in 7.3.1 for upstream fishways and 7.3.2 for downstream fishways. Monitoring will help identify potential issues and deficiencies that may affect successful passage. Monitoring should include behavioral responses, numbers and species passing, and condition of the fish passing through the facilities. Based on the results of monitoring, structural or operational modifications may be required to meet the goals of the prescription (FERC 1993, 2004). In this case, we expect that structural or operational modifications would be required if the performance standards outlined in section 7.3.5 are not met.

The Licensee proposed to conduct the following monitoring studies:

- a. Atlantic salmon - up to three years of monitoring for the upstream fishway effectiveness, downstream kelt studies using the returning imprinted adult fish, and smolt downstream passage measures.
- b. Alosine - two years of monitoring for the new upstream and downstream measures.
- c. American eel - one year of monitoring for the upstream eel ramp and two years of monitoring of downstream eel passage.

The proposed timeframes are acceptable; however, additional years may be needed in the event of poor passage performance, extreme weather, or inadequate sampling methodologies. Specific to Atlantic salmon, additional monitoring may be necessary and will be described in any appropriate Incidental Take Statement issued as part of the anticipated Biological Opinion. In addition to the Licensee's proposal, the following is required:

- Study design plans will be developed in consultation with NMFS and state and federal resource agencies. The study design shall be approved by the agencies prior to filing with the Commission for final approval.
- All monitoring will be completed with scientifically accepted practices.
- Monitoring shall begin at the start of the second migratory season after the each fishway facility (Atlantic salmon, alosines and American eel) is operational and shall continue to be conducted for the time frames proposed or as otherwise required. The first season after fishway construction shall be used as a “shake-down” period to ensure the fishway is functioning as designed.
- Reports of the monitoring studies shall be provided to the resource agencies for a minimum 30-day review and consultation prior to submittal to the Commission for final approval.
- The Licensee shall include resource agencies’ comments in the annual reports submitted to the Commission for final review.

7.3.5 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. Conceptual designs shall be provided to the agencies no later than two years before the anticipated operational date. Conceptual designs for the proposed full-depth 1” clear trash racks shall be provided at least six months prior to the first downstream passage season following issuance of any new license by FERC. 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 us and the USFWS.

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 Mattaceunk Project (FERC No.2520). The Secretary of Commerce reserves his authority to prescribe additional or amended fishways as he may decide are required in the future.