May 9, 2022

Ms. Shannon Ames, Executive Director
Low Impact Hydropower Institute
329 Massachusetts Avenue, Suite 2
Lexington, MA 02420

TROUT UNLIMITED
MAINE COUNCIL

Transmitted via e-mail to comments@lowimpacthydro.org

Subject: **Comments on Application for LIHI Certification for the Mattaceunk Project**

Dear Ms. Ames:

On behalf of its six chapters and over 2,000 members, Maine Council of Trout Unlimited (TU) submits these comments on the Brookfield ("Applicant") Application for LIHI Certification for the Mattaceunk Project dated March 29, 2022.

General Comments

Review of the application indicated: (1) the project does have documented fisheries impacts and (2) the project nonetheless appears to meet LIHI certification requirements. This highlights TU's long-standing concern that a project can have substantial impacts on the environment—in this case, impacts on fish passage, habitat and survival for sea-run fish, including endangered Atlantic salmon—and still be certified as "low impact" under LIHI's requirements. LIHI's standards are what they are, but the Mattaceunk project certification process offers an excellent opportunity to provide 'value added' to the project beyond what is contained in its FERC license. This would fulfill what we see as a key potential benefit of LIHI certification—that certification helps move licenses to take actions to reduce their impacts beyond what regulatory conditions require today. Unless the proposed actions described below are taken, LIHI certification will only serve as a tacit endorsement of the ongoing environmental damage especially mortality to endangered Atlantic salmon as described in the Mattaceunk BIOP provided as Attachment A for LIHI staff convenience.[1]

Specific Comments

The areas of TU concern are 3.2.3 Criterion C - Upstream Fish Passage, 3.2.4 Criterion D - Downstream Fish Passage and Protection and 3.2.6 Criterion F - Threatened and Endangered Species Protection. The means required to implement effective fish passage and stop the continued mortality to Atlantic salmon are complex and stretch far into the future – as much as 15 years for upstream fish passage for alosines.[2] Experience on the Saco (where the Applicant owns all of the hydro projects below Swans Falls) and other rivers in Maine has shown that delays to implementation of fish passage and protective measures are usually the case, and this should not be allowed to happen at Mattaceunk. Atlantic salmon are endangered

[1] National Marine Fisheries Service letter dated August 6, 2020, RE: Endangered Species Act Section 7 Formal Consultation for the Mattaceunk Project (FERC No. 2520-076, especially page 35.

[2] Brookfield letter subject, Low Impact Hydropower Institute Application for the Mattaceunk Project (FERC No. 2520), page 50: *"Article 401 requires the installation of a new fishway in Year 15 of the Project license specifically targeted for alosines, in compliance with the Section 18 fish passage prescriptions and Section 401 water quality certification."*

and every fish killed or injured by project operations does matter to their recovery. Alosines are important too as they are co-evolved species deemed necessary for the recovery of Atlantic salmon. It must also be noted that the Penobscot Indian Nation (PIN) was promised a sustenance fishery on the Penobscot that has yet to be delivered, and project operations will continue to degrade fisheries restoration efforts until fully implemented.

Recommendations

The terms and conditions for fish passage and protection of endangered species that are in the current license are complex and span many years. Accordingly, TU recommends that before receiving LIHI certification that the Applicant be required to provide:

- A comprehensive milestone schedule containing all the provisions of the license terms and conditions required to effect upstream and downstream fish passage and implement measures protective of Atlantic salmon.
- Specific milestone completion status with each of the yearly reports required by LIHI.

If certified and the above measures adopted:

- LIHI staff would review these annual reports for compliance with milestone completion dates.
- Failure to complete any milestone on time would result in suspension of LIHI certification until such time as the operator restored project compliance to the timeline.

Without a milestone schedule to work from, it would be unreasonable to expect LIHI staff to be able to sort out compliance with the restoration measures that the LIHI certification is based on.

TU sees this an excellent opportunity for LIHI to prevent the delays to implementation of fisheries restoration measures that continue to plague Maine's hydro operations. Fifty years have passed since the Clean Water Act promised restoration of indigenous aquatic organisms to their former ranges in our waters. The delays need to stop and LIHI can provide the incentive for the hydro industry to prevent them.

TU appreciates the opportunity to comment on this application.

Respectfully,

Stephen G. Heinz
Maine TU Council FERC Coordinator

Reply to: heinz@maine.rr.com

Attachment – Mattaceunk Project BIOP dated August 6, 2020

UNITED STATES DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
NATIONAL MARINE FISHERIES SERVICE
GREATER ATLANTIC REGIONAL FISHERIES OFFICE
55 Great Republic Drive
Gloucester, MA 01930

Attachment

August 6, 2020

Kimberly D. Bose, Secretary
Federal Energy Regulatory Commission
888 First Street, N.E.
Washington, DC 20426

RE: Endangered Species Act Section 7 Formal Consultation for the Mattaceunk Project (FERC No. 2520-076)

Dear Ms. Bose:

Enclosed is NOAA's National Marine Fisheries Service (NMFS) Biological Opinion (Opinion), issued under section 7(a)(2) of the Endangered Species Act (ESA), for the Federal Energy Regulatory Commission's (FERC) proposal to relicense the Mattaceunk Project (FERC No. 2520) on the Penobscot River in Maine. This Opinion considers the effects of operating the project for a term of up to 40 years, and is based on the FERC's September 2018 Final Environmental Assessment and other sources of information as cited in the Opinion. In the Opinion, we conclude that the proposed project may adversely affect but is not likely to jeopardize the continued existence of the Gulf of Maine distinct population segment (GOM DPS) of Atlantic salmon. The Mattaceunk Project is also located in designated critical habitat for the GOM DPS of Atlantic salmon. Although ongoing operations of the hydroelectric facility will continue to adversely affect essential features of this habitat, the proposed action is not likely to adversely modify or destroy critical habitat designated for the GOM DPS of Atlantic salmon. While listed shortnose and Atlantic sturgeon occur in the Penobscot River, they do not occur in the action area.

As required by Section 7(b)(4) of the ESA, an incidental take statement (ITS) is provided with the Opinion. The ITS exempts the incidental taking of Atlantic salmon from activities associated with the ongoing operation of the hydroelectric facility as well as upstream and downstream passage and survival studies. The ITS also specifies Reasonable and Prudent Measures (RPMs) and implementing Terms and Conditions necessary to minimize the impact of these activities on Atlantic salmon.

The ITS specifies five RPMs necessary to minimize and monitor take of listed species. One RPM is specific only to the Licensee. The RPM and implementing Terms and Conditions outlined in the ITS are non-discretionary, and must be undertaken so that they become binding conditions for the exemption in section 7(o)(2) to apply. Failure to implement the terms and conditions through enforceable measures may result in a lapse of the protective coverage of section 7(o)(2). We expect that you will require compliance with the RPMs through enforceable measures of any new license issued for the Mattaceunk Project. Annual reporting that is required by the ITS will continue to supply information on the level of take resulting from the proposed action.

Section 7(a)(1) of the ESA directs Federal agencies to utilize their authorities to further the purposes of the ESA by carrying out conservation programs for the benefit of endangered and threatened species. Conservation recommendations are discretionary agency activities to minimize or avoid adverse effects of a proposed action on listed species or critical habitat, to help implement recovery plans, or to develop information. To further reduce adverse effects of the proposed project, we provide a recommendation to FERC to require compensatory mitigation for the unavoidable effects of operation on endangered Atlantic salmon. While this recommendation is discretionary, we strongly urge FERC to carry out this program.

This Opinion concludes consultation for the FERC's proposed relicensing of the Mattaceunk Project. Reinitiation of consultation is required and shall be requested by FERC or by NMFS, where discretionary Federal involvement or control over the action has been retained or is authorized by law and: (1) the amount or extent of taking specified in the incidental take statement is exceeded; (2) new information reveals effects of the action that may not have been previously considered; (3) the identified action is subsequently modified in a manner that causes an effect to listed species; or (4) a new species is listed or critical habitat designated that may be affected by the identified action. Please contact Jeff Murphy of my staff at (207) 866-7379 or Jeff.Murphy@noaa.gov for any questions involving this consultation.

Sincerely,

Jennifer Anderson

Jennifer Anderson
Assistant Regional Administrator
for Protected Resources

cc: Casey, GCNE
McDermott, F/GAR HCD
Maine DMR
U.S. FWS

File Code: FERC P-2520 Mattaceunk Project
ECO: GARFO-2019-00310

NATIONAL MARINE FISHERIES SERVICE
ENDANGERED SPECIES ACT
BIOLOGICAL OPINION

Agency: Federal Energy Regulatory Commission (FERC)

Activity Considered: Proposed Relicensing of the Mattaceunk Project (P-2520)
GAR-2019-00310

Conducted by: National Marine Fisheries Service
Greater Atlantic Regional Fisheries Office

Date Issued: August 6, 2020

Approved by: Jennifer Anderson

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LIST OF APPENDICES

1. INTRODUCTION AND BACKGROUND

This constitutes the biological opinion (Opinion) of NOAA's National Marine Fisheries Service (NMFS) issued under the Endangered Species Act (ESA) of 1973, as amended (16 U.S.C. 1531-1543) regarding the effects of the Federal Energy Regulatory Commission's (FERC) proposed issuance of a new 40-year license for the Mattaceunk Project (P-2520) on the Penobscot River, Maine. The Mattaceunk Project is a 19.2 megawatt (MW) hydroelectric project operated by Great Lakes Hydro America, LLC (GLHA or Applicant). The Project is located on the mainstem of the Penobscot River in the towns of Medway, Woodville, Mattawamkeag, and Molunkus, Maine. The existing license expired on August 31, 2018. On September 11, 2018, FERC issued an operating license pursuant to 18 CFR 16.21(b) for the Mattaceunk Project which renews annually for a period effective until a new license is issued.

As the relicensing is a new federal action, this Opinion wholly supersedes our June 20, 2013 Opinion, as well as the May 21, 2019 amended Incidental Take Statement, issued to the FERC concerning its amendment of the September 30, 1988 license for the Mattaceunk Project incorporating the provisions of an Interim Species Protection Plan (ISPP) for Atlantic salmon.

This Opinion is based on information contained in FERC's September 2018 Final Environmental Assessment (FEA) for the Mattaceunk Project (which also serves as FERC's Biological Assessment (BA)) as well as additional information filed with us post-issuance of the FEA which served to clarify the proposed action for this consultation and is cited herein. A complete administrative record will be maintained at our Maine Field Station in Orono, Maine. Consultation was initiated on April 18, 2019.

1.1. Consultation History

The Mattaceunk Project was last licensed by FERC in 1988. In 2009, the ESA listing of Atlantic salmon was expanded to include the mainstem Penobscot River. At the same time, critical habitat was designated for the species; this critical habitat designation includes the project area. On February 28, 2013, GLHA filed an ISPP with FERC describing measures it would take over the remaining term of the existing license to avoid and minimize impacts to federally-listed endangered Atlantic salmon during operation of the Mattaceunk Project. At that time, GLHA requested that FERC amend its 1988 license to incorporate the terms of the ISPP. We completed ESA section 7 consultation on the proposed license amendment with the issuance of a Biological Opinion on June 20, 2013. In that Opinion, we concluded that continued operation of the project, in compliance with the ISPP, for the remaining duration of the 1988 license, was not likely to jeopardize the continued existence of the Gulf of Maine DPS of Atlantic salmon or result in the destruction or adverse modification of designated critical habitat. On September 26, 2013, FERC amended the 1988 license to incorporate the provisions of the ISPP at the Mattaceunk Project. On May 21, 2019, we issued an amended Incidental Take Statement and accompanying letter that reflected our consideration of FERC's issuance of an annually renewable license to authorize operations of the project until the relicensing process was completed.

Below, we present major dates and actions associated with this new ESA section 7 consultation on the consequences of the proposed relicensing:

- On March 24, 2017, FERC issued a Notice of Application Accepted for Filing, Soliciting Motions to Intervene and Protests, Ready for Environmental Analysis, and Soliciting Comments, Recommendations, Preliminary Terms and Conditions, and Preliminary Fishway Prescriptions for the Mattaceunk Project.
- On May 23, 2017, we filed our Recommended Terms and Conditions and Preliminary Prescription for Fishways for the Mattaceunk Project. We also included our comments on the Applicant's final license application (FLA), draft BA and Species Protection Plan (SPP). The SPP was proposed by the applicant for incorporation into any license issued by FERC.
- On March 15, 2018, FERC issued a draft Environmental Assessment (DEA) for the application to relicense the Mattaceunk Project and requested initiation of formal ESA section 7 consultation.
- On April 12, 2018, we filed a letter with FERC stating that formal ESA section 7 consultation for the Mattaceunk Project could not yet be initiated due to a lack of sufficient information on the proposed action and its consequences to Atlantic salmon and its critical habitat.
- On June 28, 2018, we filed our Modified Section 18 Fishway Prescription for the Mattaceunk Project with FERC.
- On September 25, 2018, FERC issued the Notice of Availability of Final Environmental Assessment. The FEA requires fifteen separate modifications to GLHA's proposed SPP for Atlantic salmon. The FEA also requires GLHA to resubmit the revised SPP for Atlantic salmon post-license issuance. FERC's FEA does not contain a stand-alone BA.
- On May 21, 2019, we filed a letter initiating formal section 7 consultation with FERC, with April 18, 2019 as the date of initiation. .
- On September 3, 2019, GLHA sent us a notice reaffirming its commitment to conduct the studies and enhancement measures (which would include the smolt impoundment studies and enhancement measures) contained in the SPP filed with FERC as part of the FLA. The notice was also filed with FERC.

1.2. Application of ESA Section 7(a)(2) Standards – Analytical Approach

This section reviews the approach used in this Opinion in order to apply the standards for determining jeopardy and destruction or adverse modification of critical habitat as set forth in section 7(a)(2) of the ESA and as defined by 50 CFR §402.02 and 50 CFR §402.14 (the consultation regulations). Additional guidance for this analysis is provided by the Endangered Species Consultation Handbook, (NMFS and United States Fish and Wildlife Service (USFWS) March 1998). In conducting analyses of actions under section 7 of the ESA, we take the following steps, as directed by the consultation regulations:

- Identify the action area based on the action agency's description of the proposed action (Section 2);
- Evaluate the current rangewide status of the species with respect to biological requirements indicative of survival and recovery and the essential features of designated critical habitat (Section 3);
- Evaluate the current status of the species and essential features of designated critical habitat within the recovery unit of the action area (Section 3.2);
- Evaluate the relevance of the environmental baseline in the action area to biological requirements and the species' current status, as well as the status of designated critical

habitat (Section 4);
- Evaluate the relevance of climate change on environmental baseline and status of the species (Section 5);
- Determine the consequences of the proposed action on listed species and designated critical habitat (Section 6);
- Determine and evaluate any cumulative effects within the action area (Section 7); and,
- Evaluate whether the consequences of the proposed action, taken together with any cumulative effects and the environmental baseline, can be expected, directly or indirectly, to reduce appreciably the likelihood of both the survival and recovery of the affected species, or are likely to destroy or adversely modify its designated critical habitat (Section 8).

In completing the last step, we determine whether the action under consultation is likely to jeopardize the ESA-listed species or result in the destruction or adverse modification of designated critical habitat. If so, we must identify a reasonable and prudent alternative(s) (RPA) that avoids jeopardy or adverse modification of critical habitat and meets the other regulatory requirements for an RPA (see 50 CFR §402.02). In making these determinations, we must rely on the best available scientific and commercial data.

The critical habitat analysis determines whether the proposed action is likely to destroy or adversely modify designated or proposed critical habitat for ESA-listed species by examining any change in the conservation value of the physical and biological features of that critical habitat. As defined by NMFS and USFWS, destruction or adverse modification "means a direct or indirect alteration that appreciably diminishes the value of critical habitat as a whole for the conservation of a listed species(84 FR 45016; Aug. 27, 2019).

2. PROJECT DESCRIPTION AND PROPOSED ACTION

The Mattaceunk Project is located on the Penobscot River in Aroostook and Penobscot Counties, Maine, approximately 100 river kilometers upstream of Penobscot Bay (Figure 1). The Mattaceunk Project is the third mainstem dam on the Penobscot River. The Milford Project (FERC No. 2534) is the first mainstem dam (~river kilometer (rkm) 60) on the Penobscot River. The West Enfield Project (FERC No. 2600) is the second mainstem dam on the river (~rkm 100). In the lower Penobscot River watershed, the river splits into two significant branches: the Stillwater Branch and the mainstem. There are two hydroelectric projects located on the Stillwater Branch: Stillwater (FERC No. 2712) and Orono (FERC No. 2710).

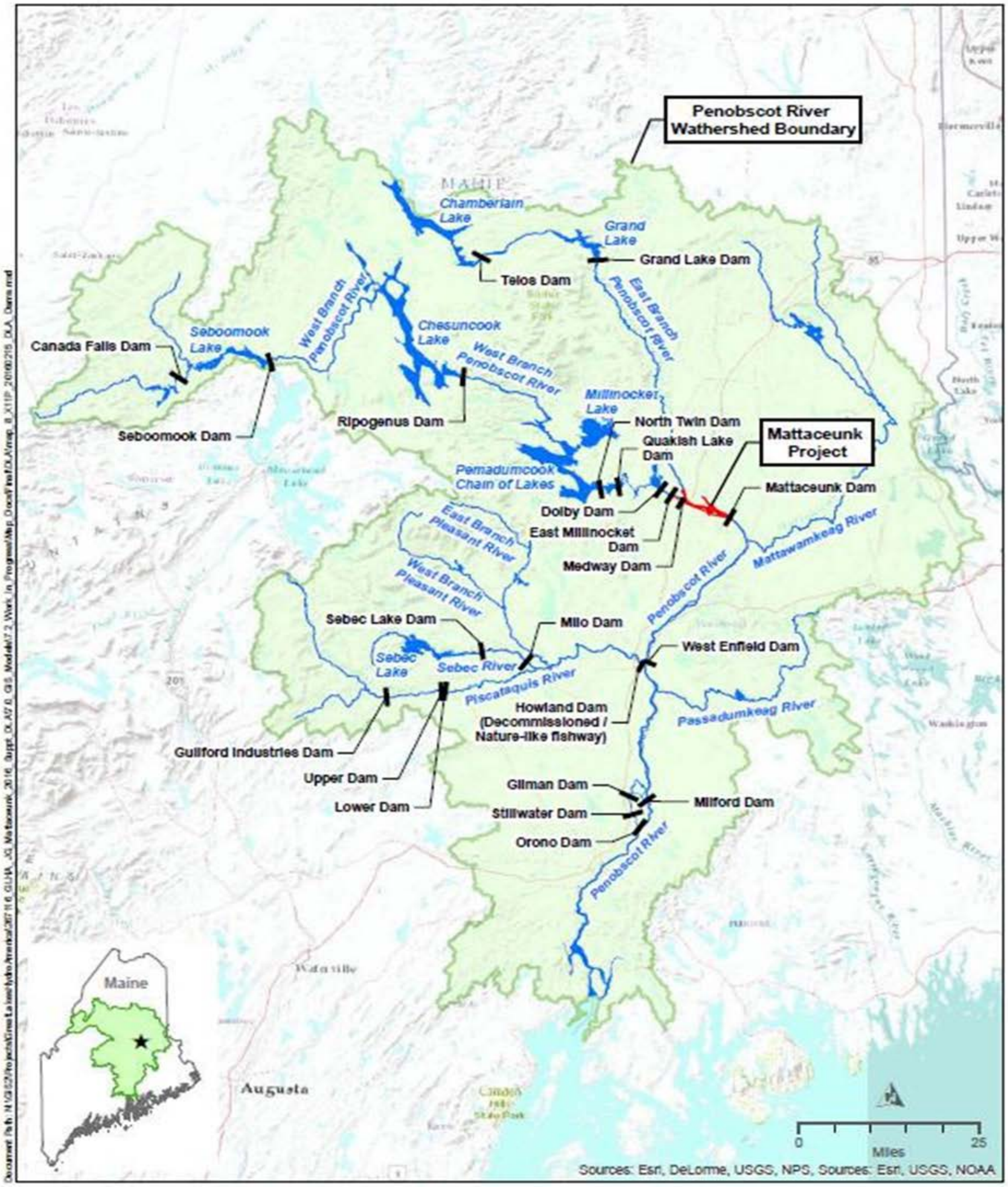

Figure 1. Location of dams in the Penobscot River watershed. Source: GLHA.

2.1. Project Facilities and Operation

The Mattaceunk Project consists of: a 1,060-foot-long, 45-foot-high dam (Weldon Dam) with a variable crest elevation; 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; 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; an upstream pool and weir fishway; 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; a downstream surface bypass fishway; 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 MW; a substation adjacent to the powerhouse; a 9-mile-long, 34.5-kilovolt (kV) transmission line; and, appurtenant facilities (Figure 2).

The Mattaceunk Project is operated in a run-of-river mode with year-round use of 4-foot-high flashboards. GLHA maintains the impoundment surface elevation within 1.0 foot of the flashboard crest elevation of 240.0 feet when the 4-foot-high flashboards are in place. The Mattaceunk Project impounds approximately 12.5 km of the Penobscot River, which includes a short section of the West Branch downstream of Medway Dam, as well as a portion of the East Branch of the Penobscot River. The impoundment also includes a limited portion of Salmon Stream.

The existing FERC license 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 by GLHA or FERC in the new 40-year license.

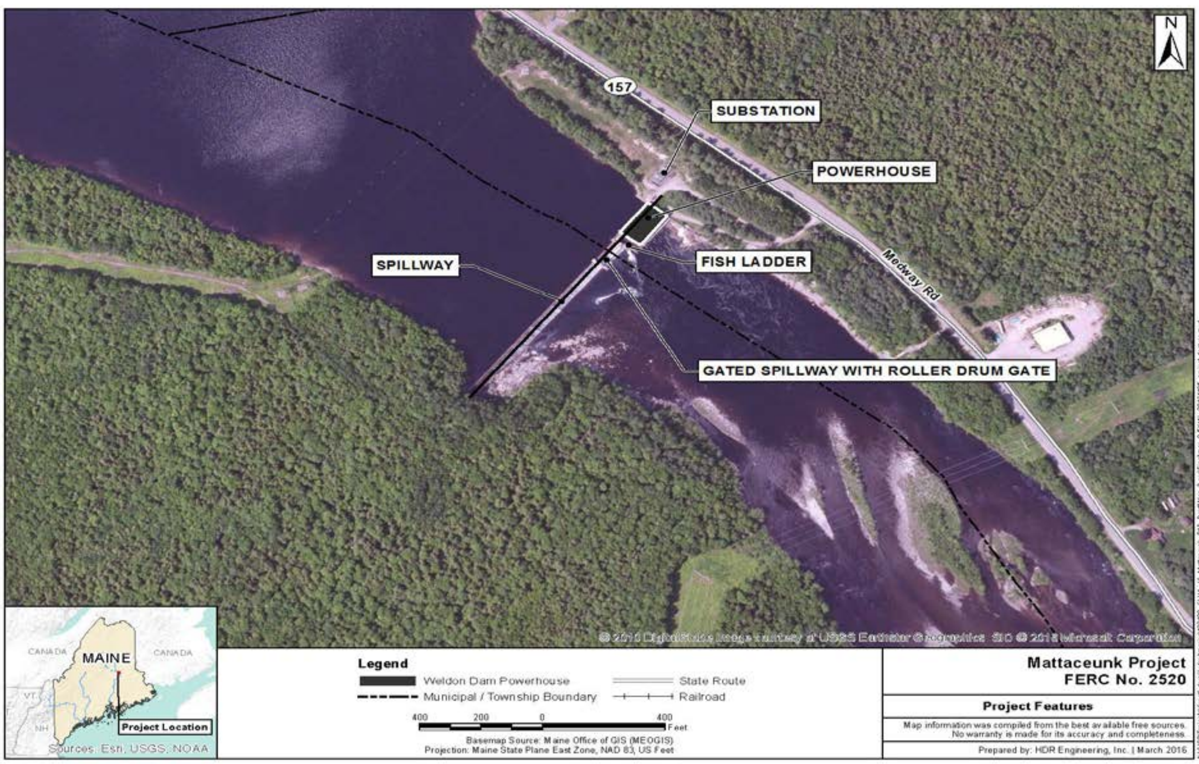

Figure 2. Location map of Mattaceunk Project area. Source: GLHA.

Fish Passage Facilities

The existing upstream fishway at the Mattaceunk Project is a pool and weir design, consisting of 36 pools with a drop of approximately 14 inches between pools. Flows through the fishway consist of 6-8 cfs transport flow. A gravity-fed pipe provides auxiliary water (7 cfs) for additional attraction flow to the entrance pool. Fish are able to ascend the fishway by either submerged orifices or weir notches. A fish trap is located at the exit of the fishway so salmon can be counted and biological samples taken by biologists.

Permanent downstream fish passage facilities were installed at the Mattaceunk Project in 1992 following the evaluation of temporary downstream passage alternatives (1987 to 1992). These facilities include single surface inlets integral with the trashracks in two of the four turbine forebays for passing fish (intakes #3 and #4), one-inch bar clear-spacing trashracks covering the top 16 feet (at full pond) of the water column to discourage fish entrainment (at depths greater than 16 feet the trashracks have 2 5/8 inch bar clear-spacing), and an underground passageway for transport of collected fish to the tailrace area.

2.2. Proposed Action

FERC is proposing to issue a new 40-year license to GLHA for the Mattaceunk Project consistent with the "Staff Alternative with Mandatory Conditions" as presented in FERC's September 2018 Final Environmental Assessment (FEA) for Hydropower License for the Mattaceunk Project. The FEA describes the "Staff Alternative with Mandatory Conditions," as the staff alternative plus all of the section 18 fishway prescriptions filed by USFWS on May 23, 2017 and by NMFS on June 28, 2018.

Here, we identify the relevant requirements of the proposed license.

Operational requirements that may affect Atlantic salmon and/or critical habitat

1. 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.
2. 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.

Upstream fish passage requirements that may affect Atlantic salmon and/or critical habitat

1. 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. Open the existing upstream fishway prior to May 1, if adult Atlantic salmon are caught in the Milford fishway prior to May 1.
2. Install, in year 15 of a new license, an upstream fishway for alosines.
3. Achieve an upstream Atlantic salmon performance standard of 95%. When analyzing telemetry test data, 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 when ambient water temperatures are at or below 23° C; and 2) the remaining 20% of test fish pass the project within 96 hours.

4. Conduct up to three years of upstream fishway effectiveness monitoring for adults using imprinted adult salmon.
5. 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. Maintain and monitor the existing fish trap at the exit of the existing upstream fishway for counting adult Atlantic salmon.
6. Coordinate with resource agencies to stock uniquely marked Atlantic salmon smolts upstream of the Mattaceunk Project in the first three years after relicensing to serve as a source of imprinted adult salmon (i.e., fish homing to areas upstream of the Mattaceunk Project) used for studying upstream passage of adults and downstream passage of kelts (post-spawned Atlantic salmon adults).
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 migrating Atlantic salmon.

Downstream fish passage requirements that may affect Atlantic salmon and/or critical habitat

1. Continue to maintain and operate 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.
2. Install full-depth trash racks with 1-inch clear bar spacing during the downstream migration of Atlantic salmon within 2 years of license issuance.
3. Open the project's log sluice (between 3 % [225 cfs] and 9% [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.
4. Achieve a downstream smolt and kelt Atlantic salmon performance standard of 96%. When analyzing telemetry test data, individual smolts 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).
5. Provide downstream passage for alosines after a new upstream fishway for alosines is operational (expected in year 16), by: (a) extending the operation of the existing downstream fish bypass such that it operates continuously from April 1 to December 1; and, (b) by opening the log sluice (and releasing between 3% [225 cfs] and 9% [690 cfs] of station hydraulic capacity) from June 1 to December 1, as needed for alosines, based on monitoring results.
6. 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 and kelts downstream past the dam.
7. If the measures described above do not achieve the 96% downstream performance standard for Atlantic salmon smolts or kelts, then GLHA will 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 downstream migrating Atlantic salmon. Each step within the adaptive

management plan will be reevaluated as necessary to determine if the performance standard is being achieved. The adaptive management measures includes the following:

a. Increase nighttime spill to between 20% and 50% of river flow at the Mattaceunk Project for three weeks during the smolt outmigration period.
b. Increase nighttime spill to between 50% and 75% of river flow.
c. Provide three weeks of 100 percent spill of river flow at night (except for one unit, which will be operated at its lowest possible setting as required for powerhouse startup).

The State of Maine issued a 401 Water Quality Certificate for the Mattaceunk Project on March 25, 2020. Our review of the 401 Water Quality Certificate did not identify any requirements that would result in effects to Atlantic salmon not considered in this Opinion. If the final license includes conditions, resulting from the 401 Water Quality Certificate or otherwise, that would cause consequences to Atlantic salmon or critical habitat that were not considered in this consultation, this consultation must be reinitiated (see 50 CFR 402.16).

As indicated above, the action that we are consulting on is the proposed relicensing of the Mattaceunk Project for a term of 40 years. Under the terms of the new FERC license, GLHA will be required to operate the Mattaceunk Project and to maintain the dam and project impoundment to meet the 19.2 MW generation capacity of the powerhouse.

In the August 31, 2016, final license application filed with FERC, GLHA proposed to conduct a study to evaluate smolt mortality in the Mattaceunk Project impoundment and to implement additional operational, structural, and/or habitat enhancement measures as needed to adequately mitigate for project consequences on upstream and downstream migrating Atlantic salmon, including consequences from the project impoundment. For purposes of this consultation and consistent with our discussions with the licensee, we consider "adequately mitigate" to mean to take action to either: reduce mortality of smolts in the impoundment to "background" levels (i.e., mortality rates that would be expected in a similar length of river absent an impoundment) or carry out habitat enhancements that increase the number of smolts migrating through the impoundment such that there is "no net loss" of smolts (i.e., production of smolts increases to "compensate" for the loss of smolts in the impoundment); or, a combination of these two alternatives. This commitment was detailed in the final license application as well as a Species Protection Plan appended to the application. Pursuant to revisions to the ESA section 7 regulations published on August 27, 2019, (84 FR 44976), measures to avoid, minimize, or offset adverse consequences are considered like other portions of the action. These measures would not occur but for FERC's proposed action. In addition, based on GLHA's commitment to conduct the studies and attendant additional measures to adequately mitigate for project consequences, we consider these measures to be reasonably certain to occur. Therefore, we consider GLHA's proposed measures to evaluate smolt mortality in the project impoundment and mitigation for project related smolt losses as part of the proposed action and consider those consequences in this Opinion.

2.3. Action Area

The action area is defined as "all areas to be affected directly or indirectly by the Federal action and not merely the immediate area (project area) involved in the proposed action" (50 CFR 402.02). The action area must encompass all areas where consequences of the proposed action may affect listed species and critical habitat. For this action, the action area includes the project facilities and the portion of the Penobscot River affected by project operations as described below.

The action area is the reach of the mainstem Penobscot River extending from the upper end of the impoundment (12.5 km upstream of the dam) to the confluence of the mainstem Penobscot River with the Mattawamkeag River (RM 143)(Figure 3); this area encompasses all consequences of the proposed action.

Figure 3. Action area within the Penobscot Bay SHRU.

3. STATUS OF THE SPECIES AND DESIGNATED CRITICAL HABITAT

The status of the GOM DPS of Atlantic salmon is determined by the level of extinction risk that the species faces, based on parameters considered in documents such as the recovery plan, status reviews, and listing decisions. The species status helps to inform the description of the species' current "reproduction, numbers, or distribution" as described in 50 CFR 402.02. This informs the description of the species' likelihood of both survival and recovery in the wild. The condition of critical habitat throughout the designated area is determined by the current function of the essential features that help to form that conservation value.

3.1. Gulf of Maine DPS of Atlantic Salmon

The Atlantic salmon is an anadromous fish species that spends most of its adult life in the ocean but returns to freshwater to reproduce. The Atlantic salmon is native to the North Atlantic Ocean, historically from the Arctic Circle to Portugal in the eastern Atlantic, from Iceland and southern Greenland, and from the Ungava region of northern Quebec south to the Housatonic River (Bigelow and Schroeder 1953). In the United States, Atlantic salmon historically ranged from Maine south to Long Island Sound. However, the Central New England DPS and Long Island Sound DPS have both been extirpated (65 FR 69459; November 17, 2000).

The GOM DPS of anadromous Atlantic salmon was initially listed jointly by the USFWS and NMFS (collectively, the Services) as an endangered species on November 17, 2000 (65 FR 69459). In 2009 the Services finalized an expanded listing of Atlantic salmon as an endangered species (74 FR 29344; June 19, 2009). The decision to expand the range of the GOM DPS was largely based on the results of a Status Review (Fay et al. 2006) completed by a Biological Review Team consisting of Federal and State agencies and Tribal interests. Fay et al. (2006) conclude that the DPS delineation in the 2000 listing designation was largely appropriate, except in the case of large rivers that were partially or wholly excluded in the 2000 listing determination. Fay et al. (2006) conclude that the salmon currently inhabiting the larger rivers (Androscoggin, Kennebec, and Penobscot) are genetically similar to the rivers included in the GOM DPS as listed in 2000, have similar life history characteristics, and occur in the same zoogeographic region. Further, the salmon populations inhabiting the large and small rivers from the Androscoggin River northward to the Dennys River differ genetically and in important life history characteristics from Atlantic salmon in adjacent portions of Canada (Spidle et al. 2003; Fay et al. 2006). Thus, Fay et al. (2006) conclude that this group of populations (a "distinct population segment") met both the discreteness and significance criteria of the Services' DPS Policy (61 FR 4722; February 7, 1996) and, therefore, recommended the geographic range included in the new expanded GOM DPS.

The current GOM DPS includes all anadromous Atlantic salmon whose freshwater range occurs in the watersheds from the Androscoggin River northward along the Maine coast to the Dennys River, and wherever these fish occur in the estuarine and marine environment. Included in the GOM DPS are all associated conservation hatchery populations used to supplement these natural populations; currently, such conservation hatchery populations are maintained at Green Lake National Fish Hatchery (GLNFH) and Craig Brook National Fish Hatchery (CBNFH), both operated by the USFWS. Excluded from the GOM DPS are landlocked Atlantic salmon and those salmon raised in commercial hatcheries for the aquaculture industry (74 FR 29344; June 19, 2009).

Atlantic salmon have a complex life history that includes territorial rearing in rivers to extensive feeding migrations on the high seas (Figure 4). During their life cycle, Atlantic salmon go through several distinct phases that are identified by specific changes in behavior, physiology, morphology, and habitat requirements.

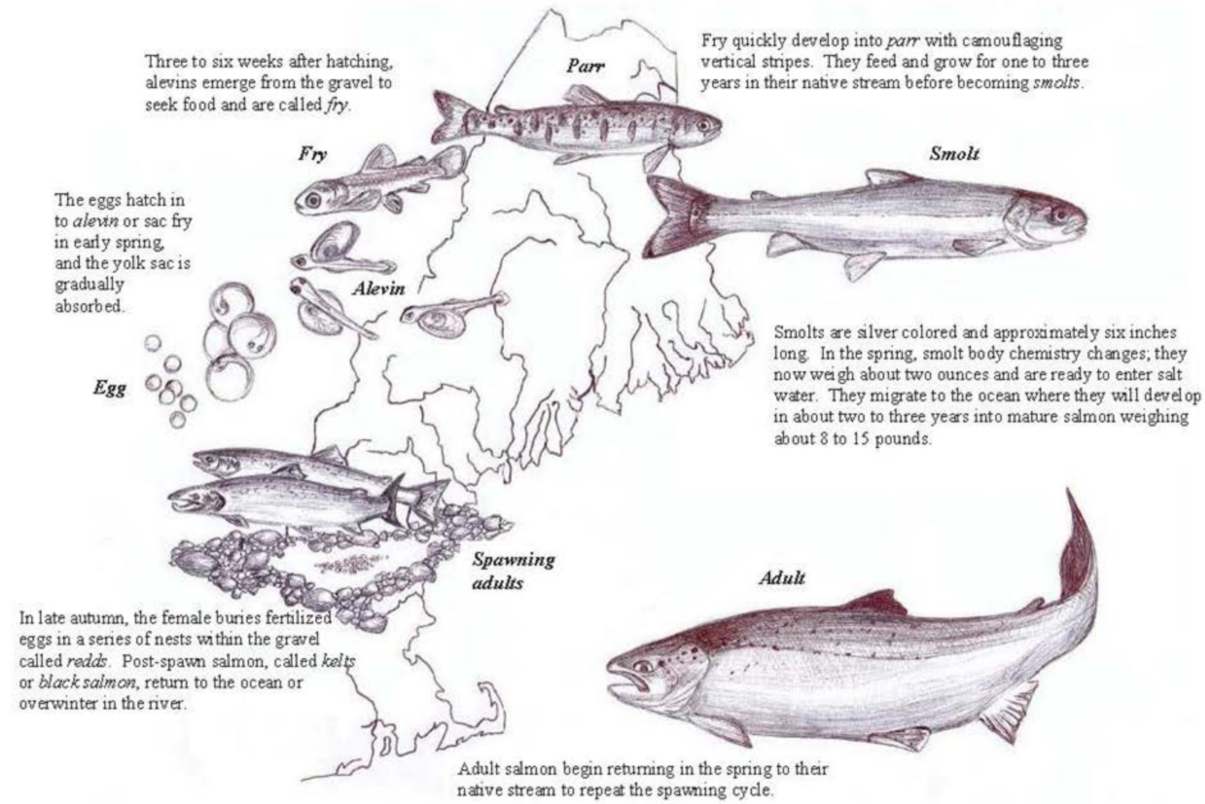

Figure 4. Life Cycle of the Atlantic salmon (diagrams courtesy of Katrina Mueller).

Adult Atlantic salmon return to rivers from the sea and migrate to their natal stream to spawn; a small percentage (1-2%) of returning adults in Maine will stray to a new river. Adults ascend the rivers within the GOM DPS beginning in the spring. The ascent of adult salmon continues into the fall. Although spawning does not occur until late fall, the majority of Atlantic salmon in Maine enter freshwater between May and mid-July (Meister 1958; Baum 1997). Early migration is an adaptive trait that ensures adults have sufficient time to effectively reach spawning areas despite the occurrence of temporarily unfavorable conditions that naturally occur within rivers (Bjornn and Reiser 1991). Salmon that return in early spring spend nearly five months in the river before spawning, often seeking cool water refuge (e.g., deep pools, springs, and mouths of smaller tributaries) during the summer months.

In the fall, female Atlantic salmon select sites for spawning in rivers. Spawning sites are positioned within flowing water, particularly where upwelling of groundwater occurs, allowing for percolation of water through the gravel (Danie et al. 1984). These sites are most often positioned at the head of a riffle (Beland et al. 1982); the tail of a pool; or the upstream edge of a gravel bar where water depth is decreasing, water velocity is increasing (McLaughlin and Knight 1987, White 1942), and hydraulic head allows for permeation of water through the redd (a gravel depression where eggs are deposited). Female salmon use their caudal fins to scour or dig redds. The digging behavior also serves to clean the substrate of fine sediments that can embed the cobble and gravel substrates needed for spawning and consequently reduce egg survival (Gibson 1993). One or more males fertilize the eggs that the female deposits in the redd (Jordan and

Beland 1981). The female then continues digging upstream of the last deposition site, burying the fertilized eggs with clean gravel.

A single female may create several redds before depositing all of her eggs. Female anadromous Atlantic salmon produce a total of 1,500 to 1,800 eggs per kilogram of body weight, yielding an average of 7,500 eggs per two sea-winter (2SW) female (an adult female that has spent two winters at sea before returning to spawn) (Baum and Meister 1971). After spawning, Atlantic salmon may either return to sea immediately or remain in fresh water until the following spring before returning to the sea (Fay et al. 2006). From 1996 to 2011, approximately 1.3% of the "naturally-reared" adults (fish originating from natural spawning or hatchery fry) in the Penobscot River were repeat spawners (USASAC 2012).

Embryos develop in redds for a period of 175 to 195 days, hatching in late March or April (Danie et al. 1984). Newly hatched salmon, referred to as larval fry, alevin, or sac fry, remain in the redd for approximately six weeks after hatching and are nourished by their yolk sacs (Gustafson-Greenwood and Moring 1991). Survival from the egg to fry stage in Maine is estimated to range from 15% to 35% (Jordan and Beland 1981). Survival rates of eggs and larvae are a function of stream gradient, overwinter temperatures, interstitial flow, predation, disease, and competition (Bley and Moring 1988). Once larval fry emerge from the gravel and begin active feeding, they are referred to as fry. The majority of fry (>95%) emerge from redds at night (Gustafson-Marjanen and Dowse 1983).

When fry reach approximately four centimeters in length, the young salmon are termed parr (Danie et al. 1984). Parr have eight to eleven pigmented vertical bands on their sides that are believed to serve as camouflage (Baum 1997). A territorial behavior (i.e., competition for food and space), first apparent during the fry stage, grows more pronounced during the parr stage, as the parr actively defend territories (Allen 1940; Kalleberg 1958; Danie et al. 1984). Most parr remain in the river for two to three years before undergoing smoltification, the process in which parr go through physiological changes in order to transition from a freshwater environment to a saltwater marine environment. Some male parr may not go through smoltification and will become sexually mature and participate in spawning with sea-run adult females. These males are referred to as "precocious parr." First year parr are often characterized as being small parr or 0+ parr (four to seven centimeters long), whereas second and third year parr are characterized as large parr (greater than seven cm long) (Haines 1992). Parr growth is a function of water temperature (Elliott 1991); parr density (Randall 1982); photoperiod (Lundqvist 1980); interaction with other fish, birds, and mammals (Bjornn and Reiser 1991); and food supply (Swansburg et al. 2002). Parr movement may be quite limited in the winter (Cunjak 1988; Heggenes 1990); however, movement in the winter does occur (Hiscock et al. 2002) and is often necessary, as ice formation reduces total habitat availability (Whalen et al.1999). Parr have been documented using riverine, lake, and estuarine habitats; incorporating opportunistic and active feeding strategies; defending territories from competitors including other parr; and working together in small schools to actively pursue prey (Gibson 1993, Marschall et al.1998, Pepper 1976, Pepper et al. 1984, Hutchings 1986, Erkinaro et al. 1998a, O'Connell and Ash 1993, Erkinaro et al. 1995, Dempson et al. 1996, Halvorsen and Svenning 2000, Klemetsen et al. 2003). Studies have indicated that parr can move relatively large distances, especially as they get closer to smoltification (Cunjak *et al*. 1989, McCormick *et al*. 1998). McCormick *et al*. (1998) suggested that parr can move substantial distances when moving to overwintering habitat and summer feeding areas, as well as when they begin to mature into smolts. Dugdale et al.

(2015) documented mainstem movement of Atlantic salmon parr up to 1.9 km in response to high river temperatures. Parr have been observed leaving its natal streams to move to other nearby streams that provide food resources or ideal temperatures for development. McCormick *et al*. (1998) observed that these fish may move to these small streams in the summer, and leave as smolts the following year.

In a parr's second or third spring (age 1 or age 2, respectively), when it has grown to 12.5 to 15 cm in length, a series of physiological, morphological, and behavioral changes occur (Schaffer and Elson 1975). This process, called "smoltification," prepares the parr for migration to the ocean and life in salt water. In Maine, the vast majority of naturally reared parr remain in fresh water for two years (90% or more) with the balance remaining for either one or three years (USASAC 2005). In order for parr to undergo smoltification, they must reach a critical size of ten centimeters total length at the end of the previous growing season (Hoar 1988). During the smoltification process, parr markings fade and the body becomes streamlined and silvery with a pronounced fork in the tail. Naturally reared smolts in Maine range in size from 13 to 17 cm, and most smolts enter the sea during May to begin their first ocean migration (USASAC 2004). During this migration, smolts must contend with changes in salinity, water temperature, pH, dissolved oxygen, pollution levels, and various predator assemblages. The physiological changes that occur during smoltification prepare the fish for the dramatic change in osmoregulatory needs that come with the transition from a fresh to a salt water habitat (Ruggles 1980, Bley 1987, McCormick and Saunders 1987, McCormick et al. 1998). The transition of smolts into seawater is usually gradual as they pass through a zone of fresh and saltwater mixing that typically occurs in a river's estuary. Given that smolts undergo smoltification while they are still in the river, they are pre-adapted to make a direct entry into seawater with minimal acclimation (McCormick et al. 1998). This pre-adaptation to seawater is necessary under some circumstances where there is very little transition zone between freshwater and the marine environment.

The spring migration of post-smolts out of the coastal environment is generally rapid, within several tidal cycles, and follows a direct route (Hyvarinen et al. 2006, Lacroix and McCurdy 1996, Lacroix et al. 2004). Post-smolts generally travel out of coastal systems on the ebb tide and may be delayed by flood tides (Hyvarinen et al. 2006, Lacroix and McCurdy 1996, Lacroix et al. 2004, Lacroix and Knox 2005). Lacroix and McCurdy (1996), however, found that post-smolts exhibit active, directed swimming in areas with strong tidal currents. Studies in the Bay of Fundy and Passamaquoddy Bay suggest that post-smolts aggregate together and move near the coast in "common corridors" and that post-smolt movement is closely related to surface currents in the bay (Hyvarinen et al. 2006; Lacroix and McCurdy 1996; Lacroix et al. 2004). European post-smolts tend to use the open ocean for a nursery zone, while North American post-smolts appear to have a more near-shore distribution (Friedland et al. 2003). Post-smolt distribution may reflect water temperatures (Reddin and Shearer 1987) or the major surface-current vectors (Lacroix and Knox 2005). Post-smolts live mainly on the surface of the water column and form shoals, possibly of fish from the same river (Shelton et al. 1997).
During the late summer and autumn of the first year, North American post-smolts are concentrated in the Labrador Sea and off of the west coast of Greenland, with the highest concentrations between 56°N and 58°N. (Reddin 1985, Reddin and Short 1991, Reddin and Friedland 1993). The salmon located off Greenland are composed of both 1SW fish and fish that have spent multiple years at sea (multi-sea winter fish or MSW) and also includes immature salmon from both North American and European stocks (Reddin 1988, Reddin et al. 1988). The

first winter at sea regulates annual recruitment, and the distribution of winter habitat in the Labrador Sea and Denmark Strait may be critical for North American populations (Friedland et al. 1993). In the spring, North American post-smolts are generally located in the Gulf of St. Lawrence, off the coast of Newfoundland, and on the east coast of the Grand Banks (Reddin 1985, Dutil and Coutu 1988, Ritter 1989, Reddin and Friedland 1993, and Friedland et al. 1999). Some salmon may remain at sea for another year or more before maturing. After their second winter at sea, the salmon over-winter in the area of the Grand Banks before returning to their natal rivers to spawn (Reddin and Shearer 1987). Reddin and Friedland (1993) found immature adults located along the coasts of Newfoundland, Labrador, and Greenland, and in the Labrador and Irminger Sea in the later summer and autumn.

3.1.1 Status and Trends of the GOM DPS of Atlantic Salmon

The reproduction, distribution, and abundance of Atlantic salmon within the range of the GOM DPS have been generally declining since the 1800s (Fay *et al.* 2006). A comprehensive time series of adult returns to the GOM DPS dating back to 1967 exists (Fay *et al.* 2006, USASAC 2013). Contemporary abundance levels of Atlantic salmon within the GOM DPS are several orders of magnitude lower than historical abundance estimates. For example, Foster and Atkins (1869) estimated that roughly 100,000 adult salmon returned to the Penobscot River alone before the river was dammed, whereas estimates of abundance for the entire GOM DPS have rarely exceeded 5,000 individuals in any given year since 1967 (Fay *et al.* 2006, USASAC 2013).

After a period of population growth between the 1970s and the early 1980s, adult returns of salmon in the GOM DPS peaked between approximately 1984 and 1991 before declining during the 2000s. Adult returns have fluctuated since with increases observed from 2008 to 2011 followed by slight increases and decreases in numbers (Figure 5). Presently, the majority of all adults in the GOM DPS return to a single river, the Penobscot, which accounted for over 90% of all adult returns to the GOM DPS over the last decade. The population growth observed in the 1970s is likely attributable to favorable marine survival and increases in hatchery capacity, particularly from Green Lake National Fish Hatchery (GLNFH)(constructed in 1974).

Marine survival remained relatively high throughout the 1980s, and salmon populations in the GOM DPS remained relatively stable until the early 1990s. In the early 1990s, marine survival rates decreased, leading to the declining trend in adult abundance observed throughout the GOM DPS of Atlantic salmon. The period from 1991 to 2004 was also evaluated because a “regime shift” has been described for Atlantic salmon populations in the North Atlantic (Chaput et al. 2005). This “regime shift” represents a change in productivity and marine survival of Atlantic salmon in the Northwest Atlantic that began in the early 1990s and has persisted to date. The increase in abundance of returning adult salmon observed between 2008 and 2011 may be an indication of improving marine survival; however the declines since 2011 suggest otherwise. Returns to U.S. waters in 2013 were only 611 fish, which ranks 43rd in the 47-year time-series (USASAC 2014). A total of 450 adults returns were estimated for 2014; the lowest for the 1991-2017 time series. Currently, adult returns remain below 1000 fish throughout the GOM DPS (Figure 5). Despite consistent smolt production, there has been extreme variability in annual returns over the past several decades.

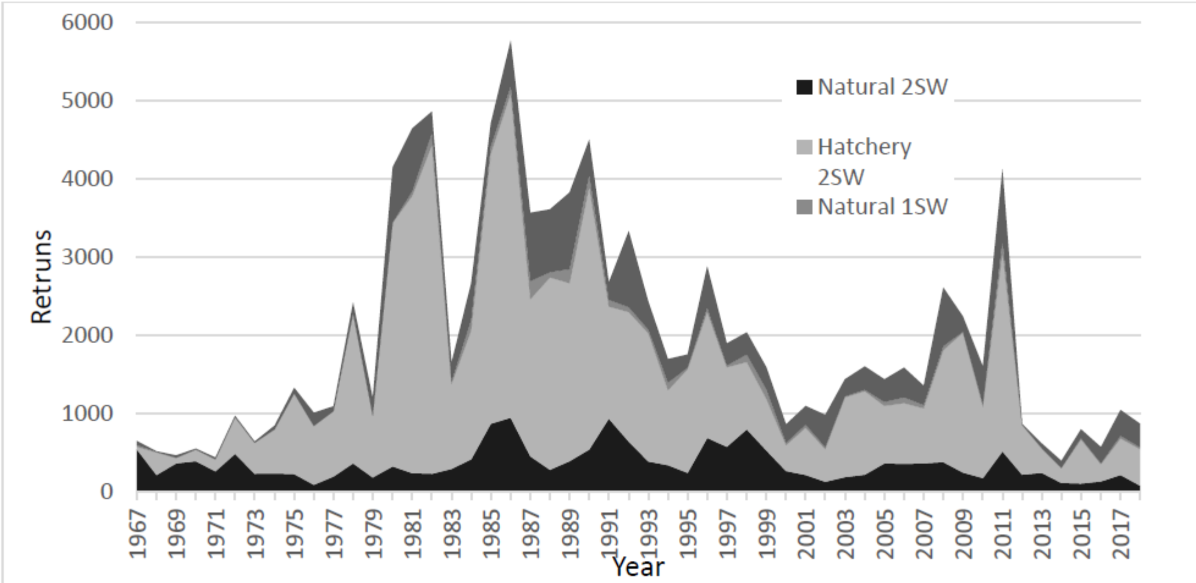

Figure 5. Summary of natural vs. hatchery adult salmon returns to the GOM DPS Rivers between 1967 and 2018 (USASAC 2019).

Since 1967 when numbers of adult returns were first recorded, the vast majority of adult returns have been the result of smolt stocking; only a small portion of returning adults were naturally reared (Figure 5). Natural reproduction of the species is contributing to only a fraction of Atlantic salmon returns to the GOM DPS. The term naturally reared includes fish originating from both natural spawning and from stocked hatchery eggs and fry (USASAC 2012). Hatchery fry are included as naturally reared because hatchery fry are not marked, and therefore cannot be distinguished from fish produced through natural spawning. Low abundances of both hatchery-origin and naturally reared adult salmon returns to Maine demonstrate continued poor marine survival.

The abundance of Atlantic salmon in the GOM DPS has been low, and the trend has been either stable or declining over the past several decades. The proportion of fish that are of natural origin is low but appears stable. The conservation hatchery program has assisted in slowing the decline and helping to stabilize populations at low levels. However, stocking of salmon has not contributed to an increase in the overall abundance of salmon and, as yet, has not been able to increase the naturally reared component of the GOM DPS. Continued reliance on the conservation hatchery program is expected to prevent extinction in the short term, but recovery of the GOM DPS will not be accomplished without significant increases in naturally reared salmon.

The historic distribution of Atlantic salmon in Maine has been described extensively by Baum (1997) and Beland (1984), among others. In short, substantial populations of Atlantic salmon existed in nearly every river in Maine that was large enough to maintain a spawning population. The upstream extent of the species' distribution extended far into the headwaters of even the largest rivers. Today, the spatial structure of Atlantic salmon is limited by obstructions to passage and also by low abundance levels and by the fact that the majority of all adults return to the Penobscot River. Within the range of the GOM DPS, the Kennebec, Androscoggin, Union, and Penobscot Rivers contain dams that severely limit passage of salmon to significant amounts of spawning and rearing habitat.

3.1.2 Designated Critical Habitat

Coincident with the June 19, 2009 endangered listing, we designated critical habitat for the GOM DPS of Atlantic salmon (74 FR 29300; June 19, 2009) (Figure 6). The final rule was revised on August 10, 2009. In this revision, designated critical habitat for the expanded GOM DPS of Atlantic salmon was reduced to exclude trust and fee holdings of the Penobscot Indian Nation and a table was corrected (74 FR 39003; August 10, 2009).

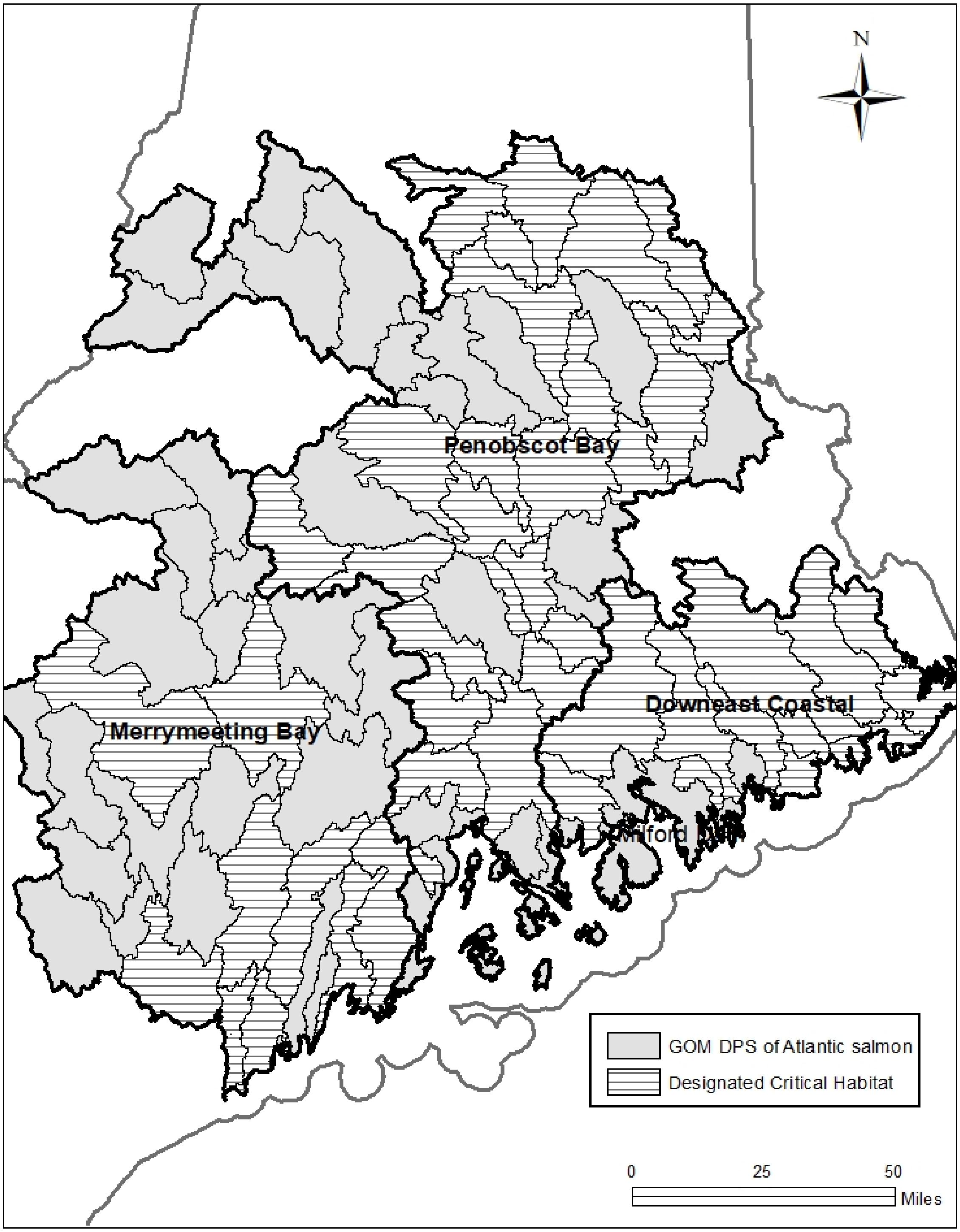

Figure 6. HUC-10 Watersheds Designated as Atlantic Salmon Critical Habitat and Salmon Habitat Recovery Units within the GOM DPS.

Critical habitat is the specific areas within the geographic area, occupied by the species at the time it was listed, that contain the physical or biological features that are essential to the conservation of endangered and threatened species and that may need special management or protection. When we designated critical habitat for Atlantic salmon, we used the term primary constituent element. Subsequently, in 2016, we revised our critical habitat regulations (81 FR 7414) and replaced the term primary constituent element with the term physical or biological features (PBFs). As noted at that time, "… the shift in terminology does not change the approach used in conducting a 'destruction or adverse modification' analysis, which is the same regardless of whether the original designation identified primary constituent elements, physical or biological features, or both" (81 FR 7214). In this opinion, consistent with our revised critical habitat regulations, we use the term PBF to describe features essential to the conservation of Atlantic salmon.

As described in the final rule, within the GOM DPS, the primary constituent elements (PCEs) for Atlantic salmon include sites for spawning and incubation, sites for juvenile rearing, and sites for migration. The essential physical and biological features of habitat are those features that allow Atlantic salmon to successfully use sites for spawning and rearing and sites for migration. These features include substrate of suitable size and quality; rivers and streams of adequate flow, depth, water temperature and water quality; rivers, streams, lakes and ponds with sufficient space and diverse, abundant food resources to support growth and survival; waterways that allow for free migration of both adult and juvenile Atlantic salmon; and diverse habitat and native fish communities in which salmon interact with while feeding, migrating, spawning, and resting. Marine waters were not included in the critical habitat designation[1]. Spawning and rearing habitat are not separated into distinct PBFs, although each habitat does have distinct features, because of the GIS-based habitat prediction model approach that was used to designate critical habitat (74 FR 29300; June 19, 2009). This model cannot consistently distinguish between spawning and rearing habitat across the entire range of the GOM DPS. The PBFs for Atlantic salmon critical habitat are presented in Table 1 below.

Table 1. Physical and Biological Features of Atlantic Salmon Critical Habitat.

PBFs for Spawning and Rearing (S&R) Habitat	
Feature 1	Deep, oxygenated pools and cover (*e.g.*, boulders, woody debris, vegetation, etc.), near freshwater spawning sites, necessary to support adult migrants during the summer while they await spawning in the fall.
Feature 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.
Feature 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.
Feature 4	Freshwater rearing sites with space to accommodate growth and survival of Atlantic salmon parr.
Feature 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.

[1] Although successful marine migration is essential to Atlantic salmon, we were not able to identify the essential features of marine migration and feeding habitat or their specific locations at the time critical habitat was designated.

Feature 6	Freshwater rearing sites with cool, oxygenated water to support growth and survival of Atlantic salmon parr.
Feature 7	Freshwater rearing sites with diverse food resources to support growth and survival of Atlantic salmon parr.
PBFs for Migration (M) Habitat	
Feature 1	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.
Feature 2	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.
Feature 3	Freshwater and estuary migration sites with abundant, diverse native fish communities to serve as a protective buffer against predation.
Feature 4	Freshwater and estuary migration sites free from physical and biological barriers that that delay or prevent emigration of smolts to the marine environment.
Feature 5	Freshwater and estuary migration sites with sufficiently cool water temperatures and water flows that coincide with diurnal cues to stimulate smolt migration.
Feature 6	Freshwater migration sites with water chemistry needed to support sea water adaptation of smolts.

In order for designated habitat to function for Atlantic salmon, it must contain one or more PBFs within the acceptable range of values required to support the biological processes for which the species uses that habitat. Critical habitat includes all perennial rivers, streams, and estuaries and lakes connected to the marine environment within the range of the GOM DPS, except for those areas that have been specifically excluded as critical habitat. Critical habitat was designated only in areas (HUC-10 watersheds) occupied by the species at the time of listing. Critical habitat includes the stream channels within the designated stream reach and includes a lateral extent as defined by the ordinary high-water line or the bankfull elevation in the absence of a defined high-water line. In estuaries, critical habitat is defined by the perimeter of the water body as displayed on standard 1:24,000 scale topographic maps or the elevation of extreme high water, whichever is greater.

3.1.3 Summary of Factors Affecting Recovery of Atlantic Salmon

In January, 2019, the USFWS and NMFS issued the final recovery plan for the 2009 expanded listing of the GOM DPS of Atlantic salmon (USFWS and NMFS 2018). The Final Recovery Plan presents a new recovery planning approach (termed the Recovery Planning and Implementation, or RPI) which has been adopted by the USFWS. RPI plans focus on the statutory elements of recovery criteria, recovery actions, and time and cost estimates. The plan presents a recovery strategy based on the biological and ecological needs of the species as well as current threats and conservation accomplishments that affect its long-term viability. The 2019 recovery plan wholly supersedes the recovery plan approved in 2005 for the DPS listed in 2000 (NMFS and USFWS, 2005).

The overall goal of the recovery plan is to remove the GOM DPS of Atlantic salmon from the Federal List of Endangered and Threatened Wildlife. The interim goal is to reclassify the DPS from endangered to threatened status. The plan divides the GOM DPS into three Salmon Habitat

Recovery Units (SHRU) as follows: 1) Merrymeeting Bay; 2) Penobscot Bay; and 3) Downeast Coastal. Provided below are the biological criteria for reclassification and delisting.

Biological Criteria for Reclassification – Reclassification of the GOM DPS from endangered to threatened will be considered when all of the following biological criteria are met:

- *Abundance*: The DPS has total annual returns of at least 1,500 adults originating from wild origin, or hatchery stocked eggs, fry or parr spawning in the wild, with at least 2 of the 3 SHRUs having a minimum annual escapement of 500 naturally reared adults.
- *Productivity*: Among the SHRUs that have met or exceeded the abundance criterion, the population has a positive mean growth rate greater than 1.0 in the 10-year (two-generation) period preceding reclassification.
- *Habitat*: In each of the SHRUs where the abundance and productivity criterion have been met, there is a minimum of 7,500 units of accessible and suitable spawning and rearing habitats capable of supporting the offspring of 1,500 naturally reared adults.

Biological Criteria for Delisting - The Services project a 75-year timeframe to achieve delisting of the GOM DPS of Atlantic salmon. Delisting of the GOM DPS will be considered when all of the following criteria are met:

1. *Abundance*: The DPS has a self-sustaining annual escapement of at least 2,000 wild origin adults in each SHRU, for a DPS-wide total of at least 6,000 wild adults.
2. *Productivity*: Each SHRU has a positive mean population growth rate of greater than 1.0 in the 10-year (two-generation) period preceding delisting. In addition, at the time of delisting, the DPS demonstrates self-sustaining persistence, whereby the total wild population in each SHRU has less than a 50-percent probability of falling below 500 adult wild spawners in the next 15 years based on population viability analysis (PVA) projections.
3. *Habitat*: Sufficient suitable spawning and rearing habitat for the offspring of the 6,000 wild adults is accessible and distributed throughout the designated Atlantic salmon critical habitat, with at least 30,000 accessible and suitable Habitat Units in each SHRU, located according to the known migratory patterns of returning wild adult salmon. This will require both habitat protection and restoration at significant levels.

Atlantic salmon face a number of threats to their survival, most of which are outlined in the Recovery Plan (NMFS and USFWS 2018) and the latest status review (Fay *et al.* 2006). We consider the following to be the most significant threats to the GOM DPS of Atlantic salmon:

- Dams
- Inadequacy of existing regulatory mechanisms for dams
- Continued low marine survival rates for U.S. stocks of Atlantic salmon
- Lack of access to spawning and rearing habitat due to dams and road-stream crossings
- Degraded water quality
- Aquaculture practices, which pose ecological and genetic risks
- Climate change
- Depleted diadromous fish communities

- Incidental capture of adults and parr by recreational anglers
- Introduced fish species that compete or prey on Atlantic salmon
- Poaching of adults
- Recovery hatchery program (potential for artificial selection/domestication)
- Sedimentation of spawning and rearing habitat
- Water extraction
- Diseases
- Predation
- Greenland Mixed Stock Fishery.

A wide variety of activities have focused on protecting Atlantic salmon and restoring the GOM DPS, including (but not limited to) hatchery supplementation; removing dams or providing fish passage; improving road crossings that block passage or degrade stream habitat; protecting riparian corridors along rivers; reducing the impact of irrigation water withdrawals; limiting effects of recreational and commercial fishing; reducing the effects of finfish aquaculture; outreach and education activities; and research focused on better understanding the threats to Atlantic salmon and developing effective restoration strategies.

Starting in the 1960s, Greenland implemented a mixed-stock fishery for Atlantic salmon off its western coast (Sheehan et al. 2015). The fishery primarily takes 1-seawinter (1 SW) salmon of North American and European origin that would potentially return to natal waters as mature, 2 SW spawning adults or older. Because of international concerns that the fishery would have deleterious effects on the contributing stock complexes, a quota system was agreed upon and implemented in 1976, and since 1984, catch regulations have been established by the North Atlantic Salmon Conservation Organization (NASCO, Sheehan et al. 2015). In recent years, Greenland had limited the fishery to internal consumption only, which in the past has been estimated at 20 metric tons.

In 2015, Greenland unilaterally set an annual 45-ton commercial quota for 2015, 2016, and 2017 (Sheehan et al. 2015). Based on historic harvest estimates, it is estimated that on average, approximately 100 adult salmon of U.S. origin would be harvested annually under a 45-ton quota. With recent U.S. returns of Atlantic salmon averaging less than 1,000 individuals per year, the majority of which originated from hatcheries, this harvest constitutes a substantial threat to the survival and recovery of the GOM DPS. As such, the United States continued to negotiate with the government of Greenland and participants of the fishery both within and outside of NASCO to ultimately establish a new regulatory measure in 2018.

The new regulatory measure agreed to in 2018 includes a 30-ton quota and a number of elements that, if well implemented, will significantly improve the management and control of the fishery. For example, all fishers for Atlantic salmon in Greenland, including both private and commercial fishers, are now required to obtain a license. All fishers are also required to provide an accurate and detailed report of their fishing activities and landings, including no fishing effort and zero landings, prior to receiving a license to fish the following year. In both the 2018 and 2019 fishing years there was significant progress made towards improving reporting and licensing. However, in both years the quota set for the fishery was exceeded.

The final rule designating critical habitat for the GOM DPS identifies a number of activities that have and will likely continue to impact the biological and physical features of spawning, rearing, and migration habitat for Atlantic salmon. These include agriculture, forestry, changing land-use and development, hatcheries and stocking, roads and road-crossings and other instream activities (such as alternative energy development), mining, dams, dredging, and aquaculture. Most of these activities have or still do occur, at least to some extent, throughout the Gulf of Maine.

Today, dams are the greatest impediment, outside of marine survival, to the recovery of salmon in the Penobscot, Kennebec, and Androscoggin river basins (Fay et al. 2006). The Penobscot Bay SHRU contains approximately 397,000 units of Atlantic salmon spawning and rearing habitat (Wright et al. 2008). The mainstem Penobscot has the highest biological value to the Penobscot Bay SHRU because it provides a central migratory corridor crucial for the entire Penobscot SHRU. Dams, along with degraded substrate and cover, water quality, water temperature, and biological communities, have reduced the quality and quantity of habitat available to Atlantic salmon populations within the Penobscot Bay SHRU. Agriculture and urban development largely affect the lower third of the Penobscot Bay SHRU below the Piscataquis River sub-basin by reducing substrate and cover, reducing water quality, and elevating water temperatures. Introductions of smallmouth bass and other non-indigenous species significantly degrade habitat quality throughout the mainstem Penobscot and portions of the Mattawamkeag, Piscataquis, and lower Penobscot sub-basins by altering predator/prey relationships. Similar to smallmouth bass, recent Northern pike introductions threaten habitat in the lower Penobscot River. Of the 397,000 units of spawning and rearing habitat, approximately 211,000 units within was designated as critical habitat. Presently, only a fraction of habitat (the 18,600 units below the first mainstem dam on the Penobscot River) in the Penobscot Bay SHRU is available to Atlantic salmon without interference from artificial barriers (e.g.,, dams). The vast majority of suitable habitat in the Penobscot Bay SHRU is accessible only by means of constructed fishways provided at dams. Large amounts of habitat are not accessible at all due to the presence of dams in the watershed.

The Merrymeeting Bay SHRU contains approximately 356,000 units of Atlantic salmon spawning and rearing habitat (Wright et al 2008); much of this habitat is presently impeded by hydropower dams. In addition to hydropower dams, agriculture and urban development largely affect the lower third of the Merrymeeting Bay SHRU by reducing substrate and cover, reducing water quality, and elevating water temperatures. Additionally, smallmouth bass and brown trout introductions, along with other non-indigenous species, significantly degrade habitat quality throughout the Merrymeeting Bay SHRU by altering natural predator/prey relationships.

The Downeast Coastal SHRU contains approximately 60,000 units of Atlantic salmon spawning and rearing habitat (Wright et al. 2008). The current number of accessible habitat units in the Downeast Coastal SHRU is approximately 28,500. Two hydropower dams on the Union River, and, to a lesser extent, the small ice control dam on the lower Narraguagus River, limit access to abundant spawning and rearing habitat within the Downeast Coastal SHRU. In the Pleasant River and Tunk Stream, which collectively contain over 4,300 units of spawning and rearing habitat, pH has been identified as possibly being the predominate limiting factor.

3.1.4 Summary of Rangewide Status of Atlantic salmon

The GOM DPS of Atlantic salmon currently exhibits critically low spawner abundance, poor marine survival, and is confronted with a variety of additional threats. The abundance of GOM DPS Atlantic salmon has been low and either stable or declining over the past several decades. The proportion of fish that are of natural origin is extremely low but stable. The spatial distribution of the GOM DPS has been severely reduced relative to historical distribution patterns. The conservation hatchery program assists in slowing the decline and helps stabilize populations at low levels, but has not contributed to an increase in the overall abundance of salmon and has not been able to increase the proportion of the naturally reared component of the GOM DPS. Continued reliance on the conservation hatchery program could prevent extinction in the short term, but recovery of the GOM DPS must be accomplished through increases in naturally reared salmon. Lastly, the "regime shift" of low marine survival that began in the early 1990s has persisted to date and recovery of the species cannot be fully accomplished absent improvements in marine survival.

3.2. Status of Atlantic salmon and critical habitat in the Penobscot Bay SHRU

A summary of the status of the species rangewide and designated critical habitat in its entirety was provided above. This section will focus on the status of Atlantic salmon and designated critical habitat in the Penobscot Bay recovery unit. In describing critical habitat for the GOM DPS, we divided the DPS into three Salmon Habitat Recovery Units or SHRUs. The three SHRUs include the Downeast Coastal region, Penobscot Bay, and Merrymeeting Bay. The SHRU delineations are also reflected in the 2019 recovery plan and were designed to: 1) ensure that a recovered Atlantic salmon population has widespread geographic distribution to help maintain genetic variability; and 2) provide protection from demographic and environmental variation. A widespread distribution of salmon across the three SHRUs will provide a greater probability of population sustainability in the future, which will be needed to achieve recovery of the GOM DPS.

The Penobscot Bay SHRU includes the entire Penobscot basin and extends west as far as, and including the Ducktrap watershed, and east as far as, and including the Bagaduce watershed. The Penobscot Bay SHRU is dominated by a large, complex river system (Penobscot River) which serves as the primary migration corridor to numerous watersheds representing diverse habitats. As stated in section 3..3.1 2,000 adult spawners in each of the three SHRUs is being used as a benchmark for evaluating the entire GOM DPS for recovery.

3.2.1 Status and Trends of Atlantic Salmon in the Penobscot Bay SHRU

Returning Adults

The Penobscot River watershed supports the largest runs of Atlantic salmon in the GOM DPS. This is due to the large amount of available habitat and large-scale stocking program that includes parr, fry, smolt and restocking of captured sea-run adults after spawning at the Craig Brook National Fish Hatchery (CBNFH). Roughly 600,000 smolts are stocked in the Penobscot River watershed annually. In addition, over two million fry and parr are stocked in the Penobscot River watershed annually.

All adult Atlantic salmon returning to the Penobscot River are intercepted at the first mainstem dam in the lower Penobscot River (Milford Dam). The trap at the Milford Dam began operation in 2014. Adult Atlantic returns salmon were previously recorded at the Veazie Dam fishway, until it was removed in 2013. Adults captured at the Milford Dam fishway are either taken to CBNFH for captive breeding or returned to the river upstream of the Milford Dam. Since the initial listing of the GOM DPS of Atlantic salmon in 2000, the number of returning adults (both naturally-reared and conservation hatchery stocked) captured at the fishway trap at either Veazie Dam or Milford Dam has ranged from as low as 534 in 2000 to as many as 3,123 in 2011(Figure 7)(USASAC 2018). The majority of adult returns to the Penobscot River are of hatchery origin (Fay et al. 2006). Of the 849 adult salmon returning to the Penobscot in 2017, 90% were of hatchery smolt origin, and the balance (10%) originated from fry stocking or natural reproduction (USASAC 2018). In 2018, 772 adult Atlantic salmon returned to the Penobscot River with 8% of the total run originating from fry stocking or natural reproduction (USASAC 2019).

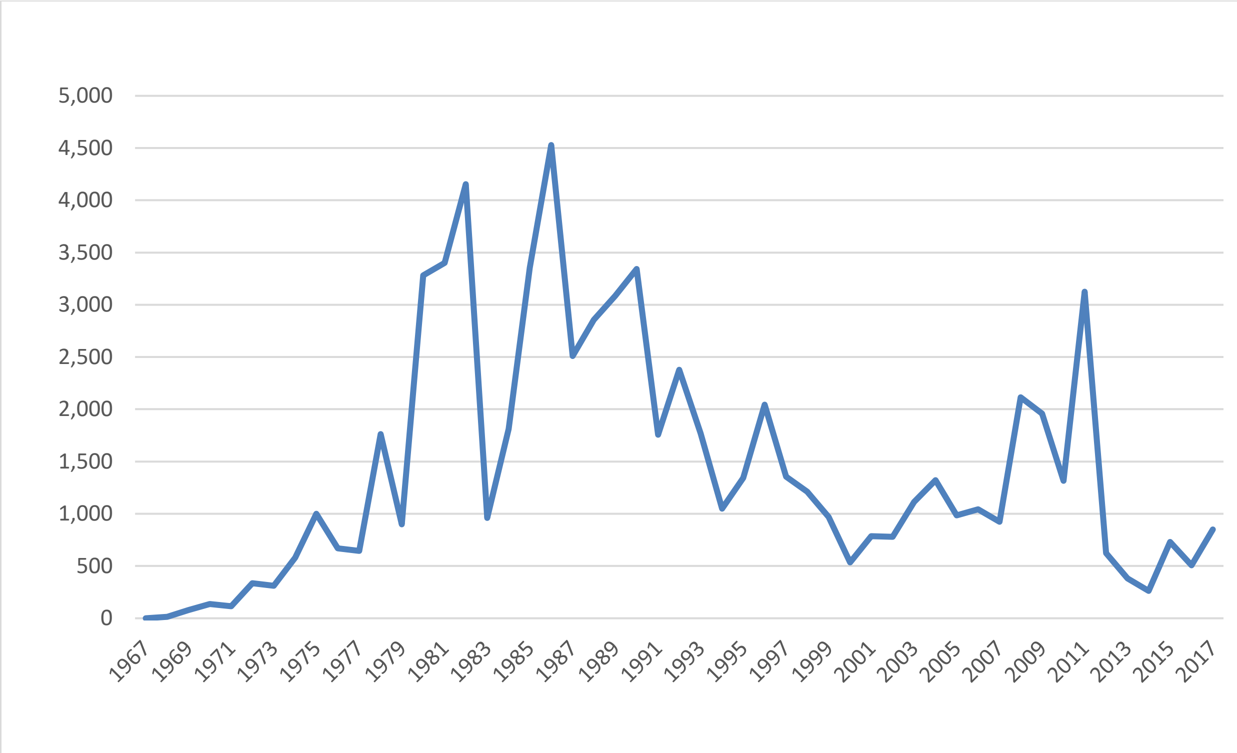

Figure 7. Adult returns to the Penobscot River between 1967 and 2017 (Fay *et al.* 2006, USASAC 2018).

The Milford fishway trap is operated each year from May 1 to October 31 (MDMR, MDIFW 2009). The majority of the adult salmon captures at Milford occur in June, with the median capture date occurring around the last week of June. According to current broodstock management plans, 650 adult salmon are typically collected each year at the Milford Dam for transport to the CBNFH (MDMR 2018). Because of the goal of providing an equal ratio of male and female spawners for hatchery breeding purposes, as well as a proportion of 1-sea winter returns ("grilse"), the goal of 650 spawners is not consistently achieved.

Adult salmon that are collected at Milford and not transported to the hatchery for broodstock are put back in the river above the dam and allowed to continue their upstream migration. Although there are fishways at dams above Milford, including West Enfield and Mattaceunk, there are presently no annual counts of salmon using those fish passage facilities[2]. Studies have shown, however, that upstream migration in the lower Penobscot River proceeds relatively quickly unless dam flashboards are down or water temperature is elevated (Shepard 1995, Gorsky 2005).

Post-spawned Adults

Following spawning in the fall, Atlantic salmon kelts may immediately return to the sea, or over-winter in freshwater habitat and migrate in the spring, typically April or May (Baum 1997). Spring flows resulting in spillage at the dams facilitate out-migration of adult salmon (Shepard

[2] Counts of adult salmon were discontinued at the Mattaceunk Project in 2018 as discussed in Section 5.1.

1988). Downstream passage success of kelts was assessed as part of radio tag studies conducted for smolts in the Penobscot (GNP 1989, Shepard 1989a, Hall and Shepard 1990). Kelts tended to move downstream early in the spring (mostly mid-April through late May), regardless of whether fish were tagged in the spring or fall (i.e., most radio-tagged study fish generally stayed in the river near where they were placed until the following spring). Due to high river flows in 2010, a large portion of tagged kelts (90%) passed dams via spillage (i.e., over the dam) (Spencer et al. 2010, 2011). Kelt attraction to, and use of, downstream passage facilities in the Penobscot River watershed was highly variable depending on facility, year of study, and hydrological conditions (e.g., spill or not). At the upstream confluences (i.e., the Stillwater Branch and the mainstem), kelts followed the routes in approximate proportion to flow in the two channels.

Smolts

Out-migrating Atlantic salmon smolts in the Penobscot River watershed are the result of wild production following natural spawning and juvenile rearing, or from stocking fry, parr, and smolts (Fay *et al.* 2006). The majority of the salmon run on the Penobscot is the result of stocked smolts and will likely remain as such for the foreseeable future. Current management plans call for stocking 600,000 hatchery reared smolts at various locations in the mainstem above the Milford Dam and in the Piscataquis River sub-drainage (MDMR, MDIFW 2009).

Based on NMFS Penobscot River smolt trapping studies in 2000 - 2005, smolts migrate from the Penobscot between late April and early June with a peak in early May (Fay *et al.* 2006). These data also demonstrate that the majority of the smolt migration appears to take place over a two-week period after water temperatures rise to 10°C. Timing of smolt migrations may differ amongst rivers within the GOM DPS (Figure 8). In 2015, smolt trapping studies on the Piscataquis River in the Penobscot Bay SHRU indicated a median migration date of about May 12 with a migration duration of 23 days (USASAC 2016).

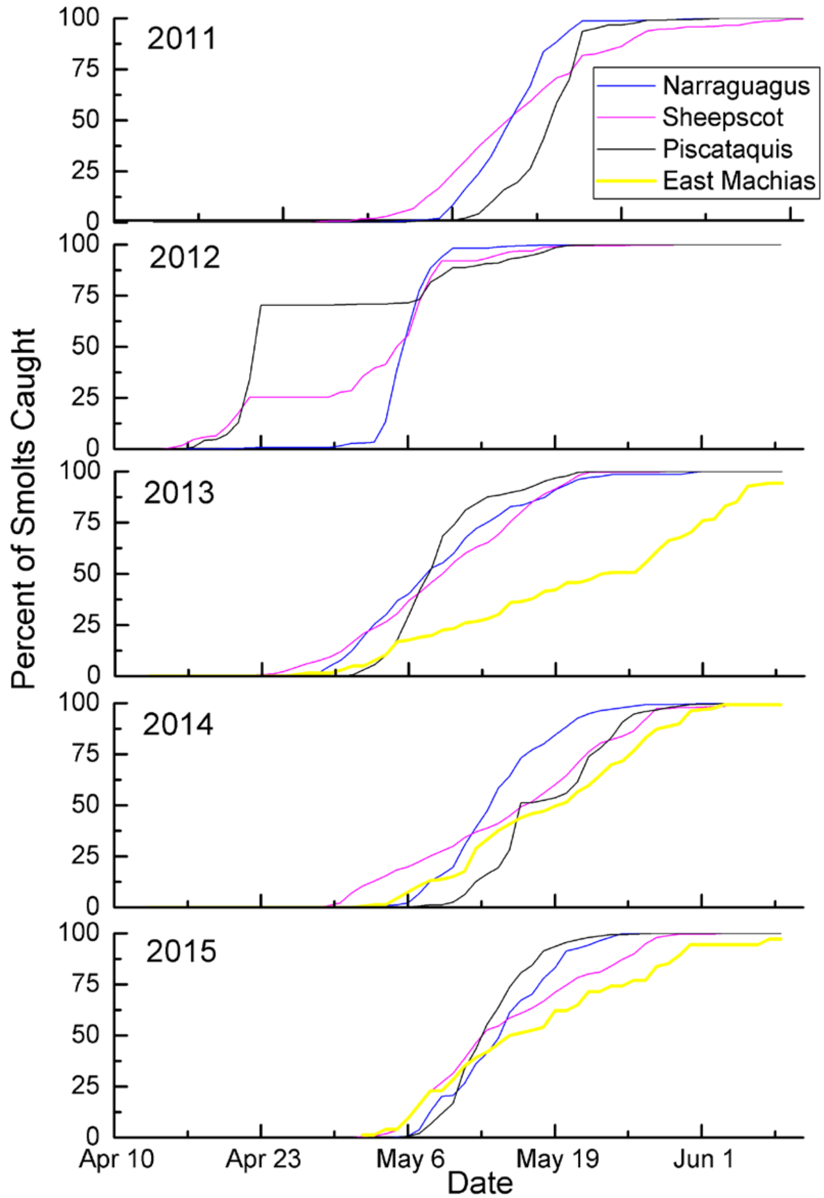

Figure 8. Cumulative percent smolt capture of all origins by date (run timing) on the Narraguagus (blue line), Sheepscot (pink line), Piscataquis (black line), and East Machias (yellow line) rivers, Maine (2011-2015) (USASAC 2016).

3.2.2 Status of Critical Habitat for Atlantic Salmon in the Penobscot Bay SHRU

In Section 3.1.2, we identify the physical and biological features of critical habitat in the GOM DPS of Atlantic salmon. In this section, we examine the status of critical habitat within the Penobscot Bay SHRU. Areas designated as critical habitat within each SHRU, including Penobscot Bay, are described in terms of habitat units. One habitat unit represents 100 m^2 of salmon spawning or rearing habitat. The quantity of habitat units in each SHRU was estimated through the use of a GIS-based salmon habitat model (Wright *et al.* 2008). For each SHRU, we determined that there were sufficient habitat units available within the currently occupied habitat to achieve recovery objectives in the future; therefore, no unoccupied habitat was designated as critical habitat.

The Penobscot Bay SHRU contains approximately 397,000 units of spawning and rearing habitat for Atlantic salmon among approximately 17,440 km of rivers, lakes and streams. Of the 397,000 units of spawning and rearing habitat, approximately 211,000 units was designated as critical habitat. The migration PBFs identified in Table 1 above are not fully functional throughout much of the 211,000 units of critical habitat due to dams. Similarly, the spawning and rearing PBFs of much of the 211,000 units of critical habitat do not adequately function due to impoundments and flow modifications caused by dams. Presently, only a fraction of habitat (the 18,600 units below the first mainstem dam on the Penobscot River) is fully accessible and suitable to Atlantic salmon without interference from artificial barriers (e.g., dams). The 18,600 units of suitable and accessible habitat in the Penobscot Bay SHRU contain all of the physical and biological features of designed critical habitat for Atlantic salmon that are identified in Table 1 above (NMFS 2009).

The vast majority of suitable habitat in the Penobscot Bay SHRU is accessible only by means of constructed fishways provided at dams. Large amounts of habitat are not accessible at all due to the presence of dams in the watershed. Three watersheds (Molunkus Stream, Passadumkeag River, and Belfast Bay) were excluded from critical habitat designation due to economic impact. Certain tribal lands within the Penobscot Bay SHRU are also excluded from critical habitat designation.

Significant amounts of riverine habitat in the Penobscot River have been altered by the construction of dams. FERC (1997) estimated that 27% (19 miles) of mainstem habitat (i.e., not including the Stillwater Branch segment) was impounded by five dams between head-of-tide and the confluence of the East and West Branches in Medway. Removal of the Veazie and Great Works Dams restored a substantial amount to free-flowing habitat in the lower Penobscot River. On the West Branch, approximately 57% of the 98 river miles is impounded (USACOE 1990). Approximately 11% of the approximately 74 miles of the Piscataquis River mainstem, 28% of the approximately 43 miles of the Sebec River tributary to the Piscataquis, and 8% of the approximately 25 miles of the Passadumkeag River (below natural barrier at Grand Falls) is impounded (USACOE 1990).

The removal of the Veazie and Great Works Dams in 2012 and 2013 restored a significant amount of riverine habitat (~12 km) in the lower Penobscot River; however, the existence of dams continues to degrade Atlantic salmon habitat throughout the Penobscot River watershed. Impoundments created by dams in the Penobscot River watershed limit access to habitat, alter habitat, increase predation, and degrade water quality through increased temperatures and lowered dissolved oxygen levels. Furthermore, because hydropower dams are typically constructed in reaches with moderate to high underlying gradients, approximately 50% of available gradient in the mainstem, and 41% in the West Branch, is impounded (USACOE 1990, FERC 1997). Coincidently, these moderate to high gradient reaches, if free-flowing, would likely constitute the highest value as Atlantic salmon spawning, nursery, and adult resting habitat within the context of all potential salmon critical habitat within these reaches.

The operation of dams in a store-and-release mode on the East Branch, and especially on the West Branch of the Penobscot River alter the natural hydrograph and thus impact the PBFs of critical habitat by reducing spring runoff flows and severe flood events, and augmenting summer and early fall flows. Such operations in turn reduce sediment flushing and transport and physical scouring of substrates, and increase surface area and volume of summer and early fall habitat in the mainstem. Water drawn from impoundments in the West Branch often constitutes half or more of the streamflow in the mainstem during the otherwise drier summer months (data analyzed from FERC 1996a).

3.2.3 Factors Affecting the Penobscot Bay SHRU and Critical Habitat

Hydroelectric Facilities

The Penobscot River has been extensively developed for hydroelectric power production. Hydroelectric dams are known to impact Atlantic salmon through habitat alteration, fish passage delays, and entrainment and impingement. There are approximately 116 dams in the Penobscot River watershed; 23 of these dams generate electricity under a FERC hydropower license or exemption (Fay *et al.* 2006). Six FERC licensed dams are located within designated critical habitat in the Penobscot River including the Milford, Orono, Stillwater, West Enfield, Mattaceunk, and Browns Mills. All of these dams operate in a run-of-river mode and have fishways specifically designed to pass Atlantic salmon. Of these FERC dams, only the Browns Mills Dam is not located on the Penobscot River.

Since the GOM DPS was expanded to include the Penobscot River in 2009, we have worked extensively with many dam owners to reduce the impacts of dams on listed Atlantic salmon and its designated critical habitat in the Penobscot River watershed. As part of the Penobscot River Restoration Project, the first and second mainstem dams (Veazie and Great Works) were decommissioned and removed in 2012 and 2013 to benefit anadromous species restoration in the Penobscot River. The Howland Dam at the confluence of the Piscataquis and Penobscot Rivers was also decommissioned and partially removed as part of the Penobscot River Restoration Project in 2016.

GLHA is a subsidiary of Brookfield Renewable Partners L.P. (Brookfield). We have worked with Brookfield to implement Atlantic salmon Species Protection Plans (SPPs) at four of their hydroelectric projects on the Penobscot River including Milford, Orono, Stillwater, and West Enfield. The SPPs are contained in the FERC licenses for each project and require very high upstream and downstream Atlantic salmon survival performance standards at each project. All four projects must achieve a 96% downstream survival performance standard for Atlantic salmon smolts and kelts. In addition, the FERC licenses for the Milford and West Enfield Projects require a 95% upstream passage performance standard for adult Atlantic salmon. Brookfield has made significant progress towards achieving these performance standards at each of the projects since implementing the SPPs in 2013. Once the upstream and downstream performance standards are achieved at the Milford Project, an additional 66,700 habitat units within the

Penobscot Bay SHRU will be fully accessible for Atlantic salmon. Once the upstream and downstream performance standards are achieved at the West Enfield Project, an additional 74,800 habitat units within the Penobscot Bay SHRU will be fully accessible for Atlantic salmon.

Pre-spawned Adults

Atlantic salmon returning to spawn in the upper reaches of the Penobscot Bay SHRU must pass multiple dams in order to reach suitable spawning and rearing habitat. Several studies concerning upstream passage of Atlantic salmon at dams in the Penobscot River have been conducted since the early 1980s. Radio telemetry and other tracking studies by the MDMR, University of Maine (UM), and various hydropower project licensees have shown wide variation in site-specific upstream passage success, depending on the dam location and the environmental conditions (e.g., temperature, hydrology) during the year of study. However, upstream passage for adult Atlantic salmon has generally been improving in the Penobscot Bay SHRU since the species was listed in the Penobscot River in 2009.

In the mainstem Penobscot River, Atlantic salmon must presently pass the Milford, West Enfield, and Mattaceunk Projects to reach spawning habitat in the upper reaches of the East Branch of the Penobscot River. The East Branch contains 35% of the total estimated rearing habitat in the watershed. Studies conducted by Brookfield and UM indicate that upstream passage at the Milford Project is highly effective since installation of a new state-of-the-art fishway at the Milford Project in 2014. In 2014, upstream passage effectiveness for adult salmon at the Milford Project was 75%[3] to 95.5% (Brookfield 2015; Izzo et al. 2016). In 2015, upstream passage effectiveness for adult salmon at the Milford Project was 96% to 100% (Brookfield 2015; Izzo et al. 2016). Shepard (1995) estimated upstream passage efficiency of 89% for adult salmon at the West Enfield Project. Studies conducted at the Mattaceunk Project indicated upstream passage effectiveness ranged from 71% to 90% (GLHA 2016). As part of Brookfield's SPP for Atlantic salmon, the Milford and West Enfield Projects must achieve 96% effectiveness for adult Atlantic salmon by 2023.

Researchers at UM have monitored upstream passage of Atlantic salmon at four dams (Howland, Browns Mills, Moosehead, and Guilford) on the Piscataquis River since 2002. Upstream passage of adult salmon was monitored at each dam using Passive Integrated Transponder (PIT) technology. The effectiveness of each fishway in the Piscataquis River varied considerably over the six years of monitoring but generally ranged from 33% to 100% (Gorsky 2000; UM unpublished data). Following the partial removal of the Howland Dam in 2016, UM documented adult salmon passage effectiveness in the upstream fish bypass of 94.9% to 100% (UM unpublished data).

Early migration is an adaptive trait that ensures adult Atlantic salmon have sufficient time to effectively reach spawning areas despite the occurrence of temporarily unfavorable conditions that naturally occur within rivers (Bjornn and Reiser 1991). Gorsky (2005) found that migration in Atlantic salmon was significantly affected by flow and temperature conditions in the

[3] 2014 was the first year of operating the new Milford fishway. Several operating issues resulted in the fishway not operating during the entire fish passage season.

Penobscot River. He found that high flows led to a decrease in the rate of migration and that rates increased with temperature up to a point (around 23°C) where they declined rapidly. To avoid high flows and warmer temperatures in the river, Atlantic salmon have adapted to migrating in the late spring and early summer, even though spawning does not occur until October and November.

Delay at dams can, individually and cumulatively, affect a salmon's ability to access suitable spawning habitat within the narrow window when conditions in the river are suitable for migration. Delays in migration can cause over-ripening of eggs, increased chance of egg retention, and reduced egg viability in pre-spawn female salmonids (de Gaudemar & Beall, 1998). Additionally, migratory delay has adverse energetic effects that may reduce the likelihood that salmon will successfully spawn and outmigrate to the estuary following spawning. A small increase in energy expenditure could affect an individual's ability to spawn, or reduce the likelihood that they could survive to spawn in a subsequent year. Although Pacific salmon are generally semelparous (i.e., spawn only once) and die after spawning, Atlantic salmon have evolved to be iteroparous (i.e., spawn multiple times) and are capable of returning to the ocean after spawning and subsequently returning to their natal river to spawn again. The threshold for iteroparity has been hypothesized to be 80% energy expenditure during migration and spawning (Glebe & Leggett, 1981). That is, an individual that uses more than 80% of its energy reserves will likely die after spawning, while those that use less have the potential to survive to spawn in multiple years. At the completion of their spawning migration, the energy loss for Atlantic salmon during spawning has been estimated to be 60-70% (Jonsson et al 1997). The amount of energy used likely varies based on the length of the migration and the environmental conditions they are exposed to during migration. Salmon that migrate under warmer conditions use more energy than those that migrate under cool conditions. Water temperature directly affects the rate of all biochemical reactions in ectothermic animals, such as Atlantic salmon, including metabolic processes (Angilletta Jr et al., 2002). This effect predicts a theoretical doubling of biological processes every 10ºC, and this theoretical trend is approximated by empirical data from salmonids (Brett & Groves, 1979). Although they spawn in late fall, Atlantic salmon have adapted to migrate to spawning grounds early in the summer, which minimizes the energetic cost of the migration. The optimum migration temperature for adult salmon is between 14℃ and 20℃, which occurs primarily in the months of May and June in the GOM DPS. It is not unusual for the temperature in the mainstem of the lower Penobscot River to exceed 23℃ in the summer months when we expect salmon to be migrating in the river. Delay associated with ineffective passage at dams may therefore force salmon to spend more time in warm water, which can significantly increase the energy costs of migration. If the cumulative effects of delay in a river system increases the energetic expenditure above the 80% threshold identified by Glebe and Leggett (1981), it is likely that fewer Atlantic salmon will return to spawn in subsequent years.

We do not currently have information regarding the amount of migratory delay that would lead to a significant reduction in the energy stores of an individual salmon. This threshold likely varies considerably depending on the number of barriers in the system, the travel distance to suitable spawning habitat, and the environmental conditions (e.g., water temperature) in the river during migration. However, lacking specific information, we conservatively assume that 48 hours allows sufficient time for an adult to locate and utilize a well-designed fishway without being delayed to the point that there is a significant disruption to normal behavioral patterns (i.e., spawning). Conversely, we consider fish that take longer than 48 hours to pass a dam to experience adverse effects, as this delay could lead to a reduction in the energy available for spawning, and may preclude repeat spawning (i.e., iteroparity).

Available empirical data indicate a wide range in time needed for individual adult salmon to pass upstream of various dams in the Penobscot River watershed. At the Milford Project, most adult Atlantic salmon required more than 48 hours to pass upstream of the dam (Izzo et al. 2016; Brookfield 2015). Over several years of studies, delay times for adult salmon at Milford ranged from 1.2 hours to up to 76 days. However, most Atlantic salmon passed the Milford Project within one week in 2014 and 2015. Based upon adult salmon telemetry studies conducted by Brookfield in 2014 and 2015, adult salmon do not appear to be significantly attracted to the Orono Project on the Stillwater Branch (Brookfield 2015 and 2015). Most adult salmon continued their migration in the mainstem Penobscot River moving past the Orono Project after an average residency time of 11 hours in 2014 and 10 hours in 2015. The yearly pooled median passage time for adults at the West Enfield Dam ranged from 1.1 days to 3.1 days over four years of study, while the total range of individual passage times over this study period was 0.9 days to 61.1 days (Shepard 1995).

Outmigrating smolts

Smolts from the upper Penobscot River have to navigate through multiple dams on their migration to the estuary every spring. Smolts produced in the East Branch of the Penobscot River must navigate through the Mattaceunk, West Enfield, and Milford Dams. If downstream migrating smolts use the Stillwater Branch in the lower Penobscot River, these smolts must pass the Stillwater and Orono Dams.

Since 2016, the Licensee of the Milford, Orono, Stillwater, and West Enfield Projects has implemented a spill program designed to protect Atlantic salmon smolts in the lower Penobscot River. Pursuant to the FERC licenses for each project, Brookfield spills between 20% and 50% of total river flow during the 2-week period of peak smolt migrations in the Penobscot River. Brookfield has studied the effectiveness of the spill program in protecting downstream migrating smolts at the Milford, Orono, Stillwater, and West Enfield Projects annually from 2014 to 2018 (Normandeau 2019). The studies indicate that the spill program has significantly reduced delays of smolts at each of the dams. The vast majority of smolts passed each project within 24 hours of encountering the project dam. In 2016, 98.0% to 99.0% of tagged smolts pass the Milford, Orono, Stillwater, and West Enfield Projects within 24 hours. In 2017, 93.9% to 98.0% of tagged smolts passed each project within 24 hrs. In 2018, 92.5% to 100.0% of tagged smolts passed each project within 24 hrs. Of even greater importance, the average smolt survival at each project has exceeded 96% at each project over the three years of studies based on a 75% confidence interval.

Researchers at the UM have also monitored downstream passage survival of Atlantic salmon smolts at the four mainstem dams on the Piscataquis River since 2005 (Table 2). Survival estimates were obtained from acoustic telemetry studies carried out by Holbrook et al. (2011), Stich et al. (2014), and Molina-Moctezuma et al. (unpublished). Estimates are per river kilometer with a 95% Confidence Interval (CI). These data indicate that smolt survival through the Browns Mills Project was high each year that the project was studied (2010 – 2018). In 2015 – 2018, 100% of smolts survived passage though the 1-mile project impoundment and over the Browns Mills Dam. In 2016 -2018, smolt survival was also high at the Howland Dam; this is likely the result of decommissioning the powerhouse and construction of the nature-like bypass in 2016. The Guilford and Moosehead Dams, which currently do not generate electricity, also achieved >90% survival of smolts. These results indicate that smolt survival past the four dams in the Piscataquis River is generally very high is most years.

Table 2. Survival estimates for downstream migrating smolts in the Piscataquis River. Note: * indicates survival estimates for second release group. Note that in 2016 and 2017 there were two releases upstream of each dam in the Piscataquis River.

	Guilford			Moosehead			Browns Mill			Howland		
Year	Estimate	LCI	UCI	Estimate	LCI	UCI	Estimate	LCI	UCI	Estimate	LCI	UCI
2005	-	-	-	-	-	-	-	-	-	0.928	0.841	0.989
2006	-	-	-	-	-	-	-	-	-	0.757	0.683	0.845
2007	-	-	-	-	-	-	-	-	-	-	-	-
2008	-	-	-	-	-	-	-	-	-	-	-	-
2009	-	-	-	-	-	-	-	-	-	0.967	0.922	0.995
2010	0.984	0.953	0.999	0.914	0.844	0.967	0.937	0.85	0.994	0.956	0.919	0.983
2011	0.986	0.954	0.999	0.975	0.922	0.998	0.968	0.899	0.999	0.94	0.892	0.98
2012	0.982	0.949	0.998	0.977	0.933	0.998	0.985	0.945	0.999	0.979	0.938	0.999
2013	0.94	0.886	0.98	0.961	0.849	0.998	0.939	0.839	0.997	0.97	0.947	0.987
2014	0.955	0.891	0.995	0.962	0.898	0.998	0.966	0.894	0.999	0.979	0.932	0.999
2015	0.987	0.903	0.998	0.985	0.96	0.995	1	-	-	0.937	0.83	0.987
2016	0.965	0.919	0.985	0.953	0.832	0.988	1	-	-	0.971	0.892	0.989
2016	-	-	-	-	-	-	-	-	-	1*	-	-
2017	0.996	0.99	0.999	1	-	-	1	-	-	1	-	-
2017	-	-	-	-	-	-	-	-	-	1*	-	-
2018	0.995	0.987	0.998	0.969	0.813	0.995	1	-	-	0.965	0.899	0.988
2018	-	-	-	-	-	-	-	-	-	0.99*	0.985*	0.999*

The UM also calculated delay of Atlantic salmon smolts passing the four mainstem dams on the Piscataquis River in 2016. As indicated in Figure 9, smolt delay at the Browns Mills Dam was highest for all dams in the Piscataquis River in 2016. Almost 50% of smolts were delayed over 48 hours at Browns Mills in 2016. Delay of smolts at the remaining three dams was less than 24 hours.

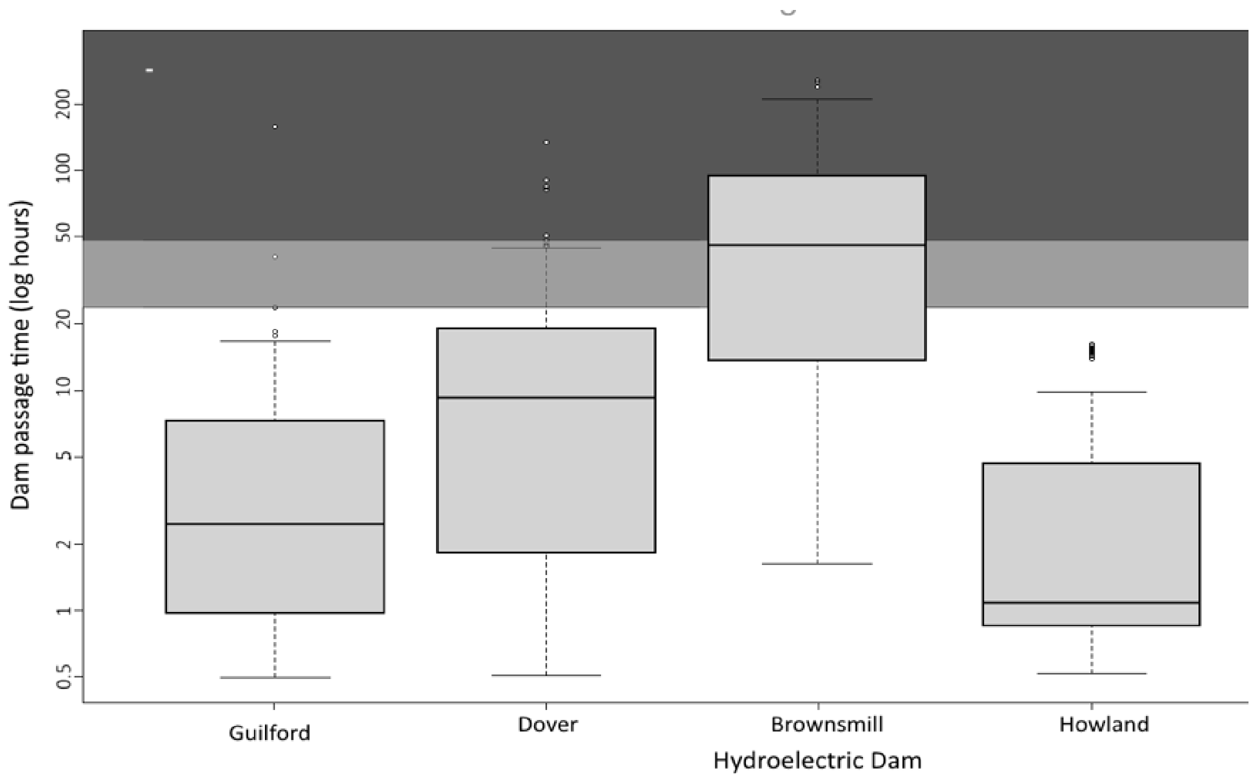

Figure 9. Total delay (in log hours) at the Howland, Browns Mills, Dover (Moosehead), and Guilford Dams for downstream migrating smolts in 2016.

Alden Research Laboratory, Inc. (Alden Lab 2012) modeled smolt survival rates at the two remaining FERC licensed dams within critical habitat in the Penobscot Bay SHRU (Table 3). Alden Lab conducted a literature review to estimate survival rates based on passage route including turbine entrainment, spill, and downstream passage facilities. Alden (2012) assumed that mortality through a properly designed bypass would not exceed 1%, whereas mortality via spillage would not exceed 3%. The estimates of mortality due to passage through the turbines was project-specific and calculated based on the characteristics of individual turbines (such as type of turbine, number of blades and the speed of rotation) and were therefore project specific. In addition to these route-specific estimates, Alden Lab also estimated a 5% indirect mortality rate (due primarily to predation and sublethal injuries during passage), regardless of passage route (Alden Lab 2012).

Table 3. Modeled smolt survival rates for the Lowell and Frankfort Hydroelectric Projects (Alden Lab 2012).

Project	Mean	Min	Max
Lowell	88.7%	84.7%	94.9%
Frankfort	92.0%	90.8%	94.4%

Outmigrating kelts

Atlantic salmon kelts move downstream after spawning in November or, alternatively, overwinter in freshwater and outmigrate early in the spring (mostly mid-April through late May). Lévesque et al. (1985) and Baum (1997) suggest that 80% of kelts overwinter in freshwater habitat prior to returning to the ocean. Downstream passage success of kelts has been assessed in the Penobscot (GNP 1989, Shepard 1989a, Hall and Shepard 1990). Kelt passage occurred during periods of spill at most dams, and a large portion of study fish used the spillage. Success over mainstem Penobscot River dams was usually greater than 90% at most sites. Kelt attraction to, and use of, downstream passage facilities was highly variable depending on facility, year of study, and hydrological conditions (e.g., spill or not). At the upstream confluences (i.e., the Stillwater Branch and the mainstem), kelts followed the routes in approximate proportion to flow in the two channels (approximately 40%/60%). Shepard (1989a) documented that kelts relied on spillage flows to migrate past the Milford Dam and former Veazie Dam during a study conducted in 1988. In fact, some kelts spent hours to days searching for spillway flows to complete their downstream migration during the 1988 study.

There is presently very little empirical data concerning site-specific survival of kelts migrating downstream of FERC dams in the Penobscot Bay SHRU. However, Alden Lab (2012) modeled the estimated survival rates of kelts at the multiple FERC dams in the Penobscot River SHRU based on turbine entrainment, spill mortality estimates and bypass efficiency (Table 4). Alden Lab's analysis accounted for both immediate and delayed mortality associated with dam passage. Through the three months of outmigration, Alden Lab indicates that mean survival rates at these dams ranged between 61% and 93%.

Table 4. Modeled kelt survival rates at various FERC projects in the Penobscot Bay SHRU (Alden Lab 2012).

Project	April			May			November		
	Mean	Min	Max	Mean	Min	Max	Mean	Min	Max
Milford	86.2%	69.3%	89.3%	84.7%	69.3%	89.5%	81.8%	65.8%	88.4%
West Enfield	91.0%	90.2%	91.6%	91.0%	90.2%	91.6%	90.8%	90.2%	94.1%
Mattaceunk	82.7%	75.8%	87.7%	85.2%	75.8%	89.5%	85.0%	75.8%	89.5%
Orono	87.9%	81.2%	90.1%	86.6%	65.8%	90.2%	83.6%	65.8%	89.4%
Stillwater	88.0%	65.8%	90.2%	85.7%	65.8%	90.3%	82.5%	65.8%	89.5%
Brown's Mill	92.7%	92.4%	94.1%	92.9%	92.4%	94.1%	93.1%	92.4%	94.1%
Lowell	82.8%	74.9%	94.5%	83.3%	74.9%	94.5%	81.2%	47.0%	94.5%
Moosehead	92.2%	92.2%	92.2%	82.3%	0.0%	92.2%	76.3%	0.0%	92.2%
Milo	64.5%	43.6%	82.0%	66.8%	43.6%	83.2%	61.6%	0.0%	89.5%
Sebec	89.7%	86.0%	94.1%	89.8%	86.0%	92.3%	89.7%	86.0%	94.1%
Frankfort	68.4%	53.5%	90.8%	70.9%	53.5%	94.1%	71.6%	53.5%	94.1%

Delayed Effects of Downstream Passage

Dams can significantly delay smolt outmigration, especially in low water years, because the individual fish must search and find an available passage route. Delays can lead to mortality of Atlantic salmon by creating conditions that increase the risk of predation (Blackwell & Juanes, 1998), and can also reduce overall physiological health or physiological preparedness for seawater entry and oceanic migration (Budy et al., 2002). Various researchers have identified a "smolt window" or period of time in which smolts must reach estuarine waters or suffer irreversible negative effects (McCormick et al., 1999). Late migrants lose physiological smolt characteristics due to high water temperatures during spring migration. Similarly, artificially induced delays in migration from dams can result in a progressive misalignment of physiological adaptation of smolts to seawater entry, smolt migration rates, and suitable environmental conditions and cues for migration. If so, then these delays are expected to reduce smolt survival (McCormick et al., 1999).

In addition to direct mortality sustained by Atlantic salmon at hydroelectric projects during upstream and downstream passage, some Atlantic salmon in the Penobscot River will sustain delayed mortality as a result of repeated passage events at multiple hydroelectric projects. That is, some individuals will die in the estuary due to physiological effects caused by passing downstream through one or more dams. Studies have investigated what is referred to as latent or delayed mortality, which occurs in the estuary or ocean environment and is associated with passage through one or more hydro projects (Budy *et al.* 2002, ISAB 2007, Schaller and Petrosky 2007, Haeseker *et al.* 2012). The concept describing this type of mortality is known as the hydrosystem-related, delayed-mortality hypothesis (Budy *et al.* 2002, Schaller and Petrosky 2007, Haeseker *et al.* 2012).

Stich *et al.* (2015a) conducted an analysis of nine years (2005 to 2013) of Atlantic salmon smolt movement and survival data in the Penobscot River to determine what effect several factors (e.g. release location and date, river discharge, photoperiod, gill NKA enzyme activity, number of dams passed) have on survival through the estuary. They determined that estuary survival decreased as the number of dams passed during freshwater migration increased (Figure 10). They estimated that each dam passed in the Penobscot led to a "dam-related estuary mortality" rate of 6% in the estuary. This mortality was attributed to migratory delay and sublethal injuries (such as scale loss) sustained during dam passage and includes smolts that miss the "smolt migration window" and are therefore unable to successfully transition to saltwater. These effects make smolts more susceptible to predation, and disease. This source of mortality results in a significant reduction in the number of smolts that would otherwise be expected to successfully outmigrate to the ocean. Considering a loss of 6% of smolts at each mainstem dam, this would result in a loss of 18% of the smolts outmigrating from areas above the Mattaceunk Dam (passing Mattaceunk, West Enfield and Milford dams), 12% of the smolts originating between the Mattaceunk and West Enfield dams (passing over those two dams), and 6% of the smolts originating between the West Enfield and Milford dams (passing only over the Milford dam)

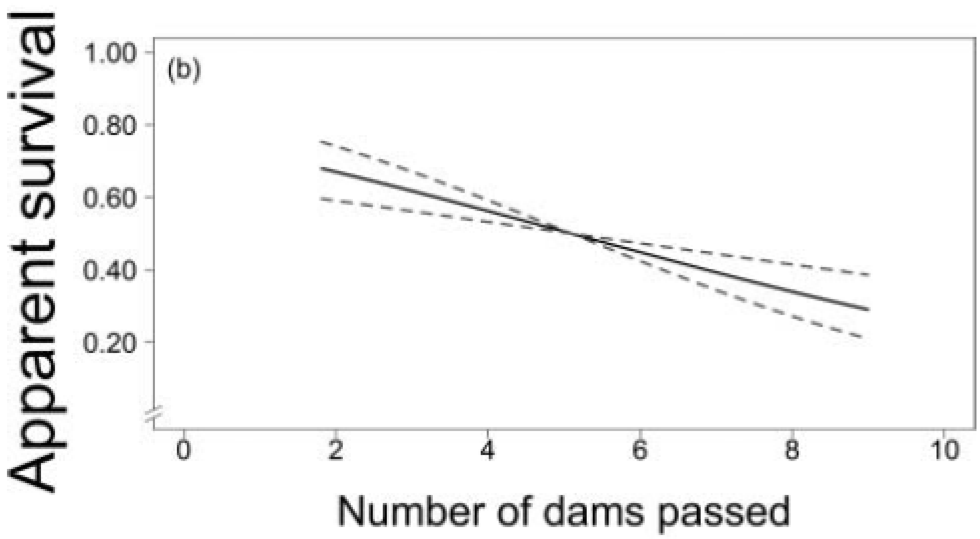

Figure 10. Apparent survival of Atlantic salmon smolts in the Penobscot River estuary based on the number of dams they passed during freshwater migration. The dark line is the mean survival and the dashed lines show the 95% confidence interval. The figure is excerpted from Stich *et al.* 2015a.

Predation

Predation was identified as a threat to Atlantic salmon in the Penobscot Bay SHRU in the 2019 final recovery plan for Atlantic salmon (USFWS and NMFS 2019). Predation upon Penobscot River smolts has been studied by Blackwell (1996), as it relates to double crested cormorants, and by Van den Ende (1993) for certain non-native fish species including smallmouth bass and chain pickerel. In addition, the Penobscot River smolt migration studies described above have documented high smolt loss rates likely due to predation throughout the river system.

Smallmouth bass and chain pickerel are each important predators of Atlantic salmon within the range of the GOM DPS (Fay *et al.* 2006). Smallmouth bass are a non-native, warm-water species whose range now extends through north-central Maine and well into New Brunswick (Jackson 2002). Smallmouth bass are very abundant in the Penobscot River—smallmouth bass inhabit the entire mainstem migratory corridor as well as many of the juvenile Atlantic salmon rearing habitats such as the East Branch Penobscot River and the Piscataquis River. Smallmouth bass likely feed on fry and parr though little quantitative information exists regarding the extent of bass predation upon salmon fry and parr. Smallmouth bass are important predators of smolts in mainstem habitats, although bioenergetics modeling indicates that bass predation is insignificant at 5°C and increases with increasing water temperature during the smolt migration (Van den Ende 1993).

Chain pickerel are known to feed upon smolts within the range of the GOM DPS and certainly feed upon fry and parr, as well as smolts, given their piscivorous feeding habits (Van den Ende1993). Chain pickerel feed actively in temperatures below 10°C (Van den Ende 1993, MDIFW 2002). Smolts were, by far, the most common item in the diet of chain pickerel observed by Barr (1962) and Van den Ende (1993). However, Van den Ende (1993) concluded that, “daily consumption was consistently lower for chain pickerel than that of smallmouth bass,“ apparently due to the much lower abundance of chain pickerel.

Northern pike were illegally stocked in Maine, and their range now includes Pushaw Lake which drains to the Lower Penobscot River (Fay *et al.* 2006). Northern pike have expanded their range in the Penobscot River to include the Pushaw Stream outlet, nearby Mud Pond and probably portions of the mainstem Penobscot River, since there are no barriers to their movement. Northern pike are ambush predators that rely on vision and thus, predation upon smolts occurs primarily in daylight with the highest predation rates in low light conditions at dawn and dusk (Bakshtansky *et al.*1982). Hatchery smolts experience higher rates of predation by fish than wild smolts, particularly from northern pike (Ruggles 1980, Bakshtansky *et al.* 1982).

Many species of birds prey upon Atlantic salmon throughout their life cycle (Fay *et al.* 2006). Blackwell *et al.* (1997) reported that salmon smolts were the most frequently occurring food items in cormorant sampled at mainstem dam foraging sites. Cormorants were present in the Penobscot River during the spring smolt migration as migrants, stopping to feed before resuming northward migrations, and as resident nesting birds using Penobscot Bay nesting islands (Blackwell 1996, Blackwell and Krohn 1997). The abundance of alternative prey resources such as upstream migrating alewife, likely minimizes the impacts of cormorant predation on the GOM DPS (Fay *et al.* 2006). Common mergansers and belted kingfishers are likely the most important predators of Atlantic salmon fry and parr in freshwater environments.

Contaminants and Water Quality

Pollutants discharged from point sources affect water quality within the Penobscot Bay SHRU. Common point sources of pollutants include publicly operated waste treatment facilities, overboard discharges (OBD), a type of waste water treatment system), and industrial sites and discharges. The Maine Department of Environmental Protection (DEP) issues permits under the National Pollutant Discharge Elimination System (NPDES) for licensed point source discharges. Conditions and license limits are set to maintain the existing water quality classification. The DEP has a schedule for preparing a number of TMDLs for rivers and streams within the Penobscot River watersheds. TMDLs allocate a waste load for a particular pollutant for impaired waterbodies. The State of Maine has recommended restricted fish consumption due to the presence of dioxin from industrial point sources through much of the lower Penobscot River. Combined sewer overflows from Milford, Old Town, Orono, Bangor, and Brewer produce elevated bacteria levels, thus inhibiting recreation uses of the river (primary contact). The lower area of the river south of Hampden to Verona Island is impaired due to contamination of mercury, PCBs, dioxin, and bacteria from industrial and municipal point sources. The water quality in the West Branch of the Penobscot River is affected by dams, attendant impoundments, and water withdrawals, discussed above. Discharges in the West Branch of the Penobscot River affect the color of water in the in the Penobscot River. Color is a factor affecting water quality (EPA 2017). Many small tributaries on the lower river in the Bangor area have impaired aquatic life due to bacteria from both non-point source and urban point sources. Parts of the Piscataquis River and its tributaries are impaired from combined sewer overflows and dissolved oxygen issues from agricultural NPS and municipal point sources. Approximately 160 miles of the Penobscot River and its tributaries are listed as impaired by the DEP.

3.2.4 Summary of the Status of the Penobscot Bay SHRU

Adult returns for the Penobscot Bay recovery unit remain well below the biological criteria established for each SHRU in the 2018 Recovery Plan. The 2019 Recovery Plan identifies a self-sustaining annual escapement target of 2,000 wild origin adults for each SHRU before delisting of the species under the ESA can proceed. The abundance of Atlantic salmon in the Penobscot Bay SHRU remains low and either stable or declining over the past several decades. The proportion of fish that are of natural origin is small and displays no sign of growth. The conservation hatchery program has assisted in slowing the decline and helping to stabilize populations at low levels, but has not contributed to an increase in the overall abundance of wild Atlantic salmon. Lastly, the “regime shift” of low marine survival that began in the early 1990s has persisted to date and recovery of the species cannot be fully accomplished absent improvements in marine survival.

Since the species was listed in the Penobscot River in 2009, significant progress has been made towards minimizing the impacts of hydroelectric dams on Atlantic salmon. Two mainstem hydroelectric dams were removed (Veazie and Great Works), a third hydroelectric dam was decommissioned (Howland) and SPPs have been implemented at four other hydroelectric dams (Milford, Orono, Stillwater, and West Enfield). We fully expect that these efforts will result in conditions that will contribute to an increased likelihood of the survival and recovery of Atlantic salmon in the Penobscot River. However, a number of activities within the Penobscot Bay SHRU including the presence of a number of small dams will likely continue to impact the biological and physical features of spawning, rearing, and migration habitat for Atlantic salmon. Other activities that continue to affect Atlantic salmon include non-native fish predation, agriculture, forestry, changing land-use and development, hatcheries and stocking, roads and road-crossings and other instream activities (such as alternative energy development), mining, dredging, and aquaculture.

4. ENVIRONMENTAL BASELINE

Environmental baseline refers to the condition of the listed species or its designated critical habitat in the action area, without the consequences to the listed species or designated critical habitat caused by the proposed action. The environmental baseline includes the past and present impacts of all Federal, State, or private actions; the anticipated impacts of all proposed Federal projects in the action area that have already undergone formal or early section 7 consultation; and the impact of state or private actions which are contemporaneous with the consultation in process. The environmental baseline, therefore, includes the past impacts of the operation of the Mattaceunk Project; that is, these past impacts have contributed to the current status of the species and critical habitat in the action area. We note that we do not consider future effects of the existence of the Weldon Dam as part of the Environmental Baseline, rather, because it is within FERC’s discretion to deny a new license for the Project and to require the removal of the dam, we consider the continued existence of the Weldon Dam over the term of the proposed new license to be consequences of the action.

The environmental baseline for this biological opinion includes the consequences of several activities that may have affected the survival and recovery of Atlantic salmon, and affected the functioning of critical habitat, in the action area. As explained above, the action area is a portion of the Penobscot River. Past impacts of the operation of the Mattaceunk Project are considered in the Environmental Baseline including the existence of the Weldon Dam and its associated impoundment. State, Federal, and private actions in other areas of the Penobscot River may impact Atlantic salmon that occur in the action area; consequences of those activities are addressed in the Status of the Species above.

Much of the information presented below was contained in GLHA's draft BA (GLHA 2016).

4.1. Status of Atlantic salmon and Critical Habitat within the Action Area

A summary of the status of the species rangewide and designated critical habitat in its entirety was presented above. This section will focus on the status of Atlantic salmon and designated critical habitat in the action area. Pre-spawned adults, kelts, and smolts occur in the action area. Additionally, the action area is within the Penobscot River critical habitat unit and is used by adults moving to upstream spawning areas, kelts returning to the ocean following spawning, and smolts migrating to the ocean. Below we summarize the status of each lifestage within the action area.

Pre-Spawned Adults

Pre-spawned adult Atlantic salmon have been documented in the Mattaceunk Project annually for decades (FERC FEA, 2018). Upstream fishway counts have been conducted at the Mattaceunk Project since 1983, typically from June through October of each year. The collected data show a peak in upstream migration during July and September, with early June, August, and late October showing minimal salmon upstream movement (Figure 11). Table 5 presents the number of Atlantic salmon documented using the fishway at the Mattaceunk Project since 1983. The percentage of adult Atlantic salmon released upstream of the former Veazie Dam or Milford that subsequently passed upstream of the Mattaceunk Project varied widely year to year, with an overall average of about 10%. It should be noted that many factors affect the number of adult salmon returning to the Mattaceunk Project. First, not all salmon entering the Penobscot River would be expected to pass the Mattaceunk Project given the presence of suitable spawning areas in tributaries downstream of the project including the Piscataquis and Mattawamkeag watersheds. Approximately 65% of all spawning and rearing habitat in the Penobscot River watershed is located downstream of the Mattaceunk Project. Assuming a proportional distribution of returns to available habitat, one would expect approximately 35% of Atlantic salmon returning to the Penobscot River to seek passage upstream of the Mattaceunk Project.

TABLE 5. Adult Atlantic Salmon Documented Returns to the former Veazie Dam, Milford Dam, and Mattaceunk Project between 1983 and 2017. Note 2017 data is still under review.

Year	Total Annual Count of Atlantic salmon captured at either Veazie (1983-2013) or Milford (2014-2016)	Count of Atlantic Salmon Released Upstream of Veazie or Milford Project	Count of Atlantic salmon at Mattaceunk Project	Percentage of Atlantic salmon released upriver that passed Mattaceunk

1983	952	365	10	2.7%
1984	1,809	957	54	5.6%
1985	3,370	2493	119	4.8%
1986	4,541	3671	481	13.1%
1987	2,519	1824	314	17.2%
1988	2,863	2093	127	6.1%
1989	3,120	2231	293	13.1%
1990	3,385	2399	290	12.1%
1991	1,767	1003	158	15.8%
1992	2,387	1613	298	18.5%
1993	1,774	1160	101	8.7%
1994	1,049	696	47	6.8%
1995	1,336	732	37	5.1%
1996	2,044	1450	62	4.3%
1997	1,355	815	20	2.5%
1998	1,210	596	27	4.5%
1999	968	498	52	10.4%
2000	534	207	18	8.7%
2001	785	278	20	7.2%
2002	780	403	99	24.6%
2003	1,112	507	40	7.9%
2004	1,323	714	183	25.6%
2005	985	521	37	7.1%
2006	1,044	508	45	8.9%
2007	925	339	60	17.7%
2008	2,117	1468	225	15.3%
2009	1,958	1282	345	26.9%
2010	1,316	634	41	6.5%
2011	3,125	2408	194	8.1%
2012	627	146	8	5.5%
2013	381	9	0	0.0%
2014	261	33	0	0.0%
2015	731	62	9	14.5%
2016	506	214	45	21.0%
2017	849	415	85	20.5%

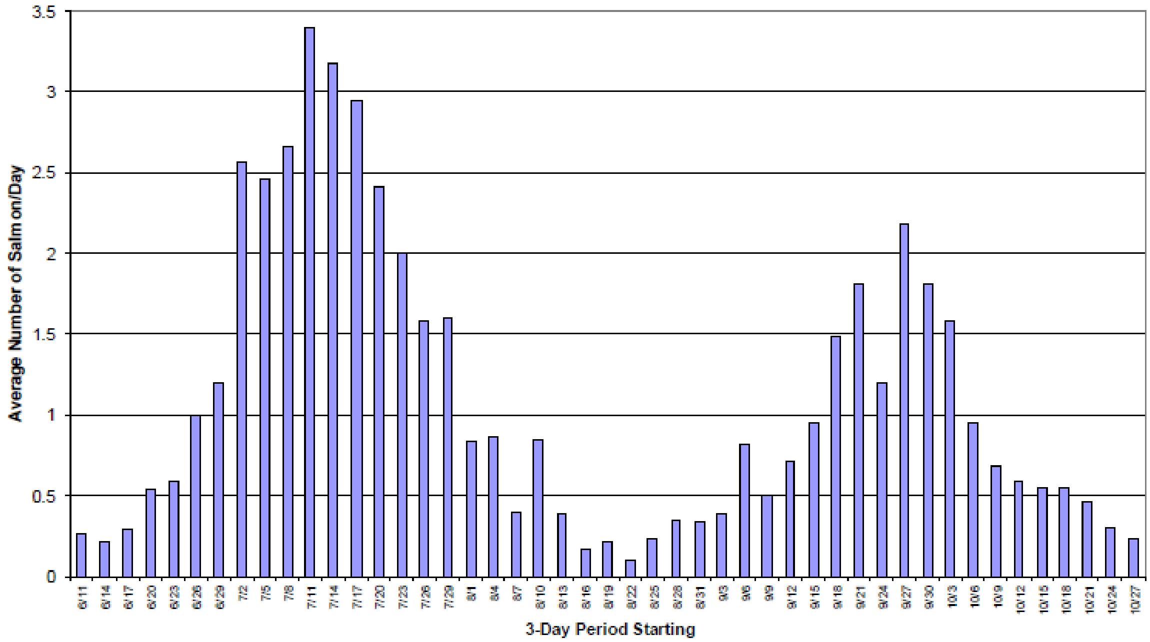

Figure 11. Seasonality of Upstream Atlantic Salmon Upstream Passage at the Mattaceunk Project (GLHA, 2016)).

Great Northern Paper (GNP), a past licensee of the Mattaceunk Project, conducted a series of upstream fish passage studies at the Mattaceunk Project from 1983 to 1986. Over this period, GNP implemented several modifications to the upstream fishway to increase effectiveness of the facility. While the number of salmon released into the mainstem above the former Veazie Dam increased by 161% from 1985 to 1986, the number of adults captured in the Mattaceunk fishway increased by approximately 400% (from 119 adults captured in 1985 to 472 in 1986). This suggests that fishway modifications had improved passage efficiency for adult Atlantic salmon and that the increase in adult Atlantic salmon captured in 1986 compared to 1985 was not due solely to the increase in the number of Atlantic salmon released above the Veazie Dam.

An additional study conducted in 1986 evaluated radio-tagged and control adult Atlantic salmon (salmon handled similarly to the radio-tagged fish but without a tag) to measure upstream passage efficiency and behavior at the Mattaceunk Project. The control fish were used to evaluate any effects from radio tagging on salmon behavior. Of 14 radio-tagged fish that reached the Mattaceunk Project, 10 were trapped in the fishway, representing a minimum efficiency of 71%. Of the 18 control salmon released downstream of the project, 16 were captured in the trap indicating an upstream passage efficiency of 89%. Based upon the 1986 study, upstream passage efficiency for adult Atlantic salmon at the Mattaceunk Project ranged from 71% to 89%

Additional analysis of Atlantic salmon upstream migration and passage can be seen from tagging efforts by MDMR, where 9 of 10 East Branch Penobscot origin salmon released at South Lincoln (24 miles downstream of the Mattaceunk Project) were captured in the Project's fish trap, at an efficiency of 90%. Based on the results of all data presented, the GNP 1986 study concluded that the upstream passage efficiencies observed at the Project were acceptable and no further fishway modifications were needed. Resource agencies agreed, and study efforts at the Project were shifted to downstream passage of smolts and kelts after the 1986 study season.

MDMR tagged several hundred Atlantic salmon adults captured at the former Veazie Dam fishway trap with PIT tags from 2002 to 2004. This study monitored the date and time of passage at upstream fishways at five mainstem (Veazie, Great Works, Milford, West Enfield, and Mattaceunk) and five major tributary hydropower dams in the Penobscot watershed (Beland and Gorsky 2004, MASC unpublished data). Of the 379 total salmon tagged at the former Veazie Dam in 2002, 21% (78 fish) successfully passed all five mainstem dams including the Mattaceunk Project. In 2003, only 1 of 461 salmon tagged at the former Veazie Dam successfully passed all five upstream dams. In 2004, 19% of tagged adults successfully passed all five mainstem dams.

In 2012, the USGS and UM conducted additional upstream passage monitoring studies at nine major dams in the Penobscot River watershed, including the Mattaceunk Project. The monitoring study used PIT tags to monitor upstream migrating adult salmon movement. In 2012, all eight PIT-tagged Atlantic salmon that were detected at the Mattaceunk fishway successfully passed upstream. Since 2012, these monitoring efforts have been reduced; no tagging occurred in 2013 due to the Veazie Dam removal construction activities, and the low numbers of Atlantic salmon available downstream of the Mattaceunk Project in 2014 and 2015 (due to low returns and hatchery broodstock collection) precluded significant study efforts. Due to equipment issues, no PIT tag monitoring was conducted by USGS or UM at the Mattaceunk Project in 2016-2018. USGS installed a new PIT monitoring system in the upstream fishway in 2019. The results of the 2019 PIT tag monitoring are not yet available and will likely be published in late 2020.

Adult salmon that are unable to safely pass the Mattaceunk Project via the existing upstream fishway will either spawn in downstream areas, return to the ocean without spawning, or die in the river. Although no studies have looked directly at the fate of fish that fail to pass through upstream fish passage facilities on the Penobscot River, we convened an expert panel in 2010 to provide the best available information on the fate of these fish. The panel was comprised of state, federal, and private sector Atlantic salmon biologists and engineers with expertise in Atlantic salmon biology and behavior at fishways. The expert panel concluded that most adult Atlantic salmon (99%) that do not use the upstream fishway at the Mattaceunk Project will stray and successfully spawn in downstream areas such as the Mattawamkeag River (i.e., we do not anticipate that any fish will return to the ocean without successfully spawning in the Penobscot River watershed). The group estimated a baseline mortality rate of 1% for Atlantic salmon that fail to pass a fishway at a given dam in the Penobscot River watershed (NMFS 2011, Appendix A). The group also estimated that 1% of adult salmon that are unable to pass the Mattaceunk Project could die as the result of insignificant adult thermal refugia during warm summer months in downstream reaches of the river. Based upon this information, it is expected that 1% of adult Atlantic salmon that do not successfully pass the Mattaceunk Project will not survive or reproduce.

Previous upstream passage studies conducted at the Mattaceunk Project were not designed to quantify the delay of adult Atlantic salmon attempting to migrate past the project. Therefore, it is presently unknown what level of delay occurs for adults at the Mattaceunk Project. Fish that are motivated to pass the Project are expected to experience delay similar to what has been observed at other hydroelectric projects within the GOM DPS. Of the fishways where migratory delay information exists, the Milford Project likely provides the best available information to characterize levels of delay adult salmon experience at the Mattaceunk Project since its located on the Penobscot River with similar hydrological conditions. The University of Maine conducted an assessment of passage delay at the Milford Project in 2014 and 2015 (Izzo et al., 2016). Although some of the fish located the fishway entrance within 5 hours of approaching the dam, 50% (in 2014) and 65% (in 2015) failed to pass within 48 hours. However, as we expect attraction to be better at the Mattaceunk Project we expect this is an overestimate of the delay that occurs at Mattaceunk Project. The Milford Project contains a bypassed reach of river that attracts migrants to an area of the dam that does not contain a fishway. The Mattaceunk Project does not contain a bypass reach of river and the existing fishway is adjacent to the powerhouse. Based on this information, we assume that under existing conditions at the Mattaceunk Project, fewer than 50% of the salmon that pass the project are expected to take more than 48-hours to pass.

Since 1983, the upstream fishway at the Mattaceunk Project has passed 3,859 adult Atlantic salmon upstream. The number of adult salmon injured or killed using the fishway since counts commenced in 1983 is not known; however, GLHA records note eight adult Atlantic salmon mortalities at the Mattaceunk Project:

- October 6, 1988 – 1 salmon injured (gill bleeding) and presumed mortality during radiotagging
- July 18, 1989 – 1 salmon found in the upstream fishway trap
- July 13, 1998 – 1 salmon found on the trashracks
- June 22, 2001 – 1 salmon found in the upstream fishway trap
- 2006 – 1 salmon, date and location not specified
- July 24, 2008 – 1 salmon found in upstream fishway trap.
- 2012 – 2 kelts found on the trashracks.

Other than as noted for 1988, there was no indication of the cause of the mortalities.

Post-spawned Adults

Post-spawned adult salmon occur annually in the Mattaceunk Project area. Based on five years of data collected at the Mattaceunk Project in the late 1990s, the seasonal timing of downstream migration of kelts demonstrate a spring migration period between April 25 and June 25 and fall migration in October and November. Kelts tended to move downstream with high flows in early spring; however, most of the study fish were hatchery kelts that were tagged and released in the spring, so fall movement was not assessed in some of these studies. Some of the adult salmon tagged in the fall at the Mattaceunk Project returned downstream after spawning. Several also moved downstream to the project prior to spawning, indicating they may have been imprinted on other areas in the watershed and were trying to locate these areas. While the timing of kelt movements in the Penobscot River may be affected by warming river temperatures in response to global climate change, no recent studies have been conducted to measure any shifts in migrating timing; however, it is possible that over time if river waters warm earlier in the year, the seasonal timing of downstream migration of kelts may also shift earlier in the year.

Downstream passage success of kelts has been assessed at the Mattaceunk Project and several other sites in the lower Penobscot River. This discussion on passage efficiency focuses on the studies conducted at the Mattaceunk Project after the permanent downstream fishway was installed in 1992 as this is the period most representative of existing baseline conditions. The initial kelt passage study conducted after the downstream fishway was operational was conducted in the fall of 1992 and spring of 1993. In the fall of 1992, study fish consisted of 25 adult Atlantic salmon collected in the upstream fishway trap at the Project that were radio-tagged and released upstream. Eight of these tagged kelts migrated downstream past the Mattaceunk Project during the fall fishway operational period of October 31 to December 1, and thus were candidates to use the new downstream fishway. Up to five of these fish used the downstream bypass system, one passed through the turbines, and two did not pass the dam during the study period. One adult did not migrate past the project but remained in the forebay, indicating it was either a mortality or had regurgitated its tag. One of these kelts ceased movements just downstream of the Mattaceunk Project suggesting it may have died in the passage attempt. The fall study occurred during a period of no-spill, which limited passage routes to the turbines or downstream fish bypass. One study kelt was collected in the downstream fish trap the following May, but it had regurgitated its radio tag. We assume GLHA did not attempt to calculate kelt survival for the 1992 study due to small sample size.

In the spring of 1993, 71 post-spawn broodstock kelts collected from the Craig Brook National Fish Hatchery were released upstream of the Mattaceunk Project and monitored for downstream passage. Thirty of these kelts were radio-tagged and 41 served as controls (Floy-tagged but not radio-tagged). Twenty-seven radio-tagged kelts passed downstream of the dam, three through the downstream passage system, one through the turbines, and the remaining kelts through spillage. The kelt that passed through the turbines ceased movement downstream of the dam (suggesting it died), while others continued further downstream, suggesting a whole-station passage survival rate of 96.3% under spill conditions.

In the fall of 1993, 13 adult Atlantic salmon were radio-tagged and released upstream of the Mattaceunk Project after capture in the upstream fishway. Only one of these fish was detected at the dam migrating back downstream after spawning that fall, and it utilized the downstream bypass route. No kelts were collected in the downstream fish trap in the spring of 1994, most likely due to continued high flow conditions and spillway passage.

The two kelt studies conducted in 1993 indicate a combined bypass collection efficiency of 73% to 82% (one fish may have escaped during an overflow problem). The condition of all kelts observed in the downstream fish trap was excellent, including additional kelts that were not part of these studies.

There is presently no empirical data concerning survival of kelts migrating downstream of the Mattaceunk Project during periods of no spillage, other than the initial study with a small sample size. However, based upon modeling conducted by Alden Lab (2012), the survival of kelts migrating downstream of the project could be a low as 75.8% during periods of low flow in the

Penobscot River. Based upon this information and data collected at the project in 1993, kelt survival at the project is expected to range from 75.8% to 96.3% under existing conditions and various river flows.

Additional kelt studies in the lower Penobscot River documented that most kelts passed dams during high flow periods, typically over the spillways, but also through gates and sluices (Hall and Shepard 1990). MDMR research that involved tracking of tagged adult Atlantic salmon in the Penobscot River basin has shown that adults can drop downstream quickly past many dams. Researchers noted that, "the presence of dams did not appear to impede downstream movement of motivated salmon, and some fish passed seven dams in as many days." In 2010, eight fish that migrated downstream of the former Veazie Dam were recaptured 17 days after being released in the Piscataquis River, and "appeared in excellent condition and showed no adverse effects from passing downstream over multiple (seven) dams" (Spencer et al. 2010, 2011). It should be noted that spillage was occurring at most of the seven dams during the 2010 study.

Fry/Parr

Atlantic salmon stocking occurs within the Penobscot River. Up until the mid-1990s, all life stages of Atlantic salmon were stocked upstream of Mattaceunk Dam. Presently, the only lifestages of Atlantic salmon stocked upstream of the Mattaceunk Project are fry (Table 6). In a typical year, over 700,000 fry are stocked upstream of the Mattaceunk Project. After two or three years in freshwater, these fry migrate past the Mattaceunk Project as smolts.

Table 6. Total Number of Fry Stocked in the East Branch of the Penobscot River and its Tributaries from 2002 – 2018.

Year	East Branch Penobscot River	Sebois River	Wassataquoik Stream	Total
2002	242,916	172,884	92,282	508,082
2003	201,469	88,213	104,298	393,980
2004	397,992	172,099	192,850	762,941
2005	446,163	239,834	209,604	895,601
2006	365,632	248,520	160,798	774,950
2007	416,624	201,732	247,190	865,546
2008	429,360	0	153,626	582,986
2009	250,480	166,650	99,597	516,727
2010	379,824	175,180	155,701	710,705
2011	246,470	326,855	133,669	706,994
2012	329,436	228,317	184,526	742,279
2013	280,084	82,407	94,845	457,336
2014	273,768	0	100,000	373,768
2015	0	0	103,986	103,986
2016	276,508	0	165,366	441,874
2017	77,148	0	36,721	113,869
2018	371,228	0	141,349	512,577

No fry or parr are stocked directly in habitat within the Mattaceunk Project area and no suitable spawning habitat has been field-mapped in the action area. Therefore, we do not expect any fry or parr to occur in the action area.

Smolts

Atlantic salmon smolts are present each spring at the Mattaceunk Project. Both hatchery and wild Atlantic salmon smolts occur annually in the Mattaceunk Project area. Based on an aggregate of six 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% of smolts) occurring in May. Given the limited number of pre-spawned Atlantic salmon occurring annually upstream of the Mattaceunk Project, the vast majority of smolts in the action area are the result of fry stocking in the East Branch of the Penobscot River and its tributaries. Based upon current stocking rates of Atlantic salmon fry upstream of the Mattaceunk Project, it is reasonable to assume that thousands of smolts migrate past the project each year.

GLHA has conducted multiple smolt passage studies at the Mattaceunk Project since the early 1980s. As discussed in Section 2, the existing downstream bypass facility includes single surface inlets at intakes 3 and 4. From 1993 to 1999 (excluding 1996 when no studies were conducted), the collection efficiency of the existing bypass was evaluated using radio-tagged smolts released upstream of the project. For several years, GLHA experimented with strobe lights to increase passage through the #3 and #4 intakes. Based on these studies, collection efficiency ranged between 17% and 59% with the use of strobe lights. In 2004, the downstream bypass was tested with no strobe lights and under typical turbine flow conditions, resulting in a passage efficiency of 41%. Given the limited success of the strobe light system in directing smolts to the bypass, it is no longer used. None of these studies evaluated passage survival.

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 dam. In 2015, GLHA released tagged smolts in the upper extent of the project impoundment to assess survival through this reach of river. In 2014, tagged smolts were released at the approximate mid-point of the impoundment thus survival through the entire impoundment was not assessed. In both years, the most common route of passage for smolts was through the turbines (2014: 70.1%; 2015: 78.5%) (Table 7). 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% of smolts, and the spillway and log sluice were each used by 6.7% of smolts. Bypass collection efficiency was 14.9% in 2014 and 8.1% 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 (Table 7). The results of these studies suggest that smolt survival through the downstream bypass and log sluice was 100%, while survival through the turbines and other spill routes (where the majority of smolts passed downstream) was between about 85% and 93%. We note that small sample sizes of fish passing the project via the spillway, bypass, and log-sluice limit the statistical accuracy of the estimates. Due to a high post-release mortality of control fish which biased the study results, we do not consider the survival estimates of the 2014 smolt study to be a reasonable predictor of actual mortality of smolts migrating through the impoundment; however, the 2015 study did not have this same problem and we consider the 2015 study as a component of the best available information on smolt survival through the impoundment. In 2015, the calculated total dam passage survival rate was 89.3% to 100.0% based upon 95% confidence interval (CI).

Table 7. Study results of 2014 and 2015 downstream smolt passage studies at the Mattaceunk Project.

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	

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. Due to a high post-release mortality of control fish which biased the study results, we do not consider the 2014 results to be a reasonable predictor of actual mortality of smolts moving through the impoundment (see above). GLHA did not use a paired-release design in 2015, but, instead released all smolts upstream of the project. In 2015, total survival past the dam was estimated to be 95.9% (point estimate) with a 95% confidence interval between 89.3 and 100%. In 2015, 12 of the 137 (8.8%) smolts detected in the forebay took over 24 hours before moving downstream, thus indicating some passage delay at the dam. 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% and 91% for wild and hatchery smolts, respectively.

The downstream smolt passage studies also evaluated migration timing and delay. Dams can significantly delay smolt outmigration, especially in low water years, because the individual fish must search and find an available passage route. Delays can lead to mortality of Atlantic salmon by creating conditions that increase the risk of predation (Blackwell & Juanes, 1998), and can also reduce overall physiological health or physiological preparedness for seawater entry and oceanic migration (Budy et al., 2002). Various researchers have identified a "smolt window" or period of time in which smolts must reach estuarine waters or suffer irreversible negative effects (McCormick et al., 1999). Late migrants lose physiological smolt characteristics due to high water temperatures during spring migration. Similarly, artificially induced delays in migration from dams can result in a progressive misalignment of physiological adaptation of smolts to seawater entry, smolt migration rates, and suitable environmental conditions and cues for migration. These delays are expected to reduce smolt survival (McCormick et al., 1999).

Based on the timing of tag detections, once smolts approached the project dam, they typically moved through quickly. The median residence 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. The rate of movement of test smolts migrating through the project impoundment was documented in 2014 and 2015. In 2014, 69 of the 102 radio-tagged smolts that were released approximately 5.5 km upstream of the Weldon Dam were detected in the forebay (GLHA 2016). In 2015, 49 tagged smolts were released in the upper portion of the project's impoundment (12.5 km upstream of Weldon Dam) and an additional 100 smolts were released 400 meters upstream of the dam. Of the 149 smolts released in 2015, 135 Atlantic salmon smolts were detected in the forebay. The median migration rates of the test smolts released moving through the impoundment was 0.21 km/h in 2014 and 0.25 km/h in 2015 (GLHA 2016). It should be noted that we cannot distinguish between delay caused by the project impoundment and delay that test fish experience through disorientation following release into the impoundment during the 2014 and 2015 studies.

In 2015, GLHA also estimated smolt survival through the project impoundment by releasing 49 radio-tagged smolts about 12.5 kilometers upstream of the project dam. All 49 smolts reached the first monitoring station about 300 meters downstream from the release site. A total of 42 smolts reached the dam, yielding an impoundment survival rate of 85.7%, or a mortality rate of 1.1% per kilometer (the distance from the release location to the dam is about 12.5 kilometers). At a 1.1% mortality per kilometer as reported, this would result in the loss of 14% of the fish though the entire impoundment. In 2015, a mortality rate representative of background mortality[4] was estimated using tag detections from receivers located about 4.7 kilometers and 6.7 kilometers downstream from the dam. A background mortality rate of 2.4% per kilometer was estimated for the 2015 study. However, since these test fish were released upstream of the dam, the 2.4% per kilometer mortality estimate does not accurately reflect true background mortality since they experienced dam passage and that passage event may have affected survival downstream of the project.

In a separate study, Stich *et al.* (2015) estimated mortality rates in the project impoundment and in free-flowing reaches of the Penobscot River (Table 8). The data from Stich et al. (2015a;

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[4] Background mortality is defined as mortality that occurs in a river unaffected by the presence or operation of a dam.

2015 b) indicate that for hatchery smolts (most smolts in the action area originate from stocked fry) which represent the vast majority of smolts in the action area), the average mortality per kilometer was higher in the project impoundment (2.7% per kilometer) than in free-flowing sections (0.80% per kilometer) of the Penobscot River. Based on these rates of mortality per kilometer for hatchery smolts, cumulative survival is lower through the project impoundment compared to a free-flowing reaches of the same length. Mattaceunk impoundment survival data collected by Stich et al. (2015b) in 2010 and 2011 for wild smolts[5] are not considered reasonable indicators of actual mortality due to "poor fish condition, low detection probabilities, smaller test fish, larger tags, lateness of the study, and different monitoring locations" (GLHA, August 3 1, 2016 Final License Application, Volume II, P. E-179). In a draft report submitted to GLHA in 2012, UM (Zydlewski and Stich unpublished data) stated that wild smolts captured in the Mattaceunk Project bypass trap in 2010 and 2011 generally had much (orders of magnitude) lower post-release survival than hatchery fish. Given the issues with the studies conducted in 2010 and 2011, the data cannot be used to estimate impoundment mortality at the Mattaceunk Project. Compared to system wide estimates in Stich et al., 2015 and in river survival estimates by Holbrook et al. (2011), the best available data (studies using hatchery smolts in 2012, 2013, and 2014 by Stich et al (2015) and 2015 by HDR (2015)) indicate that mortality for smolts in the Mattaceunk Project is among the highest of all reaches in the Penobscot River.

Based upon our review of the best available data for the Mattaceunk Project impoundment, data collected at the project using hatchery smolts in 2012, 2013, and 2014 by Stich et al (2015) and 2015 by HDR (2015) provide the best estimate of impoundment mortality. The mortality of smolts in the reach of river contained by the impoundment (adjusted for background levels of mortality) were: 2012 (7.5%); 2013 (8.7%); 2014 (5.4%); and 2015 (5.1%). The 2012 – 2014 studies conducted by Stich et al. (2015) did not estimate mortality for the entire impoundment (only the lower 6.5 km). Using the Stich 2012 – 2014 data collected in the lower 6.5 km of the project impoundment, we extrapolated mortality to the entire 12.5 km impoundment. This level of mortality in the impoundment equates to 2.7% mortality per mile compared to 0.80% mortality per mile in free-flowing sections of the Penobscot River (Stich et al. 2015a and 2015b). Based upon this data, we estimate that project-related impoundment mortality could range from 5.1% to 8.7%. Note that because we made a different determination than FERC did about the best available information on mortality in the impoundment, this is a different estimate of mortality than what FERC presents in the Final EA. FERC's Final EA assumed a mortality rate of 1.6 percent per mile for smolts emigrating through the project impoundment. As explained in our April 27, 2018 letter to FERC, we consider this 1.6% per mile estimate of mortality in the impoundment to be an underestimate.

Table 8. Mattaceunk Project impoundment smolt survival data from Stich et al. (2014) and Stich et al (2015).

5 Naturally reared smolts originating as stocked eggs, fry or parr are termed "wild" in the GOM DPS of Atlantic salmon since they cannot be distinguished from truly wild individuals.

Source	Section	Survival per km	95%Credible Interval	Reach length	Interval Survival	Cumulative Dam Survival	Cumulative Dam Mortality
Hatchery	Weldon Head Pond	0.989	0.979–0.997	2.5	0.973	0.830	**0.170**
	Weldon Head Pond	0.990	0.981–0.997	3	0.970		
	Weldon Head Pond	0.970	0.944–0.989	1	0.970		
	Weldon Dam	0.960	0.939–0.980	2.4	0.907		
	Open river 1	0.995	0.988–1.000	6.6	0.967		
	Open river 2	0.992	0.989–0.995	12	0.908		
	Open river 3	0.999	0.998–1.000	14	0.986		
Wild	Weldon Head Pond	0.993	0.974–1.000	2.5	0.983	0.792	**0.208**
	Weldon Head Pond	0.991	0.976–0.999	3	0.973		
	Weldon Head Pond	0.986	0.951–1.000	1	0.986		
	Weldon Dam	0.930	0.886–0.966	2.4	0.840		
	Open river 1	0.991	0.976–0.999	6.6	0.942		
	Open river 2	0.981	0.973–0.989	12	0.794		
	Open river 3	0.997	0.992–1.000	14	0.959		

In summary, the best available information suggests that the existing upstream fishway at the Mattaceunk Project has a minimum efficiency of 71% for adult, pre-spawned Atlantic salmon (that is, at least 71% of adult Atlantic salmon are expected to pass upstream of the project); thus, up to 29% of pre-spawn Atlantic salmon that occur in the project area will not successfully pass upstream due to the inefficiencies of the current upstream passage facility. The best available information also suggests that smolt survival over the project dam ranges from 89.3% to 100.0%. and kelt survival ranges from 75.8% to 96% under existing conditions. Once smolts approached the project dam, they typically moved through quickly. The median residence 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. The best available information also suggests that project-related impoundment mortality of smolts ranges from 5.1% to 8.7% under existing conditions at the Mattaceunk Project. Thus, we expect the loss of 5.1% to 19.4% of all smolts moving from the top of the impoundment to the area just downstream of the dam under current conditions. There is no suitable parr habitat in the Mattaceunk Project impoundment. Therefore, we do not anticipate that any parr will attempt to pass either upstream or downstream of the Mattaceunk Project.

Riverine Processes

Riverine systems are dynamic. Physical and chemical attributes vary in space and time primarily as a result of the distribution of annual surface runoff from a watershed over time (Poff et al., 2010). The variability in flow and other environmental factors is required to sustain freshwater ecosystems (Poff et al., 1997). As such, flow regime is a primary determinant of the structure and function of aquatic ecosystems (Poff et al., 2010). Diadromous fish have evolved to take advantage of this variation (Pess et al., 2014). The complex life cycle of Atlantic salmon requires a diversity of well-connected habitat types to complete their life history (Fay et al., 2006).

The extent to which streamflow modifications in the action area due to the operation of the Mattaceunk Project impact salmon habitat (including migratory corridors during applicable seasons) and restoration efforts is unknown. However, alterations of flows during smolt and kelt outmigration, and enhanced habitat quantity and, potentially, "quality" for non-native predators such as smallmouth and largemouth bass, are likely among the adverse impacts to salmon.

Impoundments created by dams limit access to habitat, alter habitat, and degrade water quality through increased temperatures and turbidity, as well as lowered dissolved oxygen levels. Furthermore, because hydropower dams are typically constructed in reaches with moderate to high underlying gradients, significant areas of free-flowing habitat have been converted to impounded habitats in the Penobscot River watershed, including the 12.5 km impounded reach upstream of the Weldon Dam.

There is abundant information that demonstrates that large project impoundments, like the one created by Weldon Dam, have a negative effect on fish and their habitat. Impounding water significantly modifies riverine habitats by converting them into lake habitats. This habitat modification creates ideal spawning conditions for non-native fish predators (e.g., bass, pike, pickerel), while eliminating riverine habitat needed by certain anadromous fish species (e.g., Atlantic salmon, American shad, blueback herring) for spawning, rearing, and migration.

In addition to creating habitat for salmonid predators, impoundments reduce the rate of movement of outmigrating salmon smolts. The combination of increased predator abundance and reduced rate of movement leads to a significantly increased probability of predation (Venditti et al., 2000). Therefore, some proportion of the mortality observed through the Weldon Dam impoundment is undoubtedly associated with the fact that the smolts are migrating through a 12.5-kilometer reach of river that has been converted by the dam.

Critical Habitat in the Action Area

As discussed previously, critical habitat for Atlantic salmon has been designated in the Penobscot River, including the Mattaceunk Project area. Within the action area of this consultation, the PBFs of Atlantic salmon critical habitat include freshwater sites for migration. The mainstem of the Penobscot River in the action area serves as a migration corridor for upstream migrating adult salmon and downstream migrating post-spawned salmon and smolts. Significant areas of spawning and rearing habitat has been field-mapped upstream of the action area by the MDMR, predominantly in the East Branch of the Penobscot River, Wassataquoik Stream, and Seboeis River. Based on a GIS-based Atlantic salmon habitat prediction model developed by the USFWS (Wright, J., et al. 2008), there are approximately 55,700 units of rearing habitat upstream of the Mattaceunk Project. The GIS-based model developed by USFWS identified the mainstem Penobscot River in the Mattaceunk Project area as potential rearing habitat however it had the lowest habitat ranking therefore indicating that it is unlikely to produce any fry. Several tributaries in the 7 km reach of river from the Mattaceunk Project to the confluence of the Mattawamkeag River contain approximately 2,150 units of rearing habitat. These tributaries are not part of the action area for this consultation.

The Mattaceunk Project is currently licensed to operate in a run-of-river mode with a year-round continuous minimum base flow of 1,674 cfs or inflow, whichever is less. From July 1 through September 30, the project operates with a daily average minimum flow of 2,392 cfs, or average inflow, whichever is less. From October 1 through June 30, the project operates with a daily average minimum flow of 2,000 cfs, or average inflow, whichever is less. Based upon water quality monitoring conducted by GLHA in 2014, the Mattaceunk Project waters are achieving Maine DEP water quality standards for Class C waters. Class C waterbodies in Maine must achieve the following water quality criteria: a) dissolved oxygen (DO) may not be less than 5 milligrams per liter (mg/L) or 60 percent of saturation, whichever is higher; b) pH between 6.0 and 8.5; c) water column chlorophyll-a ≤ 8.0 micrograms/liter (µg/L); and ≥ 2.0 meters Secchi disk depth. Class C waters must also 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

Operating the Mattaceunk Project in run-of-river mode provides nearly natural flows and 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. In 2014, GLHA conducted a minimum flow aquatic habitat study at the Project in support of the FERC relicensing activities. This study found that, under the Project's currently-licensed minimum flows, the reach of river directly downstream of the Mattaceunk Project provides adequate habitat to support aquatic life and a zone of passage for fish migration. These conclusions are based on habitat mapping and transect profile data, which together show extensive connectivity of deep-water habitats along both shorelines – these deep water habitats also extend well into the channel.

The migratory PBFs (M 1-6) occur in the action area:

- M1 - 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.
- M2 - 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.
- M3 - Freshwater and estuary migration sites with abundant, diverse native fish communities to serve as a protective buffer against predation.
- M4 - Freshwater and estuary migration sites free from physical and biological barriers that delay or prevent emigration of smolts to the marine environment.
- M5 - Freshwater and estuary migration sites with sufficiently cool water temperatures and water flows that coincide with diurnal cues to stimulate smolt migration.
- M6 - Freshwater migration sites with water chemistry needed to support sea water adaptation of smolts.

The action area does not contain any surveyed Atlantic salmon spawning and rearing habitat. The GIS-based model developed by the USFWS (Wright, J., et al. 2008) predicts a small amount of rearing habitat just downstream of the Mattaceunk Project; however, mainstem habitat in the Penobscot River would be low quality for juvenile lifestages of Atlantic salmon. Also, given the absence of suitable spawning habitat in the action area downstream of the Mattaceunk Project, no juveniles would be produced to occupy this reach of river. Therefore, we do not expect any of the 7 spawning and rearing PBFs to occur in the action area.

To assess the conservation status of critical habitat in the action area of this consultation, we consider the key attributes of properly functioning critical habitat (Table 9). Properly functioning migratory critical habitat for Atlantic salmon must have suitable depths, water velocities, water quality, and healthy fish communities.

Using this matrix along with information presented in FERC's BA, information provided by a MDMR biologist with extensive site-specific knowledge of the action area, and best professional judgement, we determined that the essential features of migration critical habitat in the action area are currently functioning in a limited capacity. The migration PBFs are not functioning adequately in the action area, largely due to the effects of the Mattaceunk Project.

PBF M1 requires 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. PBF M4 requires freshwater and estuary migration sites free from physical and biological barriers that delay or prevent emigration of smolts to the marine environment. The Weldon Dam is a barrier for adults seeking access to the 35% of the estimated rearing habitat in the Penobscot watershed that is upstream of the dam and is a barrier to smolts out-migrating from habitats above the dam. While the existing fishway provides passage for some adults, the fishway does not meet identified performance standards. Similarly, the project results in the mortality of many smolts moving downstream from habitats above the project.

PBF M2 requires 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. Due to its' large surface area and thermal heating, the Weldon Dam affects water temperature during summer months and the suitability of habitat for holding and resting of upstream migrating adult salmon.

PBF M3 calls for freshwater and estuary migration sites with abundant, diverse native fish communities to serve as a protective buffer against predation. Currently, the lack of suitable upstream passage facilities for alosines at the Mattaceunk Project reduces the distribution and abundance of native fish in the action area which reduces the ability of these native fish communities to serve as a protective buffer against migration of Atlantic salmon.

PBF M5 is fully functional in the action area; the action area has sufficiently cool water during the spring and water flows that coincide with diurnal cues to stimulate smolt migration. Operating the Mattaceunk Project in run-of-river mode provides nearly natural flows and prevents rapidly fluctuating water levels from occurring downstream of the project, which prevents stranding of migrating Atlantic salmon or dewatering of habitat downstream the project. During spring months, high flows and low water temperatures in action area are protective of the features of M5. Operation of the Mattaceunk Project does not appear to have any effects on water temperatures during the spring migration season of smolts. Also, run-of-river operations mimic a natural hydrograph which allows for stimulation of smolt migration.

PBF M6 in the action area is fully functional; the action area has the water chemistry needed to support sea water adaptation of smolts. During spring months when smolts are present in the action area, water quality in the action area is protective of the features of M5. Operation of the Mattaceunk Project does not affect water chemistry in the Penobscot River.

It should be noted that the baseline functionality of critical habitat in the action area may not always be directly related to the effects of the Mattaceunk Project. For instance, global climate change is likely a factor affecting the suitability of temperature features in the upper reaches of the action area not directly impacted by the Mattaceunk Project. Also, the abundance of non-native fish species (e.g., smallmouth bass) within free-flowing reaches of the action area is impacting native fish communities especially in the reach of the Penobscot River downstream of the confluence of the East and West Branches. The East Branch of the Penobscot River is likely less affected by non-native fish species when compared to the lower reaches of the Penobscot River.

Table 9. Habitat attributes of properly functioning Atlantic salmon critical habitat.

	Spawning Habitat		**Rearing Habitat**	**Migration Habitat**	
	Spawning Oct 1-Dec 14	*Embryo/Fry Development* Oct 1-Apr 14	*Parr Development* All Year	*Adults* Apr 15-Dec 14	*Juveniles* Apr 15-Jun 14
Depth	17-76 cm	5-15 cm	10-30 cm		
Velocity	8-83 cm/sec	4-15 cm/sec	< 120 cm/sec	30-125 cm/sec	
Temperature	7-10℃	< 10℃	7-22.5℃	<23℃	5-11℃
pH	>5.0	> 4.5			>5.5
DO		saturation, or 7-8 mg/L	>2.9 mg/L	>4.5 mg/L	
Substrate	Cobble/Gravel	Cobble/Gravel	Gravel/Boulders		
Cover	Pools, large boulders, woody debris				
Fish Communities			Many native fish species; few non-native fish species		
Food			Macroinvertebrates and small fish		

4.2. Impacts of Federal Actions that have Undergone Formal or Early Section 7 Consultation

In the Environmental Baseline section of an Opinion, we discuss the anticipated impacts of all proposed Federal actions in the action area that have already undergone formal or early section 7 consultation. Consequences of Federal actions that have been completed are encompassed in the Status of the Species section of the Opinion.

On June 20, 2013, we issued an Opinion concerning FERC’s approval to amend the license for the Mattaceunk Project to incorporate the provisions of an Interim Species Protection Plan (ISPP) that would avoid and minimize impacts to federally-listed endangered Atlantic salmon during operation of the Mattaceunk Project. On September 26, 2013, FERC approved amending the license to incorporate the provisions of the ISPP at the Mattaceunk Project. On May 21, 2019, we updated the Incidental Take Statement issued to the FERC.

We have not completed any other formal or early section 7 consultations for other activities in the action area. Impacts of the Mattaceunk Project under the terms of the existing license as amended by the 2013 SPP are considered here.

4.3. State of Private Activities in the Action Area

Scientific Studies

MDMR is authorized under the USFWS' endangered species blanket permit (No. 697823) to conduct monitoring, assessment, and habitat restoration activities for listed Atlantic salmon populations in Maine. The extent of take from MDMR activities during any given year is not expected to exceed 2% of any life stage being impacted; for adults, it would be less than 1%. MDMR will continue to conduct Atlantic salmon research and management activities in the GOM DPS while the proposed action is carried out. The information gained from these activities will be used to further salmon conservation actions.

USFWS is also authorized under an ESA section 10 endangered species blanket permit to conduct the conservation hatchery program at the Craig Brook and Green Lake National Fish Hatcheries. The mission of the hatcheries is to raise Atlantic salmon parr and smolts for stocking into selected Atlantic salmon rivers in Maine. Over 90% of adult returns to the GOM DPS are currently provided through production at the hatcheries. The hatcheries are currently preventing the extinction of the species.

Other Activities in the Action Area

In 2009, the MDMR closed all Atlantic salmon fishing in Maine. There is no indication that the fishery will be reinstated in the future. Poaching of Atlantic salmon and incidental capture of Atlantic salmon in legal fisheries have been reported in the GOM DPS; however, it is difficult to quantify due to a lack of information.

State of Maine stocking program

Competitive interactions between wild Atlantic salmon and other salmonid fishes, especially introduced species, are not well understood. In Maine, state managed programs supporting recreational fisheries often include stocking non-indigenous salmonid fish into rivers containing anadromous Atlantic salmon. Interactions between wild Atlantic salmon and other salmonids include; indigenous brook trout (S*alvelinus fontinalis*) and landlocked Atlantic salmon (*Salmo salar sebago*) and hatchery reared non-indigenous brown trout (*Salmo trutta*) and rainbow trout (*Oncorhynchus mykiss*). Competition plays an important role in habitat use by defining niches that are desirable for optimal feeding, sheltering and spawning. Limited resources may also increase competitive interactions which may act to limit the time and energy fish can spend obtaining nutrients essential to survival. This is most noticeable shortly after fry emerge from redds, when fry densities are at their highest (Hearn, 1987) and food availability is limited. Prior residence of wild salmonids may provide a competitive advantage during this time over domesticated hatchery juveniles (Letcher, 2002; Metcalfe, 2003); even though the hatchery reared individuals may be larger (Metcalfe, 2003). This may limit the success of hatchery cohorts stocked annually to support the recovery of Atlantic salmon. This could also influence the ability of juvenile Atlantic salmon to establish residency after escaping from commercial hatcheries located on GOM DPS rivers. Annual population assessments and smolt trapping estimates conducted on GOM DPS rivers indicates stocking of hatchery reared Atlantic salmon fry and parr in areas where wild salmon exist could limit natural production and may not increase the overall population level in freshwater habitats. The amount of quality habitat available to wild Atlantic salmon may also increase inter and intra-species interactions due to significant overlap of habitat use during periods of poor environmental conditions such as during drought or high water temperatures. These interactions may impact survival and cause Atlantic salmon, brook and brown trout populations to fluctuate from year to year. However, since brook trout and Atlantic salmon co-evolved, wild populations should be able to co-exist with minimal long-term effects (Hearn, 1987; Fausch, 1988). Domesticated Atlantic salmon produced by the commercial aquaculture industry that escape from hatcheries or net pens also compete with wild Atlantic salmon for food, space and mates.

5. CLIMATE CHANGE

Below, we discuss the potential impacts of climate change on Atlantic salmon and designated critical habitat. Climate change is relevant to the Status of the Species, Environmental Baseline and Cumulative Consequences sections of this Opinion; rather than include partial discussion in several sections of this Opinion, we are synthesizing this information into one discussion. Consideration of consequences of the proposed action in light of predicted changes in environmental conditions due to anticipated climate change are included in the Consequences of the Action below.

Hare et al. (2016) gave Atlantic salmon a Vulnerability Rank of Very High (100% certainty from bootstrap analysis) as well as a Climate Exposure rank of Very High and Distributional Vulnerability Rank of Moderate (87% certainty from bootstrap analysis). The authors conclude that the consequences of climate change on Atlantic salmon in the Northeast U.S. Shelf Ecosystem is very likely to be negative (>95% certainty in expert scores) due to the consequences of warming on freshwater and marine habitats and the potential to affect the phenology of Atlantic salmon migration. Ocean acidification could also affect olfaction, which Atlantic salmon use for natal homing.

As described in Hare et al., several studies have examined the effects of climate on the abundance and distribution of Atlantic salmon. In a review, Jonsson and Jonsson (2009) concluded that the thermal niche of Atlantic salmon will likely shift northward causing decreased production and possibly extinction at the southern end of the range. The Gulf of Maine DPS is the southernmost populations of Atlantic salmon in the Northwest Atlantic Ocean. Friedland et al. (2014) found that declines in post-smolt survival were associated with ocean Warming and hypothesized that in the Northwest Atlantic, the decline in survival was a result of early ocean migration by post-smolts. Mills et al. (2013) suggested that poor trophic conditions likely due to climate-driven environmental factors such as flows and water temperatures and warmer ocean temperatures are constraining the productivity and recovery of Atlantic Salmon in the Northwest Atlantic. Available evidence suggests that climate change and long-term climate variability will reduce the productivity of the Gulf of Maine DPS of Atlantic Salmon.

Atlantic salmon may be especially vulnerable to the consequences of climate change in New England, since the areas surrounding many watersheds where salmon are found are heavily populated and have already been affected by a range of stresses associated with agriculture, industrialization, and urbanization (Elliot *et al*. 1998). Climate consequences related to temperature regimes and flow conditions determine juvenile salmon growth and habitat (Friedland 1998). One study conducted in the Connecticut and Penobscot rivers, where temperatures and average discharge rates have been increasing over the last 25 years, found that dates of first capture and median capture dates for Atlantic salmon have shifted earlier by about 0.5 days/ year, and these consistent shifts are correlated with long-term changes in temperature and flow (Juanes *et al*. 2004). Temperature increases are also expected to reduce the abundance of salmon returning to home waters, particularly at the southern limits of Atlantic salmon spatial distribution (Beaugrand and Reid 2003).

A study conducted in the United Kingdom that used data collected over a 20-year period in the Wye River found Atlantic salmon populations have declined substantially and this decline was best explained by climatic factors like increasing summer temperatures and reduced discharge more than any other factor (Clews *et al*. 2010). Changes in temperature and flow serve as cues for salmon to migrate, and smolts entering the ocean either too late or too early would then begin their post-smolt year in such a way that could be less optimal for opportunities to feed, avoid predator risks, and/or thermal stress (Friedland 1998). Since the highest mortality affecting Atlantic salmon occurs in the marine phase, both the temperature and the productivity of the coastal environment may be critical to survival (Drinkwater *et al*. 2003). Temperature influences the length of egg incubation periods for salmonids (Elliot *et al*. 1998) and higher water temperatures could accelerate embryo development of salmon and cause premature emergence of fry.

Since fish maintain a body temperature almost identical to their surroundings, thermal changes of a few degrees Celsius can critically affect biological functions in salmonids (NMFS and USFWS 2005). While some fish populations may benefit from an increase in river temperature for greater growth opportunity, there is an optimal temperature range and a limit for growth after which salmonids will stop feeding due to thermal stress (NMFS and USFWS 2005). Thermally stressed salmon also may become more susceptible to mortality from disease (Clews *et al*. 2010). A study performed in New Brunswick found there is much individual variability between Atlantic salmon and their behaviors and noted that the body condition of fish may influence the temperature at which optimal growth and performance occur (Breau *et al*. 2007).

The productivity and feeding conditions in Atlantic salmon's overwintering regions in the ocean are critical in determining the final weight of individual salmon and whether they have sufficient energy to migrate upriver to spawn (Lehodey *et al*. 2006). Survival is inversely related to body size in pelagic fishes, and temperature has a direct effect on growth that will affect growth-related sources of mortality in post-smolts (Friedland 1998). Post-smolt growth increases in a linear trend with temperature, but eventually reaches a maximum rate and decreases at high temperatures (Brett 1979 in Friedland 1998). When at sea, Atlantic salmon eat crustaceans and small fishes, such as herring, sprat, sand-eels, capelin, and small gadids, and when in freshwater, adults do not feed but juveniles eat aquatic insect larvae (FAO 2012). Species with calcium carbonate skeletons, such as the crustaceans that salmon sometimes eat, are particularly susceptible to ocean acidification, since ocean acidification will reduce the carbonate availability necessary for shell formation (Wood *et al*. 2008). Climate change is likely to affect the abundance, diversity, and composition of plankton, and these changes may have important consequences for higher trophic levels like Atlantic salmon (Beaugrand and Reid 2003).

In addition to temperature, stream flow is also likely to be impacted by climate change and is vital to Atlantic salmon survival. In-stream flow defines species distribution and habitat suitability for Atlantic salmon and since climate is likely to affect in-stream flow, the physiological, behavioral, and feeding-related mechanisms of Atlantic salmon are also likely to be impacted (Friedland 1998). With changes in in-stream flow, salmon found in smaller river systems may experience upstream migrations that are confined to a narrower time frame, as small river systems tend to have lower discharges and more variable flow (Elliot *et al*. 1998). The changes in rainfall patterns expected from climate change and the impact of those rainfall patterns on flows in streams and rivers may severely impact productivity of salmon populations (Friedland 1998). More winter precipitation falling as rain instead of snow can lead to elevated winter peak flows which can scour the streambed and destroy salmon eggs (Battin *et al*. 2007, Elliot *et al*. 1998). Increased sea levels in combination with higher winter river flows could cause degradation of estuarine habitats through increased wave damage during storms (NSTC 2008). Since juvenile Atlantic salmon are known to select stream habitats with particular characteristics, changes in river flow may affect the availability and distribution of preferred habitats (Riley *et al*. 2009). Unfortunately, the critical point at which reductions in flow begin to have a damaging impact on juvenile salmonids is difficult to define, but generally flow levels that promote upstream migration of adults are likely adequate to encourage downstream movement of smolts (Hendry *et al*. 2003).

It is anticipated that these climate change effects could significantly affect the functioning of the Atlantic salmon critical habitat. Increased temperatures will affect the timing of upstream and downstream migration and make some areas unsuitable as temporary holding and resting areas. Higher temperatures could also reduce the amount of time that conditions are appropriate for migration (<23° Celsius), which could affect an individual's ability to access suitable spawning habitat. In addition, elevated temperatures will make some areas unsuitable for spawning and rearing due to effects to egg and embryo development.

6. CONSEQUENCES OF THE ACTION

Effects of the action are all consequences to listed species or critical habitat that are caused by the proposed action, including the consequences of other activities that are caused by the proposed action. A consequence is caused by the proposed action if it would not occur but for the proposed action and it is reasonably certain to occur. Effects of the action may occur later in time and may include consequences occurring outside the immediate area involved in the action. (50 CFR § 402.17). This Opinion examines the likely consequences of the proposed action on the GOM DPS of Atlantic salmon and critical habitat designated for the GOM DPS of Atlantic salmon. We consider these consequences on the species and their habitat within the context of the species status now and projected over the course of the action.

We have determined that the effects of the action are the consequences of the continued existence of the dam and the associated impoundment, operations of the hydroelectric facility, maintenance of the facility, FERC's implementation of our mandatory conditions under Section 18 of the FPA, and required studies. We also consider Brookfield's proposed impoundment studies and associated mitigation proposal as a consequence of FERC's proposed action. Consequences of the continued existence of the dam structure, including the resulting continued existence of the project impoundment, are effects of the action. Consequences of the Project through the term of the existing license were considered in the Environmental Baseline of this consultation and also reflected in the Status of the Species.

FERC is proposing to issue a new license for the Mattaceunk Project for a term of 40 years consistent with the FEA's "Staff Alternative with Mandatory Conditions." Specific measures contained in the FEA's "Staff Alternative with Mandatory Conditions" with the potential to affect listed Atlantic salmon and designated critical habitat are described in Section 2 and summarized below:

Operational requirements

1. Operate in a run-of-river mode with 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.

Upstream fish passage requirements

1. Continue to maintain, monitor, and operate the existing upstream fishway annually from May 1 to November 10 for adult Atlantic salmon.
2. Achieve an upstream Atlantic salmon performance standard of 95%. This means that no fewer than 71.25% (i.e., 75% of 95%) of adults pass the project area within 48 hours of approaching the dam (measured from 200 m downstream of the dam), no more than 23.75% (i.e., 25% of 95%) of adults pass the project between 48 and 96 hours, and no more than 5% of adults either fail to pass the project or take more than 96 hours to pass.
3. Conduct up to three years of monitoring to determine whether the upstream performance standard is being achieved.

4. If the Project does not achieve the 95% upstream passage performance standard for adult Atlantic salmon, GLHA will implement an adaptive management plan in consultation with us that includes additional operational, structural, and/or habitat enhancement measures to improve upstream passage.
5. Install, in year 15 of a new license, an upstream fishway for alosines.

Downstream fish passage requirements

1. Continue to maintain and operate 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.
2. Open the project's log sluice (between 3 % [225 cfs] and 9% [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).
3. Install full-depth trash racks with 1-inch clear bar spacing to reduce turbine entrainment of smolts and kelts.
4. Achieve a downstream smolt and kelt Atlantic salmon performance standard of 96%. This means that 96% of smolts and kelts approaching within 200 meters of the dam structure must pass within 24 hours without serious injury or mortality and that no more than 4% of smolts or kelts will suffer serious injury or mortality or take longer than 24 hours to pass downstream once within 200 m of the dam.
5. Conduct a minimum of 3 years of monitoring to evaluate whether the downstream performance standard is being achieved for smolts.
6. If the Project does not achieve the 96% performance standard for downstream passage of smolts, GLHA will implement the following Adaptive Management Plan for downstream passage:
    a. Increase nighttime spill to between 20% and 50% of river flow for three weeks during the smolt outmigration period.
    b. Increase nighttime spill to between 50% and 75% of river flow.
    c. Provide three weeks of 100 percent spill of river flow at night (except for one unit, which will be operated at its lowest possible setting as required for powerhouse startup).
7. Provide downstream passage for alosines after a new upstream fishway for alosines is operational (expected in year 16).

Following implementation of an adaptive management measure to improve either upstream or downstream passage survival (e.g., installation of bar racks, spill, etc.), GLHA must conduct studies to determine whether the performance standards are achieved. Under this adaptive management scenario, GLHA estimates that it could take up to ten years to achieve the upstream and downstream passage performance standards for Atlantic salmon after FERC's issuance of a new license. If, however, after ten years either the upstream or downstream performance standard is not achieved at the project, GLHA will propose additional modifications to improve upstream and downstream passage and request that FERC reinitiate consultation with us to consider the effects of these modifications; depending on the extent of the modifications, a license amendment may be necessary.

As explained in more detail below, we expect that the upstream and downstream performance standards included in the proposed license will be achieved within 10 years of license issuance. Because it will take time to reach these standards, we expect that over the first 10 years of the new license, upstream and downstream passage will, at a minimum, be consistent with the current conditions explained in the Environmental Baseline, and compliance with the above identified standards will be attained no later than year 11 of the license.

6.1. Upstream Fish Passage

To complete their life cycle, pre-spawn Atlantic salmon in the Penobscot River require access to suitable spawning habitat. As discussed in Section 5 above, approximately 35% of all rearing habitat in the Penobscot River watershed occurs upstream of the project; Atlantic salmon must be able to migrate successfully through the fishway at the Mattaceunk Project to access this habitat.

Fishways, in general, collect motivated fish into human-made structures that allow them to proceed in their migration over barriers. These fish are necessarily crowded together into a narrow channel or trap, which exposes them to increased levels of injury and delay, as well as to stress from elevated water temperatures, energetic exhaustion and disease exposure.

There is no surveyed spawning or rearing habitat for Atlantic salmon within the action area. While a GIS-based Atlantic salmon habitat model developed by the USFWS (Wright, J., et al. 2008) predicts rearing habitat upstream and downstream of the Mattaceunk Project, this habitat is low quality and not productive and not expected to produce fry. Therefore, as the only life stage of salmon that will be attempting to move upstream past the dam are adults, the following section focuses on upstream passage of adult Atlantic salmon in the action area.

6.1.1. License Years 1-10

As stated above, and elaborated on below, GLHA estimates that up to 10 years of monitoring and adaptive management could be needed to achieve the upstream performance standard of 95%. While we expect upstream passage for salmon to improve at the project during this period, for purposes of this analysis, we assume the effects of proposed action on upstream passage of adult Atlantic salmon during the first 10 years of the license would be, at a minimum, the same as those that are experienced under the current license, consistent with the description in Section 4. Here, we summarize these effects as part of the first 10-year period of the license whereby GLHA is trending towards achieving the performance standards at the Mattaceunk Project.

The best available information indicates the existing upstream fishway at the project has a minimum efficiency of 71% (that is, 71% of adults are expected to pass upstream). Assuming maintenance of at least this level of efficiency over the first 10-years of the new license, up to 29% of pre-spawn Atlantic salmon that occur in the Mattaceunk project area will not successfully pass upstream due to the inefficiencies of the current upstream passage facility (Table 10). Adult salmon that are unable to safely pass the Mattaceunk Project via the existing upstream fishway will either spawn in downstream areas, return to the ocean without spawning, or die in the river. Although no studies have looked directly at the fate of fish that fail to pass through upstream fish passage facilities on the Penobscot River, we convened an expert panel in 2010 to provide the best available information on the fate of these fish. The panel was comprised of state, federal, and private sector Atlantic salmon biologists and engineers with expertise in Atlantic salmon biology and behavior at fishways. The group estimated a baseline mortality rate of 1% for Atlantic salmon that fail to pass a fishway at a given dam in the Penobscot River watershed (NMFS 2011, Appendix A). The expert panel concluded that most adult Atlantic salmon that do not use the upstream fishway at the Mattaceunk Project will stray and successfully spawn in downstream areas such as the Mattawamkeag River. As such, of the 29% of Atlantic salmon adults that do not successfully pass upstream of the dam, we expect 1% to die (i.e., 0.29% of the total run of pre-spawned salmon in the action area) and 99% to spawn successfully downstream of the project (Table 10). While the amount of anticipated mortality is low, even in this 10 year period, there will be fewer salmon utilizing habitats upstream of the dam than would be absent the dam or if the 95% standard was attained more quickly because in both of those cases, more adults would have access to spawning habitats upstream of the dam.

As described previously, migratory delay at dams can, individually and cumulatively, affect a salmon's ability to access suitable spawning habitat within the narrow window when conditions in the river are suitable for migration. In addition, delays in migration can cause over-ripening of eggs, increased chance of egg retention, and reduced egg viability in pre-spawn female salmonids (de Gaudemar & Beall, 1998). Delay causes adverse energetic effects that may reduce the likelihood that salmon will successfully spawn and outmigrate to the estuary. A small increase in energy expenditure could affect an individual's ability to spawn, or reduce the likelihood that they could survive to spawn in a subsequent year. Adult salmon do not feed in the river when they return to spawn, thus their available energy for migration to the spawning site, spawning activity, and outmigration to the ocean following spawning is limited. The amount of energy used during migration likely varies based on the length of the migration and the environmental conditions in the river. Salmon that migrate under warmer conditions use more energy than those that migrate under cool conditions. Delay associated with ineffective passage at dams may force salmon to spend more time in warm water, which increases the energy costs of migration. If the cumulative effects of delay in a river system increases the energetic expenditure above the 80% threshold identified by Glebe and Leggett (1981), it is likely that would reduce the potential that an individual adult Atlantic salmon would return to spawn in subsequent years.

As indicated previously, we do not currently have information regarding the amount of migratory delay that would lead to a significant reduction in the energy stores of an individual salmon. Lacking specific information, we conservatively assume that 48 hours per dam allows sufficient time for an adult to locate and utilize a well-designed fishway without being delayed to the point that the energetic cost would result in a significant disruption to normal behavioral patterns (i.e., spawning and/or successful outmigration following spawning). We further assume that any salmon that takes more than 48 hours to pass a dam will use more energy than they would naturally, which could lead to a reduction in the energy needed for spawning, and may preclude repeat spawning (i.e., iteroparity).

It is presently unknown what level of delay occurs for adults at the Mattaceunk Project. As explained in section 4.2, based upon data collected at other dams in the GOM DPS, we assume that under existing conditions at the Mattaceunk Project, 50% of the salmon that pass the project will take more than 48-hours to pass. Therefore, over the first 10 years of the new license, we expect that 50% of adults will take longer than 48 hours to pass upstream. The consequences to Atlantic salmon of this delay is addressed below.

6.1.2. Years 11-40

The new FERC license for the Mattaceunk Project will require GLHA to safely pass 95% all pre-spawn Atlantic salmon that attempt to pass the project. This means that 95% of all adults will pass upstream without serious injury or mortality within 96 hours of reaching a distance of 200 m below the dam and that of those fish, 75% will pass within 48 hours. Once this standard is achieved, no more than 5% of pre-spawn salmon will either fail to pass successfully upstream of the project annually or will take longer than 96 hours to pass the project. Of the 5% of Atlantic salmon that do not successfully use the upstream fishway, 1% will die (i.e., 0.05% of the total run of pre-spawned salmon in the action area). The remaining 4% are likely to successfully spawn downstream of the project (Attachment A). We expect the project to operate from years 11-40 in attainment of these performance standards (Table 10). Once met, this standard represents a significant improvement in passage efficiency over current operating conditions, reducing the percentage of adult salmon that are not expected to pass upstream of the project from 29% to 5%.

As indicated in our June 28, 2018 Modified Section 18 Fishway Prescription for the Mattaceunk Project, we will consider the upstream passage performance standard of 95% achieved if: 1) 75% of the adult test fish that pass the project do so within 48 hours of approaching the dam; and 2) the remaining 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. Minimizing total delay at the project to no more than 96 hours will help to ensure adult salmon do not lose significant energetic reserves to promote successful spawning in upstream reaches of the Penobscot River. Since the existing upstream fishway at the project provides volitional passage, salmon that pass the project are not subjected to any handling and therefore no injury is anticipated. Our June 2018 Section 18 fishway prescription for the Mattaceunk Project does not provide for any trapping facilities for the new fishway which will be built in year 15 of the new project license; therefore, we do not expect that any Atlantic salmon using the new fishway will need to be handled to pass the project.

It is reasonable to expect that the 95% performance standard can be achieved within 10-years of issuance of the project license. We note that this means that we expect the 95% standard can be achieved with the existing fishway alone as well as with the new fishway required for construction by year 15 of the license. There are several potential measures that could be implemented at the project to improve upstream passage if necessary, including increasing attraction flow and adding additional entrances. These measures would each be expected to increase efficiency and/or reduce delay and contribute to attainment of the standard and could be implemented by GLHA in a timely fashion within the first 10 years of the new license. For comparison, since constructing the new upstream fishway at the Milford Project, GLHA has conducted studies and implemented adaptive management to achieve effectiveness of over 95% for adult Atlantic salmon (i.e., meaning that at least 95% of adults are passing upstream without serious injury or mortality). GLHA is, however, still addressing issues concerning delay of adult salmon passing the Milford Project. GLHA is currently developing a proposal to reduce delay of adult salmon at Milford that will be implemented following consultation with us and approval by FERC.

Summary of Upstream Passage for Adults

NMFS Interim Guidance on the ESA Term "Harass" (PD 02-110-19; December 21, 2016[6] provides for a four-step process to determine if a response meets the definition of harassment. The Interim Guidance defines harassment as to "[c]reate the likelihood of injury to wildlife by annoying it to such an extent as to significantly disrupt normal behavioral patterns which include, but are not limited to, breeding, feeding, or sheltering." The guidance states that NMFS will consider the following steps in an assessment of whether proposed activities are likely to harass: 1) Whether an animal is likely to be exposed to a stressor or disturbance (i.e., an annoyance); 2) The nature of that exposure in terms of magnitude, frequency, duration, etc. Included in this may be type and scale as well as considerations of the geographic area of exposure (e.g., is the annoyance within a biologically important location for the species, such as a foraging area, spawning/breeding area, or nursery area); 3) The expected response of the exposed animal to a stressor or disturbance (e.g., startle, flight, alteration [including abandonment] of important behaviors); and; 4) Whether the nature and duration or intensity of that response is a significant disruption of those behavior patterns which include, but are not limited to, breeding, feeding, or sheltering, resting or migrating.

Here, we carry out the four-step assessment for determining harassment. We have established that prespawn adult salmon will encounter the Mattaceunk Dam and that it will result in a disruption of their upstream migrations (step 1). We expect that 50% of prespawn adults will be delayed by more than 48 hours prior to the performance standard being achieved (year 11 of the license); whereas 25% will be delayed by more than 48 hours after the attainment of the performance standard (step 2). We have established the expected response of the exposed adults (step 3). Individual adults delayed more than 48 hours during their upstream migration will need to expend additional energy possibly under adverse river conditions (e.g., warm water), which will reduce the energy reserves available for successful spawning, and potentially affect their ability to survive to spawn in future years. Finally, we establish that the nature and duration of the response is a significant disruption of migration (step 4). Based on this four-step analysis, we find that individual prespawn adults delayed cumulatively for more than 48 hours at the Mattaceunk Project during their upstream migration are likely to be adversely affected and that consequence meets the definition of harassment. Therefore, prior to the implementation of improved fish passage and verification of the performance standards (within 10 years of license issuance), we anticipate that up to 50% of salmon adults that pass the Project will be exposed to significant delay (i.e., take more than 48 hours to pass the dam), which we consider to meet the definition of harassment. After the attainment of the performance standard (year 11 to license expiration) we expect that the amount of delay will be reduced and that 25% of adults will take more than 48 hours to pass the Project.

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6 Available at: https://www.fisheries.noaa.gov/national/laws-and-policies/protected-resources-policy-directives

As defined above, we consider “harm” in the definition of “take” as “an act which actually kills or injures fish or wildlife. We have determined that delay of greater than 48 hours would significantly disrupt the behaviors of individual adults. Migratory delay can potentially impair essential behavioral patterns to the point that injury or mortality could occur as a result (e.g., an adult could die either before or after spawning because of the energy loss associated with migratory delay). The distance to abundant spawning habitat mapped by MDMR in the East Branch of the Penobscot and Wassatoquoik Stream (~50 kilometers from the Mattaceunk Dam) is relatively short, and there are other tributaries (e.g., Meadow Brook, Salmon Stream, Tots Brook) that contain a significant amount of modelled rearing habitat that are significantly closer to the dam. Therefore, we anticipate that fish delayed between 48 and 96 hours during their upstream migration will be less likely to fully deplete their energy reserves to the point that injury or mortality occurs. However, as salmon that approach the Mattaceunk Project have already migrated through 140 kilometers of riverine habitat and have been delayed by at least two other dams, including one (i.e., Milford) that has an average migratory delay of 10.5 days, we expect that further delay could potentially lead to mortality. Therefore, we anticipate that any salmon that take more than 96 hours to pass the Mattaceunk Dam may deplete its energy reserves to the point that it may die, either before or after spawning. For these reasons, we consider delay greater than 96 hours to meet the definition of harm. Given the proposed performance standard, we expect that no more than 5% of prespawn salmon would be delayed for more than 96 hours from year 11 to 40 of the license.

Table 10. Summary of upstream passage effects on Atlantic salmon adults at the Mattaceunk Project.

	Interim Years 1-10	Performance Standard Years 11-Exp.
Unsuccessful Passage	29%	5%
Overall Mortality	0.29%	0.05%
Delay (% pass in more than 48 hrs.)	50%	25%

6.2. Downstream Fish Passage

To complete their life cycle, Atlantic salmon smolts must survive the migration from freshwater to the marine environment in a timely manner. Delays in migration can significantly affect survival of smolts as they transition from freshwater to saltwater habitat (McCormick et al., 1999). Since Atlantic salmon are an iteroparous species, it is important to ensure that post-spawn adults can safely return to the ocean after spawning. Also, the timing of entry to the marine environment is extremely important for smolt survival As discussed in Section 3.4 above, dams affect downstream migrating Atlantic salmon smolts and kelts by: 1) injury and mortality associated with entrainment through project facilities, 2) delayed outmigration influencing outmigration timing, 3) potentially increased predation on outmigrating juveniles in the project impoundment and tailrace, and 4) increasing stress levels, which leads to a subsequent decrease in saltwater tolerance (Fay et al. 2006).

6.2.1. Years 1-10

The existing effects of the Mattaceunk Project on downstream passage for Atlantic salmon are discussed in the Environmental Baseline (Section 4). During the first 10 years of the new license we expect that survival of downstream migrating salmon will, at a minimum, be equivalent to survival under existing conditions. Here we summarize the consequences of existing conditions during the 10 year period in which GLHA is trending towards achieving the performance standards at the Mattaceunk Project.

Smolts

Based upon the best available data as presented in Section 4, smolt survival over the Mattaceunk Project dam ranges from 89.3% to 100.0%, depending on river conditions (flow) and route selection (measured from 200 m upstream of the dam). Median migration time for smolt to pass the project dam was 0.24 hours under existing conditions. Delays of smolts moving through the project impoundment was documented by the University of Maine in 2014 and 2015 (Stich et al. 2015); however, we cannot distinguish between delays caused by the impoundment versus delays caused by disorientation of test fish. Despite this, the data represents the best available information concerning the delay and survival of Atlantic salmon smolts during their downstream migration over the Mattaceunk Dam (i.e., from a distance of 200 m above the dam). In addition to direct mortality of smolts, indirect mortality of smolts can occur during their migration through the river due to sub-lethal injuries, increased stress, predation, and/or disorientation following passage at the dam (Alden 2012). While some smolts that survive passage at the project could experience non-lethal stress or injury, there is no data available to quantify these effects. Smolts that experience non-lethal stress or injury from downstream passage at the project could later succumb to their injuries downstream of the dam, be subject to predation due to their reduced fitness, or continue their migration unaffected. Alden (2012) estimated that indirect mortality of smolts could be 0.5% for each available passage route (spillway, bypass, and turbines) at the Mattaceunk Project. Thus, over the first 10 years of the license, we expect no more than 10.7% (10.2% direct and 0.5% indirect) of downstream migrating smolts to die due to passage at the project (total survival of at least 89.3%, as measured from 200 m upstream of the dam)(Table 11).

In section 5.1, we describe the ongoing migratory delay currently caused by the Mattaceunk Project. Based upon data collected in 2014 and 2015, smolts approaching within 200 meters of the project dam do not experience significant delay. The median migration time was 0.24 hours for smolts approaching the dam in 2014 and 0.3 hours in 2015. In 2014, approximately 3% of smolts required longer than 24 hours to pass the project dam. In 2015, approximately 8.8% of smolts required longer than 24 hours to pass the dam (Table 11).

Studies conducted in 2014 and 2015 also documented rate of movement for smolts traveling through the 12.5 km Mattaceunk Project impoundment. The rate of movement of smolts through the impoundment ranged from 25.9 hours (median) in 2014 to 50.0 hours (median) in 2015. However, since the data cannot distinguish between delay cause by the project impoundment and delay that test fish experience through disorientation following release directly into the impoundment during the 2014 and 2015 studies, we do not have any estimates of smolt delays caused by the impoundment itself. Effects of the impoundment on smolts are considered below in Section 6.2.3.

We do not know specifically what amount of downstream passage delay at a given dam will lead to reduced fitness, the missing of the physiological smolt window, or an increase in hydrosystem delayed mortality. The threshold of effect likely varies significantly by river flow and temperature. Regardless, we expect that 24 hours provides adequate opportunity for smolts to locate and utilize well-designed downstream fishways at hydroelectric dams. A 24-hour period would allow these migrants an opportunity to locate and pass the fishway during early morning and dusk, a natural diurnal migration behavior of Atlantic salmon. Passage times in excess of 24 hours per dam would result in unnatural delay for migrants, in addition to an increased energetic cost and stress, which could potentially lead to increased predation and may also lead to reduced fitness in the freshwater to saltwater transition. It is important to note that a 24-hour delay at the Mattaceunk Project is not expected to be long enough to cause a smolt to miss the smolt migration window.

Here, we carry out the four-step assessment detailed in section 6.1 to determine whether or not the anticipated delay meets the definition of harassment. As we did above, we carry out the four step process to make this determination. We have established that all outmigrating smolts in the action area will encounter the Mattaceunk Project and these smolts will experience a disruption of their downstream migrations (step 1) and that up to 8.8% of smolts approaching within 200 meters of the dam will be delayed over 24 hours (step 2). We have established the expected response of the exposed smolts (step 3): individual smolts delayed more than 24 hours at the Mattaceunk Project dam during their downstream migration will need to expend additional energy searching for a passage route; this is expected to result in physiological stress and will increase the time the individual is exposed to predators; this delay is also expected to affect an individual's ability to successfully make the transition to saltwater. Finally, as indicated in Step 3, we establish that the nature and duration of the response is a significant disruption of migration (step 4). Based on this four-step analysis, we find that individual smolts delayed for more than 24 hours at the Mattaceunk Project dam are likely to be adversely affected and that effect amounts to harassment. Therefore, in Years 1 – 10 of a new license, we anticipate that up to 8.8% of salmon smolts that pass the project will be exposed to significant delay (i.e., take more than 24 hours to pass the final 200 m above the dam the dam), which we consider to meet the definition of harassment.

As explained in section 4.3.1, some of the smolt mortality that occurs in Penobscot Bay downstream of the Mattaceunk Project is attributable to the delayed effects of dam passage. Stich et al. (2015) determined that this delayed hydrosystem mortality equates to 6% per dam in the Penobscot River. The factors that cause this mortality are believed to be associated with cumulative migratory delay and injury associated with dam passage (Stich et al., 2015). We lack information regarding the relative degree to which these two factors affect delayed mortality, or how much of a reduction in either one would lead to a corresponding reduction of the effect. Therefore, we anticipate that hydrosystem delayed mortality will result in the mortality of approximately 6% of smolts annually passing the Mattaceunk Project. As explained above, these smolts are likely to die in the estuary.

Parr

There is no suitable parr habitat in the Mattaceunk Project impoundment. Therefore, because we do not expect parr to occur in the action area, we do not anticipate that parr will pass downstream of the Mattaceunk Project.

Post-Spawned Adults (Kelts)

As stated above, we assume it could take up to 10 years of monitoring and adaptive management to achieve the downstream kelt performance standard of 96%. While we expect downstream passage for kelts to improve at the project during this period, for purposes of this analysis, we assume the consequences of the proposed action on the downstream passage of kelts during the 10-year adaptive management period would be the same as the survival rates kelts experienced during current operating conditions described in Section 4.

Based upon the best available data presented in Section 4, kelt survival at the Mattaceunk Project is expected to range from 75.8% to 96% under existing conditions. This data represents the best available information concerning the survival of kelts during their downstream migration through the Mattaceunk Project area. While some kelts that survive passage at the project may experience stress or injury, there is no site-specific data available to quantify these effects.

6.2.2. Years 11-40

The new FERC license for the Mattaceunk Project will require GLHA to safely pass 96% all smolts and kelts migrating through the project area within 24 hours of approaching the Mattaceunk Project dam. Once this standard is achieved, no more than 4% of all smolts and kelts will be killed passing downstream at the project (Table 11). We expect the project to operate from 2021 to 2060 under these performance standards. When analyzing telemetry test data, individual smolts 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). Consistent with the four-step assessment taken above to assess the effects of delays on smolts, we expect no more than 4% of smolts that pass the project will be exposed to significant delay (i.e., take more than 24 hours to pass the dam), which we consider to meet the definition of harassment.

In addition, we anticipate that up to 6% of smolts passing the Mattaceunk Project may die due to dam-related estuary mortality as described by Stich et al. (2015) and Nieland and Sheehan (2020). We anticipate that 6% may be a conservative estimate as we expect that the proposed downstream improvements will reduce migratory delay, which is one of the causative factors of hydrosystem delayed mortality; however, at this time we are not able to predict the extent to which the anticipated reduction in delay at the Weldon project would reduce mortality experienced in the estuary.

The new license requires a number of measures to improve downstream survival including operating the log sluice with 3-9% of station capacity for the 3 week smolt migration period in the spring. This is expected to increase survival of smolts by providing an additional route of passage. The license also requires installation of full depth 1” racks which will directly reduce entrainment in the turbines, which minimizes an existing source of mortality. If these two measures do not achieve the 96% standard, a spill program will be implemented which has proven to be an effective method at increasing smolt survival at other projects. If the standard is not achieved within 10 years of FERC’s issuance of a new license, GLHA will propose modifications to improve upstream and downstream passage and will request that FERC reinitiate section 7 consultation with us to assess the effects of these modifications on Atlantic salmon; depending on the extent of the modifications, a license amendment may be necessary.

Reducing generation to increase spillage flows has been demonstrated to significantly improve survival and reduce delays of downstream migrating Atlantic salmon smolts at other projects in the Penobscot River. In five years, Brookfield Power was able to increase smolt survival at the West Enfield, Orono, Stillwater, and Milford Project by an average of almost 10% (range 7.6% to 11.7%) through the use of a similar adaptive management approach using spillage to protect Atlantic salmon. While we are still reviewing the data, it appears that two of the projects (Stillwater and Milford) may be achieving the downstream smolt performance standard of 96% survival based upon three years of studies (GLHA 2018). Preliminary data also indicate that the smolt performance standard of 96% survival was reached in two years of studies at the West Enfield and Orono Projects. Prior to implementing seasonal turbine shutdowns at the Howland Dam, the probability of survival through the reach ranged from 75% to 92% (Stich et al. 2015). Following turbine shutdowns and increased spill at Howland, smolt survival increased by almost 8%. This demonstrates that at many projects spill is an effective method for increasing survival of downstream migrating smolts.

Based on this, it is reasonable to expect that GLHA will achieve compliance with the 96% standard for smolts and kelts within the first 10 years of the license and that once achieved, no more than 4% of downstream migrating smolts or kelts will die at the project. Also, the 96% standard assumes that these fish will not experience any significant delay (i.e., >24 hours) passing the Mattaceunk Dam.

6.2.3. Downstream Passage - Consequences of Impoundment Operation, and GLHA Mitigation Plan

As discussed in Section 5 above, data on smolt studies in the Mattaceunk Project impoundment carried out in 2012, 2013, and 2014 by Stich et al (2015) and 2015 by HDR (2015) provide the best estimate of the mortality rate for smolts migrating downstream through the impoundment. Based upon this data, we expect that project-related impoundment mortality under current conditions ranges from 5.1% to 8.7%. This level of mortality in the impoundment equates to 2.7% mortality per kilometer compared to 0.80% mortality per kilometer in free-flowing sections of the Penobscot River (Stich et al. 2015a and 2015s). Based on these rates of mortality per kilometer for smolts, cumulative survival is lower through the project impoundment compared to a free-flowing reach of the same length. Therefore, but for the existence of the Mattaceunk Project, more Atlantic salmon smolts would survive migrating through the project impoundment. Higher rates of smolt mortality in the Mattaceunk Project impoundment is likely related to increased predation and migratory delays that result from the conditions created by the impoundment which would not exist but for the continued existence of the dam.

The number of smolts produced upstream of the Mattaceunk Project is presently unknown and inconsistent from year to year due to natural variability and variability in annual stocking. This variability is expected to continue over the license term, however, we expect the number of smolts produced upstream of the project to increase as survival of Atlantic salmon improves at the project. We also expect the number of smolts to increase throughout the Penobscot River via the implementation of improvements to fish passage at downstream hydropower projects. Increased smolt abundance will, over time, lead to increased numbers of adult returns to the river as a greater number of smolts in the river means that more smolts leave the river and can mature to adulthood and eventually return as pre-spawn adults. Based upon past conservation hatchery stocking upstream of the Mattaceunk Project (average of 557,000 fry per year), estimated fry to smolt survival in the Penobscot River (5.2%; NEFSC 2012; meaning that of 557,000 fry stocked, approximately 28,964 will survive to the smolt stage), and the 5.1- 8.7% dam- related mortality rate in the impoundment, we estimate that under existing conditions, between 1,477 and 2,520 smolts would be killed annually due to impoundment effects. We note that not all of the smolts produced in the East Branch of the Penobscot River will reach the Mattaceunk Project impoundment due to predation and other natural mortality factors; thus, our estimate of the number of smolts actually killed at the project annually is conservative. Nevertheless, over the course of a new 40-year license, the number of smolts that could be killed because of the Mattaceunk Project impoundment is expected to increase as the number of smolts upstream of the project increases. There are approximately 55,700 units of modeled rearing habitat of varying quality upstream of the Mattaceunk Project. According to Baum (1997), one unit of rearing habitat could produce from 1 to 3 smolts annually. Therefore, based on the amount of potential habitat upstream of the project, and assuming for the purposes of this analysis it is all productive, the potential smolt production in rearing habitat upstream of the Mattaceunk Project could range from 55,700 to over 150,000 annually if all of the available habitat was being utilized. As an example of the potential impacts of impoundment mortality, if these numbers of smolts were migrating through the action area, we would anticipate the death of approximately 2,840 to 13,000 smolts annually due to impoundment mortality (assuming impoundment mortality of 5.1-8.7%). Based on current adult return rates to the Penobscot of approximately 0.2% (10-year average as reported in USASAC 2019) or 2 adults for every 1,000 smolts, the mortality of smolts in the Mattaceunk impoundment could result in 3 to 26[7] fewer adult returns to the Penobscot River annually than would occur absent the impoundment (or modifications that resulted in smolt mortality in the impoundment equal to an unimpounded reach of the river). However, it is important to note that as the majority of smolts considered in the 0.02% adult return rate are stocked below the Milford Dam, this return rate likely greatly overestimates potential adult return rate to the Mattaceunk project area as smolts migrating from the project area must pass through 3-4 dams and the direct and indirect mortality associated with that downstream passage is not accounted for in this adult return estimate.

In the August 31, 2016, final license application filed with FERC, GLHA proposed to conduct a study to evaluate smolt mortality in the Mattaceunk Project impoundment and to implement

[7] Based on the anticipated smolts resulting from current fry stocking practices (28,964), the smolt mortality rate in the impoundment, and an adult return rate of 2 per 1,000 smolts, this loss of smolts is equivalent to 3 to 5 adult returns; considering a scenario with full habitat utilization, the smolts killed (2,840-13,000) would be equivalent to 6 to 26 adult returns.

additional operational, and structural, and/or habitat enhancement measures as needed to adequately minimize and mitigate for project consequences on upstream and downstream migrating Atlantic salmon, including in the impoundment. As explained above, we interpret "adequately mitigate or minimize" to mean achievement of a "no net loss" standard; that is, either minimizing mortality in the impoundment so that it is no greater than the background mortality experienced by smolts in free-flowing reaches of the Penobscot River, or else enhancing the population via habitat improvement leading to increased smolt production that would reduce the population level impact of the loss of smolts migrating through the impoundment. These measures were detailed in the final license application as well as a Species Protection Plan appended to the application. While FERC is not proposing to include these measures as requirements of the new license, GLHA has confirmed to us and to FERC that they intend to carry out these studies and to mitigate for the loss of smolts in the impoundment. Because we consider this reasonably certain to occur, and there is no higher standard required for consideration of mitigation or other beneficial activities, we consider the consequences of this proposal here.

As described in our June 28, 2018 comment letter to the FERC, GLHA has proposed to develop a mitigation plan for the loss of Atlantic salmon smolts that result from maintaining the project impoundment as necessary following the completion of impoundment smolt survival studies. We expect the studies of impoundment mortality to be a component of the downstream smolt performance studies discussed in 7.2 below. As there will be no need for any additional study fish to complete the impoundment survival studies, all effects resulting from proposed impoundment studies are considered in that section. It is necessary to conduct the studies prior to identifying minimization or mitigation measures that will be included as part of the actual plan. The minimization/mitigation plan will be developed in consultation with us and other state and federal resource agencies. The mitigation plan must detail the schedule and proposed measures for minimizing and/or mitigating the loss of Atlantic salmon smolts in the project's impoundment. A draft of the plan will be provided to the resource agencies within one year of the completion of the studies. If the studies confirm that mortality in the impoundment is above background levels as measured in an appropriate free-flowing control reach during the study, we will conclude that mitigation is warranted and must be initiated the following year. A period of 10 years to initiate any mitigation measures is appropriate since there is the potential for smolt studies to be conducted for up to nine consecutive years at Mattaceunk Project in order to achieve the downstream performance standard. This timing is appropriate because we expect the studies will provide information that will allow for a better understanding of the source of losses of smolts in the impoundment and identification of methods to reduce that mortality. We expect the mitigation plan would cover the duration of the project license and include measures that would: (a) 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, (b) increase the number of smolts in the project area such that a "no net loss" standard is achieved. Measures that could increase the number of smolts in the project area could include habitat restoration projects in areas upstream of the Weldon Dam that either restore access to habitat or otherwise create conditions that result in increased productivity. GLHA's September 3, 2019, letter to us reaffirmed this commitment to developing and executing a mitigation plan for the loss of smolts from the effects of operating the project impoundment.

Implementing the mitigation plan is expected to offset loses of smolts caused by the existence and operation of the project impoundment. Minimization measures would reduce or eliminate the causes of increased mortality in the impoundment such that levels of smolt loss would be comparable to free flowing reaches of the river. This would result in an increase in the number of smolts successfully outmigrating through the action area to the ocean. Alternatively, if measures cannot be identified or implemented that fully reduce the amount of mortality in the impoundment to background levels (i.e., equivalent to an un-impounded reach of the Penobscot River) habitat enhancement measures and/or habitat restoration activities would be implemented. The measures will be designed to increase the abundance of smolts in the action area to compensate for those lost due to impoundment effects. The licensee will need to develop a mitigation proposal that bases the scale of the offset on the mortality rate determined from the studies and on the amount of that mortality that was not able to be minimized through project modifications. For example, if the studies indicated that 8.7% of smolts were lost in the impoundment due to project operations and 2.7% of that mortality could be eliminated through project modifications, the mitigation proposal would need to be designed to either restore access to rearing habitat capable of producing the remaining number of smolts anticipated to be killed or otherwise improve the productivity of accessible rearing habitat to improve smolt production to an equivalent amount. In this example, compensation would be required for 6% of smolts. To determine the amount of habitat access or improvement that would be required for such compensation, we would consider potential smolt production above the dam to estimate the number of smolts that would be expected to migrate through the impoundment. For example, we could determine that, based on the availability of rearing habitat upstream of the dam (55,700 units) and anticipated smolt production of 1 to 3 smolts per unit, there is the potential for 55,700 to 167,100 smolts to migrate through the impoundment. Mitigation for 6% of those individuals (up to 10,026) would require either: restoration of access of an equivalent number of habitat units (10,026 units (100m^2 per unit) which is approximately 1 km^2 of rearing habitat; or, habitat modifications to increase productivity of accessible habitat designed to result in an equivalent increase in the number of smolts in the action area.

This mitigation would increase the number of smolts moving through the impoundment, which would reduce the population level effects of impoundment mortality. That is, it would offset the loss of smolts due to impoundment mortality and the subsequent loss of the associated adult returns. Following on the example above, and using a 0.2% smolt to adult return rate (10 year average reported in USASAC 2019), the 10,026 smolt mortalities would result in 20 fewer potential adults returning to the action area; the mitigation plan would be designed to avoid that loss of potential adult returns.

Habitat enhancement or restoration could increase the abundance of smolts migrating through the impoundment; however, the mortality rate depends on operational minimization measures at the dam or in the impoundment. Regardless, in any scenario, more smolts would be successfully outmigrating through the action area than occurs under current conditions. Both minimization and mitigation ultimately serve the same purpose: to increase the numbers of smolts outmigrating in the Penobscot River. Based on GLHA’s commitment to conduct the studies and attendant additional measures to adequately mitigate for project consequences, we consider these measures to be reasonably certain to occur.

Studies to further characterize mortality in the impoundment and to develop minimization and/or mitigation measures are expected to be completed within 8 years of license issuance. We expect that any identified measures to reduce mortality will be implemented by year 10 of the new license. However, if habitat enhancement is part of the mitigation strategy, full implementation may take additional time (e.g., time will be needed for salmon to utilize any newly accessible habitat and for smolts to be produced within that habitat). As such, for any years that full mitigation of impoundment losses are not realized, smolt stocking will be implemented to offset the calculated loss of smolts in the impoundment (i.e., stocking of 4,800 – 13,000 smolts). Any proposal for stocking would require careful consideration and would need to be considered at least one year in advance of the 10-year milestone to achieve no net loss of smolts in the project impoundment. We address the need to prepare a stocking plan in section 10.2 (Reasonable and Prudent Measures) of this Opinion. At this time, we expect any plans for stocking would be on an interim basis until enhancement measures can be fully implemented. Based on this, starting in year 10 of the project license we expect that either: the loss of smolts in the impoundment will have been minimized so that mortality rates in the impoundment are equivalent to an unimpounded reach of the Penobscot River; or, the number of smolts in the action area has been increased to compensate for the anticipated mortality of smolts in the impoundment (i.e., up to 13,000 smolts/year) through habitat enhancement resulting in increased smolt production, or in the short-term, through stocking. This minimization and/or mitigation approach is expected to translate into an increase in potential adult returns of 2-26 individuals/year from year 11-40 of the project license.

Table 11. Summary of downstream passage consequences on Atlantic salmon smolts and kelts at the Mattaceunk Project.

	Interim Years 1-10	Performance Standard Years 11-Exp.
Downstream Passage Mortality	10.7%	4.0%
Impoundment Mortality	8.7%	No Net Loss
Delayed Mortality	6%	6%*
Delay (% pass in more than 24 hrs.)	8.8%	4.0%

*This is a conservative estimate. We expect the attainment of downstream passage standards will lower delayed mortality of smolts.

6.3. Other Consequences of Dam Operations

Under the new FERC license, the Mattaceunk Project will be operated in a run-of-river mode with a year-round continuous minimum base flow of 1,674 cfs or inflow, whichever is less. From July 1 through September 30, the project will operate with a daily average minimum flow of 2,392 cfs, or average inflow, whichever is less. From October 1 through June 30, the project will operate with a daily average minimum flow of 2,000 cfs, or average inflow, whichever is less. Operating the Mattaceunk Project in run-of-river mode provides nearly natural flows and prevents rapidly fluctuating water levels from occurring downstream of the project, which prevents stranding of migrating Atlantic salmon or dewatering of habitat downstream the project.

In 2014, GLHA conducted a minimum flow aquatic habitat study at the Project in support of the FERC relicensing activities. This study found that, under the Project's currently-licensed minimum flows, the reach of river directly downstream of the Mattaceunk Project provides adequate habitat to support aquatic life and a zone of passage for fish migration. These conclusions are based on habitat mapping and transect profile data, which together show extensive connectivity of deep-water habitats along both shorelines – these deep water habitats also extend well into the channel. Based on past monitoring and maintenance of run of river requirements, we do not anticipate any negative consequences to salmon from water manipulations.

6.4. Maintenance Activities

GLHA performs regular facility maintenance at the Mattaceunk Project to ensure safe operations throughout the year, including fish passage facility maintenance. Routine maintenance activities include flash board replacement and inspections and raking of the trash racks upstream of the powerhouse. None of these maintenance activities are expected to impact Atlantic salmon. GLHA is required to consult with us on any changes in operation including maintenance activities and debris management at the project to ensure the protection of Atlantic salmon in the action area.

GLHA is required to construct the new fishway at the Mattaceunk Project in year 15 of the new FERC license. Prior to construction, FERC must approve the engineering plans for the fishway. GLHA will also need to obtain an Army Corps of Engineer's permit for any in-water construction. The issuance of this permit would be a discretionary Federal action subject to the requirements of ESA section 7. Because no plans are available for the new fishway, any consequences of construction are unknown at this time and are not reasonably certain to occur and cannot be analyzed here. If it is determined that the construction of the new fishway may affect Atlantic salmon or their critical habitat, this consultation may need to be reinitiated to consider those consequences.

6.5. Consequences of Required Monitoring

Under the proposed action, numerous measures will be implemented to minimize project effects on Atlantic salmon passage in the action area. In order to determine the effectiveness of the performance measures, GLHA must conduct multiple upstream and downstream survival studies at the Mattaceunk Project.

The downstream smolt survival studies will involve obtaining Atlantic salmon smolts from GLNFH, surgically implanting radio transmitter tags, and then releasing tagged smolts into the Penobscot River. The handling and implantation of radio tags will injure all of the fish used in the studies, and a small proportion will likely be killed. Studies on outmigrating smolts will be conducted after each adaptive measure is implemented. The study period after each measure could be up to three years. An initial three-year study will be conducted, potentially followed by the sequential implementation of two different adaptive downstream passage measures (i.e., spill) if the standard has not been met. This means that there is the potential for smolt studies to be conducted for up to nine consecutive years at Mattaceunk Project. We estimate that each smolt study will use 200 smolts from the GLNFH. Therefore, it is conservatively estimated that

1,800 smolts will be tagged and released as part of monitoring downstream passage success at the Mattaceunk Project.

Upstream passage efficiency studies will be conducted likely using adult Atlantic salmon trapped either at the Mattaceunk Project or the Milford Dam. The adult fish will be gastrically implanted with a radio telemetry tag prior to being released to the river. The handling and implantation of radio tags will injure all of the fish used in the studies. During upstream monitoring of fishways at the Mattaceunk Project, we estimate that up to 50 pre-spawn adults a year will have radio tags gastrically implanted prior to release downstream of the project. We expect GLHA will perform up to three years of upstream passage studies for adult salmon. GLHA will also conduct three years of kelt downstream studies likely using up to 50 post-spawned Atlantic salmon each year. Therefore, it is conservatively estimated that up to 300 adult Atlantic salmon will be tagged and released as part of monitoring upstream and downstream passage success at the Mattaceunk Project.

Radio telemetry will be used as the primary technique for the proposed upstream and downstream passage studies. There are two techniques used to implant fish with radio tags and they differ in both their characteristics and consequences. First, a tag can be inserted into a fish's stomach by pushing it past the esophagus with a plunger. Stomach insertion does not cause a wound and does not interfere with swimming. This technique is benign when salmon are in the portion of their spawning migrations during which they do not feed (Nielsen 1992). In addition, for short-term studies, stomach tags allow faster post-tagging recovery and interfere less with normal behavior than do tags attached in other ways. This is the technique that GLHA will likely use on adult Atlantic salmon for the upstream passage studies.

The second method for implanting radio tags is to surgically place them within the body cavities of (usually juvenile) salmonids. These tags do not interfere with feeding or movement. However, the tagging procedure is difficult, requiring considerable experience and care (Nielsen 1992). Because the tag is placed within the body cavity, it is possible to injure a fish's internal organs. Infections of the sutured incision and the body cavity itself are also possible (Chisholm and Hubert 1985, Mellas and Haynes 1985). This is the technique that GLHA is likely to use on Atlantic salmon smolts for the downstream passage studies.

Fish with internal radio tags often die at higher rates than fish tagged by other means because radio tagging is a complicated and stressful process. Mortality is both acute (occurring during or soon after tagging) and delayed (occurring long after the fish have been released into the environment). Acute mortality is caused by trauma induced during capture, tagging, and release. It can be reduced by handling fish as gently as possible. Delayed mortality occurs if the tag or the tagging procedure harms the animal in direct or subtle ways. Tags may cause wounds that do not heal properly, may make swimming more difficult, or may make tagged animals more vulnerable to predation (Howe and Hoyt 1982, Matthews and Reavis 1990, Moring 1990). Tagging may also reduce fish growth by increasing the energetic costs of swimming and maintaining balance.

All fish used in the proposed studies will be subject to handling by one or more people. There is an immediate risk of injury or mortality and a potential for delayed mortality due to mishandling. Those same fish that survive initial handling will also be subject to tag insertion for identification purposes during monitoring activities. It is assumed that a 100% of the fish that are handled and tagged will suffer injury, and some of these will die due to immediate and long term effects of being trucked, handled and tagged.

All 1,800 Atlantic salmon smolts used in the downstream survival studies will be handled and injured. In addition to the direct and indirect consequences associated with dam passage, a proportion of the smolts are anticipated to be killed due to handling and tagging. in addition. There is some variability in the reported level of mortality associated with tagging juvenile salmonids. NMFS' Northeast Fisheries Science Center documented no immediate mortality while tagging 666 hatchery reared juvenile Atlantic salmon between 1997 and 2005 prior to their release into the Dennys River. After two weeks of being held in pools, only two (0.3%) of these fish were subject to delayed mortality. Over the same timeframe, the Science Center surgically implanted tags into wild juvenile Atlantic salmon prior to their release into the Narraguagus River. Of the 679 fish tagged, 13, or 1.9%, died during surgery (NMFS, unpublished data). It is likely there were delayed mortalities as a result of the surgeries, but this could not be quantified because fish were not held for an extended period. In a study assessing tagging mortality in hatchery reared yearling Chinook salmon, Hockersmith *et al.* (2000) determined that 1.8% (20 out of 1,133) died after having radio tags surgically implanted. Given this range of mortality rates, it is anticipated that no more than 2% of Atlantic salmon smolts will be killed due to handling and tagging during the proposed downstream monitoring over nine years of study.

All adult salmon used in the upstream and downstream passage studies will be harassed and injured due to handling and tagging. However, short term effects of handling and tagging on adult salmon appear to be negligible. Bridger and Booth (2003) indicate that implanting tags gastrically does not affect the swimming ability, migratory orientation, or buoyancy of test fish. Due to handling and tag insertion, it is possible that a small proportion of the study fish will be killed due to delayed effects. As pre-spawn adult Atlantic salmon do not feed (Fay et al. 2006), gastrically implanted tags will not affect the diet of the tagged individuals prior to spawning. However, if a tagged adult salmon does not regurgitate the tag post-spawning, the fish may have impaired feeding. In a study of adult sockeye salmon in Alaska, it was determined that 2% (one out of 59 fish) of adults tagged with esophageal radio tags died within 33-days of tagging (Ramstad and Woody 2003). Assuming a similar rate with Atlantic salmon, it can be anticipated that 2% of the 300 study fish (six fish) could be subject to mortality due to upstream and downstream passage monitoring activities at the Mattaceunk Project. Mortalities are expected to be minimized by having trained professionals conduct the procedures using established protocols for all tag insertions involving adult salmon.

6.6. Consequences to Critical Habitat

In this analysis, we consider the direct and indirect consequences of the action on the critical habitat PBFs that we determined to be in the action area (see Section 4.2 Environmental Baseline). For each PBF that may be affected by the action, we then determine whether any possible consequences to the feature are adverse, insignificant, discountable, or entirely beneficial. In making this determination, we consider the action's potential to affect how each PBF supports Atlantic salmon's conservation needs in the action area. Part of this analysis is consideration of the conservation value of the habitat and whether the action will have consequences on the ability of Atlantic salmon to use the feature(s), temporarily or permanently..

There is no rearing or spawning habitat in the immediate Mattaceunk Project area. No spawning or rearing habitat occurs in the project impoundment. The closest rearing habitat is located in tributaries located several kilometers downstream of the Mattaceunk Project that will not be affected by project operations. As such, the project will have no consequences on spawning and rearing habitat.

Operation of the Mattaceunk Project may affect migratory habitat in the action area. Below, we analyze the potential consequences of the proposed action of each of the migration PBFs.

M1 - Freshwater migratory sites free from physical and biological barriers that delay or prevent access of adult salmon seeking spawning grounds needed to support recovered populations

In Section 5.0, we established that the baseline conditions of M1 in the action area have limited function due to the presence of the Mattaceunk Project. Since GLHA will be required to operate and maintain upstream fishways for Atlantic salmon at the project as part of their new FERC license, the physical and biological features of migratory habitat in the project area will continue to function in a limited capacity throughout the period considered in this consultation. Although the existing fishway is not 100% effective at passing upstream migrating Atlantic salmon, once the upstream performance standards are achieved by year 10 of the new license, at least 95% of adult salmon will be able to utilize the fishway to access spawning habitat upstream of the Mattaceunk Project. At that point, spawning habitat upstream of the Mattaceunk Project will be considered accessible. Of the 5% of adult salmon that do not use the existing fishway, nearly all of these fish will be able to spawn in downstream reaches of the river including the Mattawamkeag River. While the fishways do not eliminate all of the adverse consequences of the project on the function of critical habitat in the action area, the operation and maintenance of fishways at the Mattaceunk Project does serve to ensure that an opportunity for upstream migration is available at the project. Habitat upstream or downstream of a hydro dam will be considered "accessible" by the Services if Atlantic salmon passage performance standards necessary to avoid jeopardizing the species are achieved at any particular dam. Therefore, the migration feature of critical habitat in the action area is expected to function throughout the entire period of a new license issued by the FERC. Following the attainment of upstream performance standards at the project together with the installation of a new fishway at the project in Year 15 of the new license, the PBFs of M1 will be considered functional.

Under the new FERC license, the Mattaceunk Project will be operated in a run-of-river mode with a year-round continuous minimum base flow of 1,674 cfs or inflow, whichever is less. From July 1 through September 30, the project will operate with a daily average minimum flow of 2,392 cfs, or average inflow, whichever is less. From October 1 through June 30, the project will operate with a daily average minimum flow of 2,000 cfs, or average inflow, whichever is less. Based upon water quality monitoring data conducted by GLHA, the Mattaceunk Project waters are expected to achieve Maine DEP water quality standards for the Penobscot River over the term of the new FERC licensee. Operating the Mattaceunk Project in run-of-river mode provides nearly natural flows and prevents rapidly fluctuating water levels from occurring downstream of the project, which prevents stranding of migrating Atlantic salmon or dewatering of habitat downstream the project. In 2014, GLHA conducted a minimum flow aquatic habitat study at the Project in support of the FERC relicensing activities. This study found that, under the Project's currently-licensed minimum flows, the reach of river directly downstream of the Mattaceunk Project provides adequate habitat to support aquatic life and a zone of passage for fish migration. These conclusions are based on habitat mapping and transect profile data, which together show extensive connectivity of deep-water habitats along both shorelines – these deep water habitats also extend well into the channel.

FERC's proposed new license for the Mattaceunk Project will not completely eliminate adverse effects to adult Atlantic salmon migration habitat in the action area. However, the physical and biological features of migratory habitat will function in the action area

M2 - 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.

In Section 5.0, we established that the baseline features of M2 in the action area are fully functional with the exception of temperature (which has limited function). Dams inundate free-flowing reaches of river and may increase stream temperatures upstream and downstream of the structure (Fay et al. 2006). In general, dam impoundments increase water depth, increase the water retention time (flushing rate) within a given river reach, and dampen daily fluctuations in water temperatures. Run-of-the-river impoundments are typically shallow and have little effect on temperature (GLHA 2016).

Under the new FERC license, the Mattaceunk Project will be operated in a run-of-river mode with a year-round continuous minimum base flow of 1,674 cfs or inflow, whichever is less. From July 1 through September 30, the project will operate with a daily average minimum flow of 2,392 cfs, or average inflow, whichever is less. From October 1 through June 30, the project will operate with a daily average minimum flow of 2,000 cfs, or average inflow, whichever is less. Based upon water quality monitoring data conducted by GLHA, the Mattaceunk Project waters are expected to achieve Maine DEP water quality standards for the Penobscot River over the term of the new FERC licensee. Maine DEP water quality standards for the upper Penobscot River are protective of Atlantic salmon migration sites. As noted above, operating the Mattaceunk Project in run-of-river mode provides nearly natural flows.

The water retention time for the Mattaceunk Project is short which demonstrates that there is a rapid transfer of water through the riverine Mattaceunk impoundment, and consequently, there would be little increased exposure to solar radiation and warming effects. Data collected by GLHA in 2014 showed that water temperatures in the impoundment were lowest in early fall (late September through October) and highest in late summer (June through early September), ranging from 13.1 to 23.8°C throughout the season. Figure 12 below demonstrates that the project impoundment is having little effect on water temperatures in the Penobscot River.

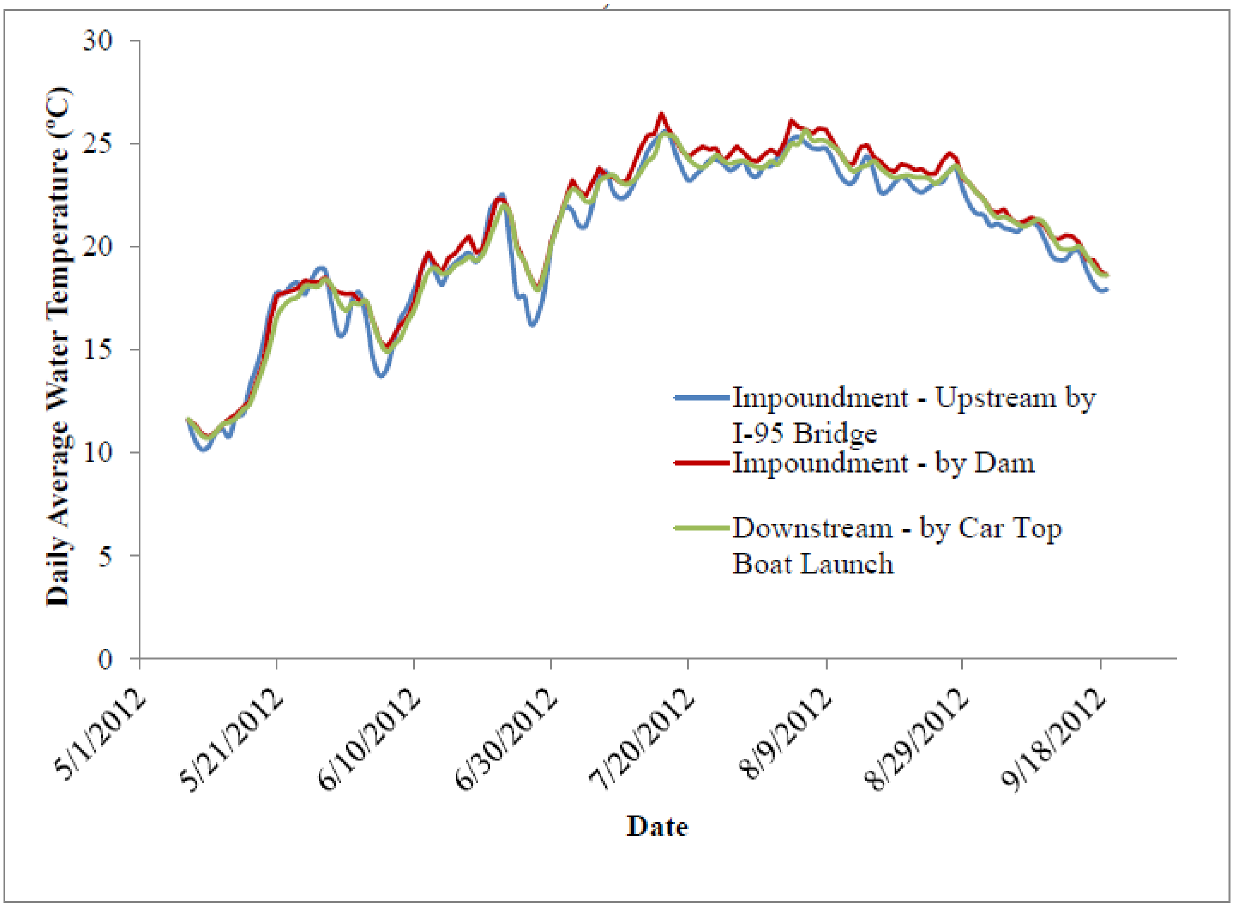

Figure 12. Daily average water temperature in the Mattaceunk Project impoundment from May to September 2012. Source GLHA.

In 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). Dissolved oxygen (DO) levels in the impoundment exceeded 5.0 mg/L which is suitable for adult Atlantic salmon migrations. DO concentrations in the deepest area of the impoundment ranged from about 7.0 to 9.5 mg/l. DO concentrations in surface waters of the impoundment ranged from 8.0 to 9.8 mg/L and were lowest in late summer and highest in the early fall.

The new FERC license will require the Mattaceunk Project to operate in a run-of-river mode which serves to protect water quality in the Penobscot River downstream of the Mattaceunk Project. However, the new license will also require GLHA to maintain the project impoundment. Impoundment temperatures are suitable for much of the upstream adult migration season in the action area which is typical for most rivers in Maine during summer months. Also, cool water tributaries exist throughout the action area that could provide temporary holding and resting areas for adult salmon during summer months. As such, we have determined that the features of M2 in the action area will be fully functional throughout most of year. During summer months, the features of M2 will also function albeit at a limited degree). Elevated water temperatures can cause delays in migrations as Atlantic salmon will reduce migratory behavior and seek coldwater refugia.

FERC's proposed new license for the Mattaceunk Project will not completely eliminate any adverse effects to the features of M2 in the action area. However, the physical and biological features of migratory habitat will function in the action area.

M3 - Freshwater and estuary migration sites with abundant, diverse native fish communities to serve as a protective buffer against predation.

In Section 5.0, we established that the baseline features of M3 have limited function due to the presence of the non-native fish species in the Penobscot River. Species such as smallmouth bass prey on juvenile Atlantic salmon in the Penobscot River (Fay *et al.* 2006). FERC's new license for the Mattaceunk Project will require GLHA to construct a new upstream fishway for alosines in Year 15. The new fishway at the Mattaceunk Project will help accomplish the goals of restoring river herring and American shad in the East Branch of the Penobscot River. Alosines are thought to serve as a protective buffer against predators of Atlantic salmon. American shad and alewife populations have grown dramatically in the Penobscot River watershed since implementation of the Penobscot River Restoration Project in 2014. In 2014, approximately 187,000 river herring (blueback herring and alewives) were passed at the first dam on the lower Penobscot River. In 2018; over 2.1 million river herring were passed at Milford. In 2014 and 2018, approximately 800 and 4,000 American shad were passed at Milford, respectively. Adult spawning alewives and American shad are known to occur in the Penobscot River downstream of the Mattaceunk Project.

It is presently not known how effective the upstream fishway at the Mattaceunk Project is for adult spawning American shad or alewives. However, the abundance of herring and shad in freshwater sites downstream of the Project serves as a predator buffer to protect Atlantic salmon smolts downstream of the Mattaceunk Project. Once the new fishway is installed and alosines have access to the Penobscot River upstream of the Mattaceunk Project, Atlantic salmon smolts will also be further protected from natural predation as alosines will serve as a predator buffer. We fully expect that the restoration of alosines upstream of the Mattaceunk Project will significantly improve the features of M3 in the upper reaches of the action area leading to increased smolt survival and production in the Penobscot River SHRU. After construction of the new fishway, the features of M3 are expected to be fully functional.

M4 - Freshwater migration sites free from physical and biological barriers that delay or prevent emigration of smolts to the marine environment

In Section 5.0, we established that the baseline features of M4 in the action area have limited function due to the presence of the Mattaceunk Project. GLHA will be required to operate and maintain downstream fishways for Atlantic salmon smolts at the project as part of their new FERC license. Once the downstream performance standard is achieved for smolts (i.e., 96% of smolts will survive passing the project within 24 hours of approaching the dam), the features of M4 will be considered fully functional.

M5 – Freshwater and estuary migration sites with sufficiently cool water temperatures and water flows that coincide with diurnal cues to stimulate smolt migration.

In Section 5.0, we established that the baseline features of M5 in the action area are fully functional. The new FERC license will require the Mattaceunk Project to operate in a run-of-river mode which serves to protect water quality in the Penobscot River. Operating the Mattaceunk Project in run-of-river mode provides nearly natural flows and prevents rapidly fluctuating water levels from occurring downstream of the project, which prevents stranding of migrating Atlantic salmon or dewatering of habitat downstream the project. During spring months, high flows and low water temperatures in action area are protective of the features of M5. Operation of the Mattaceunk Project does not appear to have any significant effects on water temperatures during the spring migration season of smolts. Also, run-of-river operations at the project will serve to stimulate smolt migration by mimicking a natural hydrograph. Therefore, we conclude that FERC's issuance of a new license for the Mattaceunk Project will have an insignificant effect on the PBFs of M5 in the action area.

M6- Freshwater migration sites with water chemistry needed to support sea water adaptation of smolts.

In Section 5.0, we established that the baseline features of M6 in the action area are fully functional. The new FERC license will require the Mattaceunk Project to operate in a run-of-river mode which serves to protect water quality in the Penobscot River. During spring months, water quality in the action area is protective of the features of M5. Operation of the Mattaceunk Project does not affect water chemistry in the Penobscot River. Therefore, we conclude that FERC's issuance of a new license for the Mattaceunk Project will have no effect to the PBFs of M6 in the action area.

7. CUMULATIVE EFFECTS

Cumulative effects are defined in 50 CFR §402.02 as those 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. The consequences of future state and private activities in the action area that are reasonably certain to occur are continuation of recreational fisheries, discharge of pollutants, and development and/or construction activities resulting in excessive water turbidity and habitat degradation. It is important to note that the definition of "cumulative effects" in the section 7 regulations is not the same as the NEPA definition of cumulative effects.

Impacts to Atlantic salmon from non-federal activities are largely unknown in the Penobscot River. It is possible that occasional recreational fishing for anadromous fish species may result in the illegal capture of Atlantic salmon. Despite strict state and federal regulations, both juvenile and adult Atlantic salmon remain vulnerable to injury and mortality due to incidental capture by recreational anglers and incidental catch in commercial fisheries. The best available information indicates that Atlantic salmon are still incidentally caught by recreational anglers. Evidence suggests that Atlantic salmon are also targeted by poachers (NMFS 2005). Commercial fisheries for elvers (juvenile eels) and alewives may also capture Atlantic salmon as bycatch. No estimate of the numbers of Atlantic salmon caught incidentally in recreational or commercial fisheries exists.

Pollution from point and non-point sources has been a major problem in this river system, which continues to receive discharges from sewer treatment facilities and paper production facilities (metals, dioxin, dissolved solids, phenols, and hydrocarbons). Atlantic salmon are vulnerable to impacts from pollution and are likely to continue to be impacted by water quality impairments in the Penobscot River and its tributaries.

Contaminants associated with the action area are directly linked to industrial development along the waterfront. PCBs, heavy metals, and waste associated with point source discharges and refineries are likely to be present in the future due to continued operation of industrial facilities. In addition many contaminants such as PCBs remain present in the environment for prolonged periods of time and thus would not disappear even if contaminant input were to decrease. It is likely that Atlantic salmon will continue to be affected by contaminants in the action area in the future.

Sources of contamination in the action area include atmospheric loading of pollutants, storm water runoff from development, groundwater discharges, and industrial development. Chemical contamination may have an effect on listed species reproduction and survival.
As noted above, impacts to listed species from all of these activities are largely unknown. However, we have no information to suggest that the effects of future activities in the action area will be any different from effects of activities that have occurred in the past.

8. INTEGRATION AND SYNTHESIS OF EFFECTS

In the "consequences of the action" analysis above, we considered the consequences of the terms of a new license for the Mattaceunk Project that FERC proposes to issue together with GLHA's actions to minimize and mitigate for project-related impoundment effects on Atlantic salmon smolts in the action area (together, the consequences of the action). In the discussion below, we consider whether the consequences of the action would be expected, directly or indirectly, to reduce appreciably the likelihood of both the survival and recovery of the listed species in the wild by reducing the reproduction, numbers, or distribution of the GOM DPS of Atlantic salmon. We also determine whether the proposed action will destroy or adversely modify designated critical habitat for Atlantic salmon

The purpose of this analysis is to determine whether the proposed action in the context established by the status of the species, environmental baseline, and cumulative effects, would jeopardize the continued existence of any listed species in the action area or result in destruction or adverse modification of critical habitat. In the NMFS/USFWS Section 7 Handbook, for the purposes of determining jeopardy, survival is defined as, "the species' persistence as listed or as a recovery unit, beyond the conditions leading to its endangerment, with sufficient resilience to allow for the potential recovery from endangerment. Said in another way, survival is the condition in which a species continues to exist into the future while retaining the potential for recovery. This condition is characterized by a species with a sufficient population, represented by all necessary age classes, genetic heterogeneity, and number of sexually mature individuals producing viable offspring, which exists in an environment providing all requirements for completion of the species' entire life cycle, including reproduction, sustenance, and shelter." Recovery is defined as, "Improvement in the status of listed species to the point at which listing is no longer appropriate under the criteria set out in Section 4(a)(1) of the Act."

We recognize that the operation of the Mattaceunk Project in accordance with FERC's proposed new license and GLHA's actions will lead to an improvement in upstream and downstream passage for Atlantic salmon as compared to current operations. However, the project will continue to affect the abundance, reproduction and distribution of salmon in the Penobscot River by harassing (delay), injuring and killing upstream migrating pre-spawn adults, as well as outmigrating smolts and kelts; these effects would not occur if the project was not relicensed and the dam was removed.

Summary of Upstream Passage Effects

As explained above, we expect that the upstream performance standard of 95% for pre-spawned Atlantic salmon adults in the action area will be achieved by the end of year 10 of the license. During years 1-10 of the license, the best available information indicates the existing upstream fishway at the project will pass 71% of all adult salmon in the action area. Up to 50% of all pre-spawn salmon could take over 48 hours to successfully pass upstream of the Mattaceunk Project in the first 10 years of the new license; we have determined that these effects meet NMFS' interim definition of harassment. As such, of the 29% of Atlantic salmon adults that do not successfully pass upstream of the dam, we expect 1% to die (i.e., 0.29% of the total run of pre-spawned salmon in the action area). The remaining 28% are expected to successfully spawn in areas downstream of the Mattaceunk Project.

Following the ten-year adaptive management period, we expect that 95% of all adult Atlantic salmon will survive upstream passage at the Mattaceunk Project. Of these adult Atlantic salmon that pass successfully upstream of the project, we expect that 75% will pass within 48 hours of approaching 200 m of the dam, and the remaining 25% will pass between 48 and 96 hours. Of the 5% of Atlantic salmon that do not successfully use the upstream fishway, 1% will die. The remaining 4% are expected to successfully spawn in areas downstream of the Mattaceunk Project. We expect the project to operate from years 11 – 40 of the license in compliance with these performance standards.

The best available information suggests that upstream movements of parr in the Penobscot River are not affected by the Mattaceunk Project.

Summary of Downstream Passage Effects

Kelts

During the first 10 years of the FERC license, we anticipate that 75.8% to 96% of downstream migrating kelts will survive passage over the dam. Once the downstream performance standard is achieved, we anticipate that no more than 4% of kelts will die due to project operations.

Smolts

As explained above, we expect that the project will achieve the smolt downstream performance standard of 96% by the end of year 10 of the license. We expect downstream passage for smolts to have an increasing trend over the first 10 years of the license as adaptive management measures are implemented. The best available data indicate that smolt survival through the Mattaceunk Project will range from 89.3% to 100.0% during this period. We also expect that up to 8.8% of salmon smolts that pass the project will experience significant delay (i.e., take more than 24 hours to pass the dam), which we consider to meet the definition of harassment.

Following the ten year adaptive management period, we expect that 96% of smolts will survive passing the Mattaceunk Project. All of these fish are expected to pass within 24 hours of encountering the project dam. Therefore, we expect that from years 11-40, no more than 4% of smolts will die while passing downstream of the dam and that the 96% of smolts that successfully pass will do so within 24 hours of approaching 200 m of the dam.

As explained above, some of the smolt mortality that occurs in Penobscot Bay downstream of the Mattaceunk Project is attributable to the delayed effects of dam passage. Stich et al. (2015) determined that this delayed hydrosystem mortality equates to 6% per dam in the Penobscot River. Therefore, we anticipate that up to 6% of smolts passing the Mattaceunk Project will experience hydrosystem delayed mortality and die in the estuary. We expect the attainment of downstream performance standards at the project will, however, reduce hydrosystem delayed mortality of smolts originating upstream of the Mattaceunk Project although we are not able to quantify the extent of that reduction at this time.

Summary of Impoundment Effects

We assume it could take up to 9 years for GLHA to complete studies concerning smolt impoundment mortality. The best available data indicate that impoundment mortality of smolts during the first ten years of the new license is expected to be between 5.1 and 8.7%. Minimization and/or mitigation measures will be implemented by year 10 leading to a reduction of the effects of impoundment mortality on the Penobscot River population of Atlantic salmon during years 11-40 of the proposed license.

There are approximately 55,700 units of rearing habitat upstream of the Mattaceunk Project. According to Baum (1997), one unit of rearing habitat could produce from 1 to 3 smolts annually. Therefore, based on the amount of available habitat upstream of the project, the number of smolts produced upstream of the Mattaceunk Project could range from 55,700 to over 150,000 annually. If this number of smolts migrated downstream through the impoundment annually and there was no reduction in impoundment mortality (i.e., mortality continued at 5.1-8.7%), the presence of the Mattaceunk Project impoundment would lead to the loss of approximately 4,800 to 13,000 smolts annually. However, the number of smolts killed annually under current stocking conditions (approximately 600,000 fry) and existing levels of impoundment mortality (5.1-8.7%), approximately 2,500 smolts are killed in the Mattaceunk impoundment each year. This level of mortality is expected to continue for up to the first 10 years of the license. As explained above, based on a smolt to adult return rate of 0.02%, this loss of smolts would result in an equivalent loss of up to 3-5 adult returns.

Following implementation of avoidance, minimization, and compensation measures (which we expect to be implemented within one year following preparation of the impoundment mortality mitigation plan), we expect no-net loss of smolts resulting from the operation and maintenance of the project impoundment beginning in year 10 of the new license. It is important to note that the "no net loss" standard could be achieved in a number of different ways, each of which would have significantly different effects. If GLHA is able to successfully reduce mortality of smolts in the impoundment to background levels (i.e., the mortality rate that would be anticipated in this reach of the river if the dam and its impoundment were not present), then this source of mortality (estimated at up to 8.7% of smolts outmigrating from habitats upstream of the Weldon Dam) would be eliminated in Years 11-40 of the license. In that case, the mortality rate for smolts migrating through the impoundment would be equivalent to the mortality rate of smolts migrating through an unimpounded reach of the Penobscot River and we would expect 2,500-13,000 more smolts to outmigrate from the action area (depending on the amount of stocking, habitat usage, and productivity). However, if GLHA is unable to fully reduce that mortality level to background/natural levels and pursues habitat enhancement to increase the productivity of the habitats upstream of the dam (either through increased accessibility or increased productivity of accessible habitats), the mortality rate in the impoundment may only be partially reduced or not reduced at all. However, in that case, with increased productivity upstream of the dam there would be more smolts outmigrating from habitats upstream of the dam so the effects of the loss of smolts migrating through the impoundment to the Penobscot River population would be reduced compared to what they would be absent the mitigation.

In the event that habitat enhancement is pursued and required increases in productivity are not realized by the end of year 10, GLHA would need to implement a short-term stocking program of smolts to achieve no net loss of smolts in the project impoundment. At least one year prior to the 10 year milestone, GLHA will need to prepare a stocking plan as described in section 10.2 of this Opinion.

Summary of Maintenance Activities Consequences

GLHA performs regular facility maintenance at the Mattaceunk Project to ensure safe operations throughout the year, including fish passage facility maintenance. Routine maintenance activities include flash board replacement and inspections and raking of the trash racks upstream of the powerhouse. None of these maintenance activities are expected to impact Atlantic salmon.

Summary of Passage Study Consequences

All Atlantic salmon smolts used in the downstream passage studies will be handled and injured due to tag insertion. The proposed smolt studies could involve handling and surgical implantation of radio tags in up to 2,000 smolts. Of these, up to 2% (40 fish) are expected to die due to handling and tagging.

To study the effects of dam passage on upstream and downstream migrating adults (pre-spawned and kelts), up to 300 adults will be surgically implanted with radio tags during the studies. Up to 2% of the 240 study fish (six fish) are expected to die due to handling and tagging.

In summary, we expect the death of 1 out of every 350 adults (i.e., 1% of 29% of adults that fail to pass=0.3%) attempting to migrate upstream of the dam in years 1 -10 and that this rate will decrease to 1 out of every 2,000 adults for years 11-40 (i.e., 1% of 5% of adults that fail to pass=0.05%). Combined with the reduction in delay, we expect this to increase the number of adults that pass successfully above the dam, thereby increasing abundance of adults in the action area and will lead to an increase in potential spawning, which is necessary to support increased abundance in the action area and increased reproduction in the area above the dam. While the loss of smolts due to impoundment effects will continue over the life of the license, by year 11, the proposed action will result in no net loss of smolts in the impoundment This will lead to a greater number of smolts migrating out of the action area and the Penobscot River, which should result in for a greater number of adult returns.

8.1. Jeopardy Analysis

Jeopardy is defined as "an action that reasonably would be expected, directly or indirectly, to reduce appreciably the likelihood of both the survival and recovery of a listed species in the wild by reducing the reproduction, numbers, or distribution of that species" (50 CFR 402.02). Therefore, to determine if the proposed action will jeopardize the GOM DPS of Atlantic salmon, we conduct an analysis of the consequences of the proposed action on survival and recovery.

The 2019 Recovery Plan projects four phases of recovery over a 75-year timeframe to achieve delisting of the GOM DPS of Atlantic salmon. The four phases of recovery are:

> Phase 1: The first recovery phase focuses on identifying the threats to the species and characterizing the habitat needs of the species necessary for their recovery.
>
> Phase 2: The second recovery phase focuses on ensuring the persistence (survival) of the GOM DPS through the use of the conservation hatcheries while abating imminent threats to the continued existence of the DPS. Phase 2 focuses on freshwater habitat used by Atlantic salmon for spawning, rearing, and upstream and downstream migration; it also emphasizes research on threats within the marine environment.
>
> Phase 3: The third phase of recovery will focus on increasing the abundance, distribution, and productivity of naturally reared Atlantic salmon. It will involve transitioning from dependence on the conservation hatcheries to wild smolt production.
>
> Phase 4: In Phase 4, the GOM DPS of Atlantic salmon is recovered and delisting occurs. The GOM DPS will be considered recovered once: a) 2,000 wild adults return to each SHRU, for a DPS-wide total of at least 6,000 wild adults; b) each SHRU has a population growth rate of greater than 1.0 in the 10-year period preceding delisting, and, at the time of delisting, the DPS demonstrates self-sustaining persistence; and c) sufficient suitable spawning and rearing habitat for the offspring of the 6,000 wild adults is accessible and

distributed throughout the designated Atlantic salmon critical habitat, with at least 30,000 accessible and suitable habitat units s in each SHRU, located according to the known migratory patterns of returning wild adult salmon.

We are presently in Phase 2 of our recovery program (ensuring the survival of the GOM DPS through the use of the conservation hatcheries while abating imminent threats to the continued existence of the DPS). As indicated in the 2019 Recovery Plan for Atlantic salmon, the Services do not have plans to transition from dependence on conservation hatcheries to wild fish production in the foreseeable future. Therefore, for purposes of our survival analysis, we assume hatchery supplementation will continue in the Penobscot SHRU over the 40-year life of the new project license. We anticipate that as passage improves at the Mattaceunk Project, stocking upstream of the project will become a higher priority. The hatchery program, sponsored by the U.S. FWS, has been in place for over 100 years and, because we do not have any information to the contrary, we expect it will continue over the duration of the license. The importance of continuation of the hatchery program is recognized in the 2019 Final Recovery Plan (U.S. FWS and NMFS 2019) and continuation of the hatchery and stocking efforts are an integral part of the Services' recovery strategy. Stocking above the Weldon Dam has been somewhat limited due to high mortality anticipated for outmigrating smolts; we expect that as passage conditions improve over the life of the license, the areas upstream of the dam will become a priority for stocking and that more stocking will occur in these waters.

The jeopardy analysis makes a conclusion regarding the survival and recovery of the GOM DPS of Atlantic salmon as a whole, and not just survival and recovery of the species in the action area. Therefore, in the survival and recovery portions of this analysis, we consider how the consequences to individual salmon that were identified in the "Consequences of the Action" section of this Opinion will affect the Penobscot River population of Atlantic salmon, how the consequences to the Penobscot River population will affect the Penobscot Bay SHRU, and then finally, how the consequences to the Penobscot SHRU are likely to affect the survival and recovery of the GOM DPS as a whole. As highlighted in the 2019 Recovery Plan, the survival and recovery of the Penobscot SHRU is necessary for attainment of the delisting criteria and recovery of the GOM DPS.

The first step in conducting this analysis is to assess the consequences of the proposed action on the survival of the species. Survival is defined as the condition in which a species continues to exist into the future while retaining the potential for recovery. This condition is characterized by a species with a sufficient population, represented by all necessary age classes, genetic heterogeneity, and number of sexually mature individuals producing viable offspring, which exists in an environment providing all requirements for completion of the species' entire life cycle, including reproduction, sustenance, and shelter (USFWS and NMFS 1998).
The three criteria that are evaluated under the survival analysis include: reproduction, numbers and distribution. The number of returning adult Atlantic salmon, particularly 2SW females, to the Penobscot Bay SHRU is a metric of both the reproduction and numbers of the species. The 2006 Atlantic Salmon Status Review concluded that "…substantial genetic and demographic problems would arise if total abundance were to fall below 100 adults" at any point in time (Fay et al 2006). We also consider whether the action will result in less than 150 adult females being

collected for broodstock at the Milford Dam[8]. Any proposed action that is likely to cause the total abundance of Atlantic salmon to fall below 100 adults at any point in time in the GOM DPS or risk capturing fewer than 150 adult females for broodstock is expected to seriously reduce the viability of the population and have significant consequences for the continued existence (survival) of Atlantic salmon in the wild.

The proposed action will continue to result in adverse effects to Atlantic salmon in the action area. Once the performance standards are met, delay and death of pre-spawn adults attempting to migrate past the dam is expected to be very low (1 death for every 2,000 adults, compared to 1 for every 350 adults in years 1-10). However, smolt mortality will continue to occur both at the project and in the estuary (as a result of hydro-system delayed mortality). Under existing conditions and with the limited stocking effort above the Weldon Dam, the action area currently contributes minimally to the production of Atlantic salmon in the Penobscot SHRU; this minimal contribution is expected to continue over years 1-10 of the license. The improvements described in the proposed action will increase the potential for the action area to contribute to the production of Atlantic salmon in the Penobscot SHRU. As explained in the Effects of the Action section of this Opinion, over the first 10 years of the license, considering the mortality rate for passage through the impoundment (5.1-8.7%) as well as the mortality rate attributable to dam passage (10.7%), we expect 15.8-19.4% of smolts migrating through the action area to die due to causes attributable to the Mattaceunk project. Of the smolts that pass over the dam, 6% will experience delayed mortality before they leave the river due to effects of the project. This mortality is on top of natural mortality and mortality attributable to other hydro projects in the system. The number of smolts migrating through the action area in the first 10 years of the license is expected to remain low due to limited stocking effort above the dam and the low number of adults expected to return to the project area during this time. By year 11 of the license, we expect that the mortality rate for passage through the impoundment will be reduced to background levels or compensatory mitigation will have been implemented to compensate for the smolts killed due to impoundment mortality. At this time, the mortality rate attributable to dam passage will be reduced to 4%; we expect that the reduction in delay will reduce the amount of delayed mortality from 6% but we are not able to quantify any reduction at this time. Similarly, we expect maintenance of high levels of survival and decrease in delay for kelts passing downstream of the project and a significant reduction in mortality and decrease in delay for adults passing upstream of the project. Combined, these factors are expected to result in an increase in the potential abundance and reproduction in the upper Penobscot over the life of the license compared to current conditions. While survival for smolts, kelts, and adults will be lower in the action area than it would be absent the dam, the survival of smolts, kelts, and adults as a result of the proposed action is expected to allow for the continued persistence of Atlantic salmon in the action area and for abundance and reproduction to increase over time. Operation of the project consistent with the proposed new license (i.e., inclusive of the proposed performance standards) is expected to lead to a significant increase in the percentage of smolts

[8] 150 2SW female adults represents the estimated number of females required to maintain the current annual production of 550,000 hatchery-reared smolts. The current annual broodstock target for the Penobscot River is 650 individuals, which supports the production of hatchery-reared smolts, parr, fry, and eggs that are used for restoration purposes. We focus on 2SW females as they are the primary limiting life stage for the Penobscot River population. In addition, considering that >90% of adult returns originate from smolt stocked fish we focused the broodstock collection on what is needed to support the smolt stocking program.

that successfully migrate out of the action are; a significant increase in the percentage of adults that successfully migrate upstream past the dam; and a significant reduction in delay for adults. The number of smolts migrating to the ocean is the determinative factor in the number of adult returns. Increasing smolt survival is therefore key to increasing abundance in the action area and increasing reproduction in the upper Penobscot River. We expect the proposed action to result in an increase in returns to the action area which will lead to an increase in future reproduction and abundance; that is, the proposed action will improve the potential of the action area and the upper Penobscot River to support a viable population of Atlantic salmon. However, the rate and extent of this increase will be greatly influenced by the extent of stocking upstream of the dam, survival rates in other portions of the Penobscot River, and survival rates in the ocean. Below, we describe modeling efforts that have been undertaken by NMFS to help facilitate consideration of the consequences of the project on Atlantic salmon.

To facilitate consideration of the effects of dams on the survival and recovery potential of Atlantic salmon, NMFS' Northeast Fisheries Science Center (NEFSC) developed a population viability analysis (PVA) called the Dam Impact Analysis (DIA) model to assess the effects of dams on Atlantic salmon, focusing on hydroelectric dams and the population in the Penobscot River watershed (Nieland and Sheehan, 2020). The DIA model simulates the life cycle of Atlantic salmon, tracking the number and origin of salmon through their life stages, especially during the smolt and adult stages when salmon interact with dams. This model was previously used to assess the effects of various activities involving five hydroelectric dams on the lower Penobscot River on listed Atlantic salmon in 2012 (Nieland et al. 2013). NEFSC updated the model to reflect changes in the watershed and to analyze the effects of issuing a new FERC license for the Mattaceunk Project. In addition to dam-related effects, the DIA model also examines how hatchery supplementation, including changes in the number of smolts stocked and stocking location, and increased survival in the egg-to-smolt and marine life stages affect the population of Atlantic salmon in the Penobscot River watershed. The DIA model did not attempt to model parr losses in the action area since none are expected to occur. It is important to note that the number of outmigrating smolts is the determinative factor affecting adult returns to the Penobscot Bay SHRU.

The DIA model utilizes life history characteristics and the best available information concerning passage survival rates at FERC dams in the Penobscot River to predict how the proposed action of relicensing the Mattaceunk Project affects future abundance of Atlantic salmon. The DIA model evaluates the relative effect that changes in various inputs could have on the abundance of returning 2SW female Atlantic salmon to the Penobscot River under the survival and recovery conditions (see Table 12: the "recovery" condition incorporates improved freshwater survival rates). Adults were modeled as 2SW females exclusively because more than 90% of female returns to the Penobscot River are 2SW fish. The DIA model uses the following inputs in its analysis:

- Production Units
- Eggs per Female
- Egg-to-Smolt Survival
- Smolt Production Cap

- Stocking
- In-river Mortality
- Impoundment Mortality
- Downstream Dam Survival Rates
- Indirect Latent Mortality
- Hatchery Discount[9]
- Sex-ratio Discount
- Marine Survival
- Straying
- Upstream Dam Passage Rates
- Upstream Dam Passage Inefficiency
- Broodstock Collection
- Performance Metrics

The DIA model compares baseline survival conditions in the action area (i.e., survival of upstream migrating adults and downstream migrating kelts and smolts at rates experienced under the terms of the existing license) to the conditions expected with the implementation of the upstream and downstream performance standards at the Mattaceunk Project for both the survival and recovery analysis (Table 12). The model also assesses the effects of impoundment mortality on Atlantic salmon smolts. In the 2013 version of the DIA model, the starting population of 2 sea-winter (SW) females was based on the number of adults returning to the Penobscot River, but some of those returns were removed for use as broodstock in the hatchery and did not spawn in the river. In the current version of the model, the number of seeded 2SW females is based on the calculated 10-year mean of the total number of 2SW female returns during 2008–2017 (n=487) and then subtracted 150 (which was the target number of 2SW females removed from the Penobscot River each year to support the smolt stocking program) for an estimated escapement of 337 females. The DIA model also assumed a dam-related estuary mortality rate of 6% for each dam (i.e., hydrosystem delayed mortality) to align with a Penobscot River-specific estimate (Stich et al. 2015). This indirect latent mortality rate was applied based on the number of dams that fish passed. We also note that model runs were completed that demonstrate the anticipated effects of a “no Weldon Dam” scenario; we reference those model runs here where they can help illustrate the impacts of the proposed action on Atlantic salmon in the action area, the Penobscot River population of Atlantic salmon, the Penobscot SHRU, and/or the GOM DPS as a whole.

Table 12. The conditions considered in the DIA model for the Penobscot River watershed, based on the proposed action of implementing upstream and downstream performance standards and minimizing impoundment mortality of smolts.

9 Although hatchery- and wild-origin smolts experience the same kinds of mortality, hatchery-origin smolts typically experience lower survival than wild-origin smolts, and so a discount was applied to hatchery-origin smolts to estimate the number of wild-equivalents before they migrated out to sea.

	Survival		Recovery	
	Baseline	*Proposed*	*Baseline*	*Proposed*
Passage Survival Rates	Existing	95% Upstream 96% Downstream	Existing	95% Upstream 96% Downstream
Average Impoundment Mortality Ra	7.2%	0%	7.2%	0%
Hatchery	Stocking	Stocking	Stocking	No stocking (phased)
Marine Survival	Pre-Regime Shift	Pre-Regime Shift	Pre-Regime Shift	Post Regime Shift
Freshwater Survival	Contemporary	Contemporary	Contemporary	Improved

The DIA model provides us with information that informs our consideration of the consequences of the proposed action on future reproduction and numbers of Atlantic salmon in the action area, the Penobscot River population and the Penobscot Bay SHRU as well as the consequences of the action on distribution of Atlantic salmon. We consider the proportion of DIA model runs where pre-spawn Atlantic salmon are able to access high quality spawning and rearing habitat in the upper Penobscot watershed as an indicator of the consequences of the action on distribution of Atlantic salmon. The survival analysis assumes that the following conditions are maintained over the time period considered in this consultation: current passage survival rates at all other dams in the Penobscot River; existing freshwater and marine survival rates; and existing hatchery stocking practices (Table 12). We consider these reasonable assumptions based on the information presented in the Status of the Species and Environmental Baseline sections of this Opinion.

Below, we analyze whether the proposed action (FERC issuance of a new license consistent with the "Staff Alternative with Mandatory Conditions") together with GLHA's proposed actions (to minimize or mitigate for project-related impoundment consequences of Atlantic salmon smolts) will reduce the reproduction, numbers, or distribution of the Atlantic salmon in the action area and Penobscot Bay SHRU to a point that reduces appreciably the species likelihood of survival in the wild.

Abundance

To inform our analysis of how the proposed action is likely to affect the survival of the species, we considered scenarios where the DIA model compares adult Atlantic salmon abundance between three scenarios including: 1) existing conditions of Atlantic salmon survival in the action area and Penobscot SHRU ("Existing"); 2) conditions whereby the Mattaceunk Project is achieving the 95% upstream performance standard for pre-spawned fish and the 96%

downstream performance standard for smolts[10] while existing losses of project-related impoundment mortality of smolts continues to occur ("Proposed w/ Impound"); and 3) proposed conditions whereby the Mattaceunk Project is achieving the 95% upstream performance standard for pre-spawned fish and the 96% downstream performance standard for smolts and there is no net reduction of smolts originating upstream of the Mattaceunk Project due to operation of the project impoundment (i.e., either elimination of impoundment mortality or an increase in smolt production to "offset" the loss of smolts in the impoundment). The DIA model also compares changes to adult salmon abundance in the Penobscot River under a scenario in which the Mattaceunk Project is removed; the scenario is only for informational purposes as dam removal is not part of the proposed action under consideration.

The DIA model results indicate that adult abundance within the Penobscot Bay SHRU or the Penobscot River itself is not significantly different in any of the three scenarios addressed above (i.e., under baseline conditions or following achievement of the upstream and downstream performance standards at the Mattaceunk Project or after project-related impoundment effects on smolts are minimized to background levels or mitigated to achieve "no net loss") (Figure 13). The model results indicate that following a decrease in abundance after generation one[11], adult salmon abundance in the Penobscot Bay SHRU remains stable just above approximately 650 individuals regardless of the scenario considered. It is important to note that this result is due to the fact that the model incorporates current stocking practices (with the majority of Atlantic salmon stocked in the Penobscot River downstream of the project), which results in few Atlantic salmon being produced upstream of the Mattaceunk Project. Therefore, due to the small number of salmon considered to be in the action area by the model, the impact of any improvements to upstream or downstream passage survival are limited when considering the overall abundance of salmon in the Penobscot River or the SHRU as a whole. Based upon the DIA model, at no time will the number of adults returning to the Penobscot River dip below 100 adults at any time (the point at which we would expect substantial genetic and demographic problems, as described in the 2006 Status Review) under baseline conditions or following achievement of upstream and downstream performance standards and mitigation of impoundment related smolt mortality. The model results demonstrate that if there is no change in current stocking practices (i.e., the majority of stocking continues to occur downstream of the action area) over the life of the new license, the proposed action will not have any significant consequences on the numbers of adult Atlantic salmon in the Penobscot Bay SHRU and that the abundance of Atlantic salmon in the SHRU will persist at a small, but stable, population size.

[10] Kelts (i.e., potential repeat spawners) were not included in the model due to limited quantitative information for model inputs and the limited number of kelts in the present-day Penobscot population (USASAC 2018).
[11] The decrease in adult abundance from generation 1 to generation 2 was a product of the number and location of adults seeded in generation 1 and survival under baseline conditions.

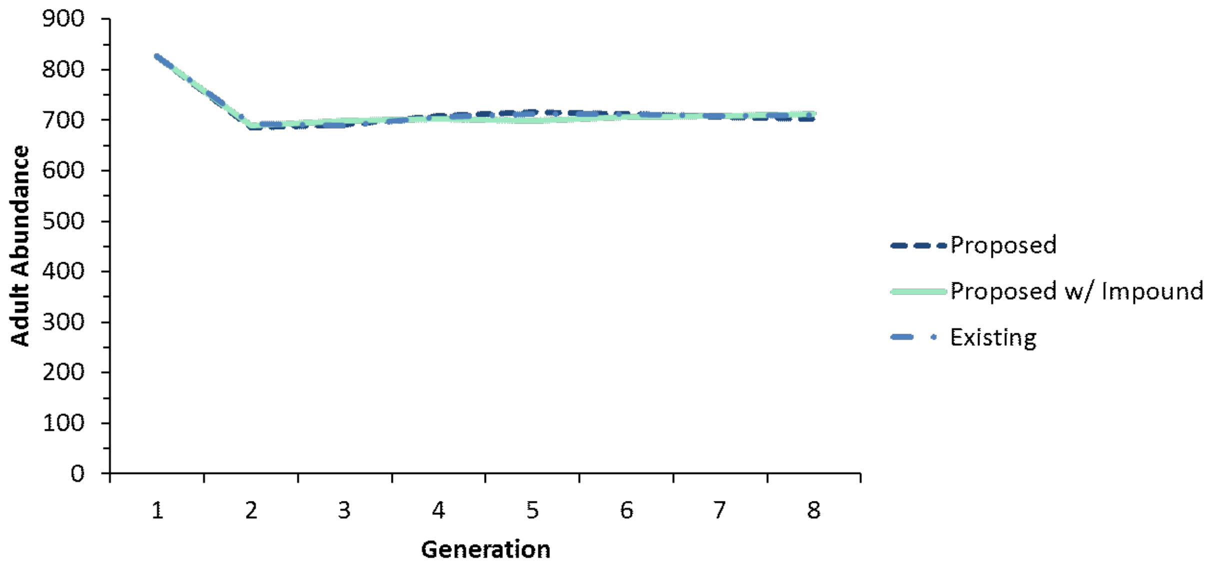

Figure 13. Median adult Atlantic salmon abundance in the Penobscot Salmon Habitat Recovery Unit in generations 1 – 8 under three modeled scenarios in the DIA model.

Similarly, considering the three scenarios modeled, the DIA model does not predict any change to adult Atlantic salmon abundance within the action area under the three scenarios (Figure 14). After two generations, the model predicts that few, if any, Atlantic salmon adults will return to the action area. This is because, in the model, no smolts are stocked upstream of the Mattaceunk Project and any wild or naturally reared smolts produced upstream of the project are not likely to return as adults due to in-river mortality and low marine survival. The model results highlight that without significant improvement in freshwater or marine survival, and without the continued input of stocking above the dam, survival rates outside of the action area are so low that very few, if any, salmon are expected to return to the action area. This is the case even in the "no Weldon dam" scenario.

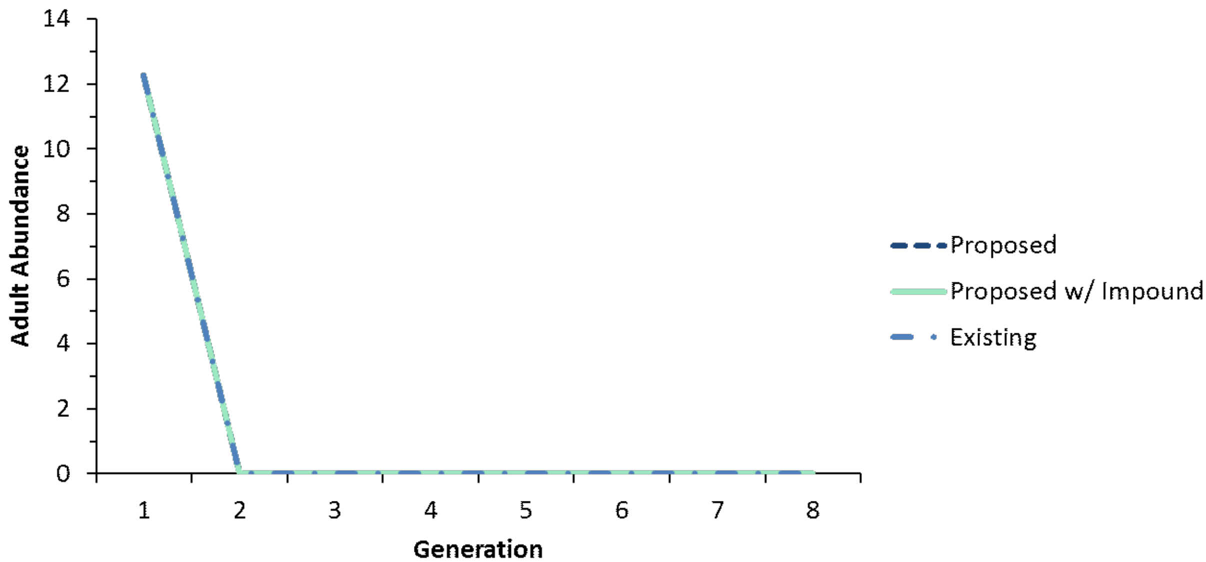

Figure 14. Median adult Atlantic salmon abundance in the Action Area (Production Unit 2) in generations 1 – 8 under three modeled scenarios in the DIA model.

The DIA Model also includes a separate analysis of smolt mortality (Figure 15). The DIA model compared three different sources of smolt mortality in the action area (in-river, impoundment, and dam mortality) by analyzing the fate of a theoretical starting population of 1,000 smolts migrating through the action area. The analysis indicates that the greatest number of smolts would be killed under existing (baseline) conditions at the Mattaceunk Project. The proposed action, inclusive of reduction in impoundment mortality, is predicted to improve smolt survival in the action area by almost 25%.

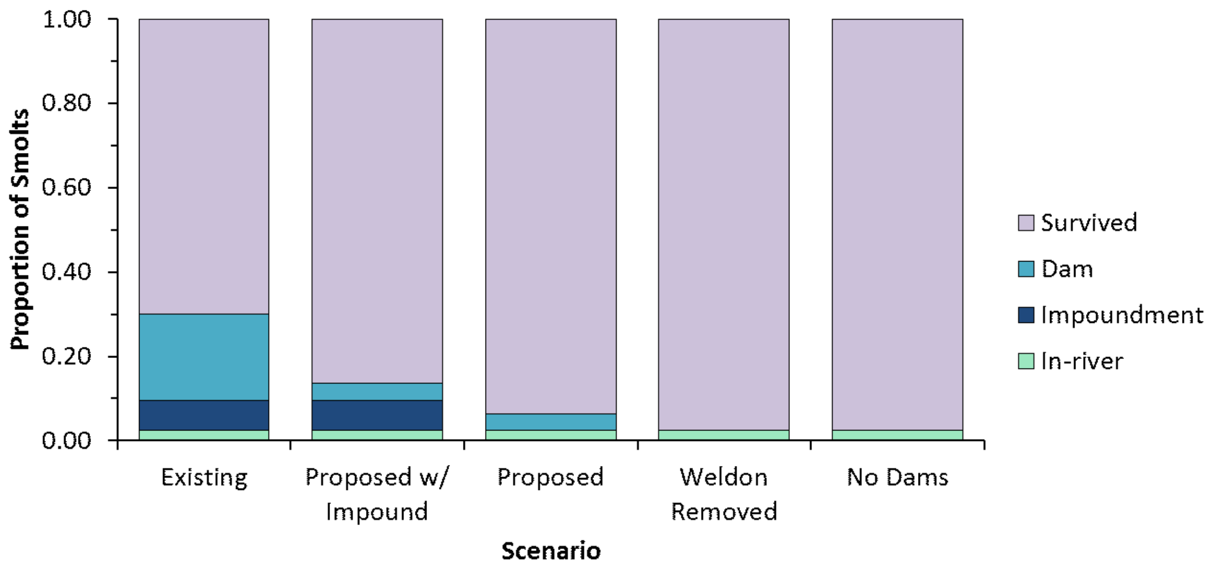

Figure 15. Median proportion of Atlantic salmon smolts that survived and were killed at the Mattaceunk Project, due to impoundment mortality and in-river mortality in the Action Area (Production Unit 2) under five modeled scenarios in the DIA Model

The proposed action will result in a significant increase in the survival rate for smolts migrating downstream through the action area and an increase in the percentage of returning adults that can pass successfully upstream of the dam and access upstream spawning habitats. However, as highlighted by the DIA model results, the impact that these increased survival and passage rates will have on the abundance of Atlantic salmon in the action area, the Penobscot River, or the SHRU is limited by the very limited number of adults that currently return to the action area and the very limited number of smolts that are currently produced upstream of the dam (either by natural reproduction or fry stocking). Once smolts migrate through the action area, they must pass three or four additional dams and then successfully migrate through the estuary, survive at least one year at sea, and then survive their return migration back up the river over three dams. The very low survival rate for smolts and adults dampens the impacts of any increased survival rates in the action area on overall abundance. As such, if there are no changes to current stocking practices and marine and freshwater survival rates of Atlantic salmon remain as is, we do not expect any significant changes in juvenile or adult abundance in the Penobscot River as a result of the proposed action. That is, while the level of smolt and adult mortality anticipated as a result of the proposed action, inclusive of the smolt and adult mortality in years 1-10, is predicted to allow for persistence of Atlantic salmon at an abundance that will allow for attainment of current broodstock goals of 650 adult fish, without changes in stocking practices or improved freshwater or marine survival we do not expect abundance in the action area to increase. We note that this is the same prediction even if we were considering a "no Weldon Dam" scenario.

<u>Distribution</u>

The proposed action will facilitate an increase in the distribution of Atlantic salmon in the Penobscot River, as operating the fishways in compliance with the performance standards will improve access to upstream habitats. This will result in more accessibility to upstream spawning and rearing habitat. Once the performance standards are achieved, we will consider the habitat units upstream of the dam fully accessible; this is a significant increase in the amount of accessible habitat in the Penobscot SHRU. Improvements in fish passage are also expected to support an increase in stocking in the action area which will serve to facilitate further increases in abundance, reproduction, and distribution.

The DIA model can be used to help inform consideration of the effects of the proposed action on the distribution of Atlantic salmon. The DIA model assesses Atlantic salmon distribution with the Penobscot Bay SHRU under the three scenarios described above. The DIA model did not predict any significant changes to Atlantic salmon distribution within the Penobscot Bay SHRU (Figure 16). Again, this is due to the fact that current stocking practices largely determine the distribution of salmon in the Penobscot Bay SHRU. The majority of Atlantic salmon are stocked in the Penobscot River downstream of the project. However, we note that the improved upstream passage that will result from operation of the project in compliance with the proposed new license, would result in an increase in accessibility of habitats upstream of the project. Further, the reduction in mortality in the impoundment and associated upstream and downstream survival, will support a change in current stocking practices that make it more likely that future stocking will occur upstream of the project. However, even if stocking practices are not changed, the improved upstream passage of adults will result in improved access to upstream habitats which will improve the distribution of Atlantic salmon in the action area, the Penobscot River, and thereby, the SHRU as a whole.

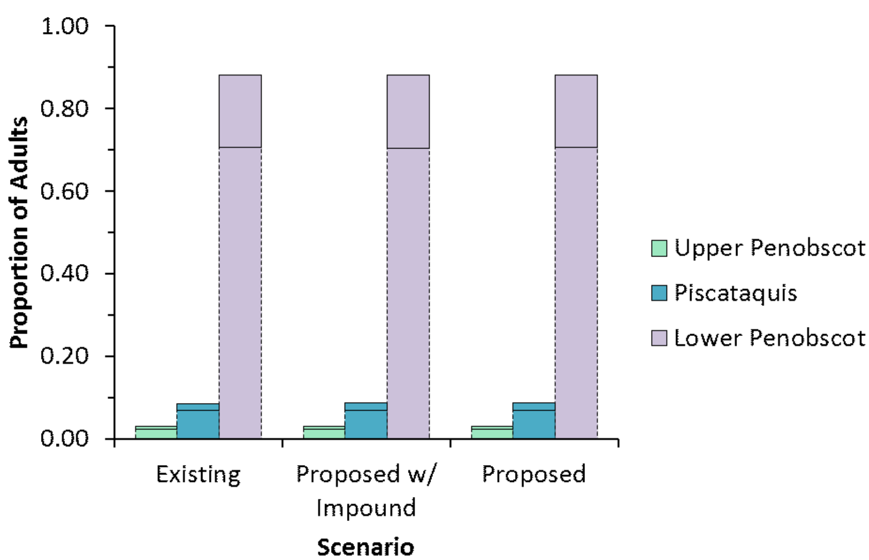

Figure 16. Median proportion of wild- (solid borders) and hatchery-origin (dashed borders) adult Atlantic salmon in the Upper Penobscot, Piscataquis, and Lower Penobscot areas of the Penobscot River watershed under three modeled scenarios in the DIA model.

Summary

In summary, the proposed action is anticipated to result in an increase in adults accessing habitats upstream of the dam and an increase in smolts outmigrating from the action area. We expect that this will contribute to the potential for increased abundance and reproduction in the action area, the Penobscot River population, and the Penobscot SHRU. We also expect the proposed action to result in an increase in distribution of Atlantic salmon in the action area, the Penobscot River population, and the Penobscot River SHRU. When compared to a future scenario without the proposed action (i.e., no license is issued and the dam is removed), the proposed action would reduce the potential numbers and reproductive potential (through a reduction in numbers) but the impacts to abundance and reproduction in the action area, Penobscot River population, and Penobscot SHRU are negligible, as demonstrated by the DIA model.

During the first 10 years of the project license, downstream survival of smolts will improve at the project as a result of the installation of the new 1" trashracks which will substantially reduce turbine entrainment at the project. We also expect further improvement of smolt survival through adaptive management of project operations based upon the results of the smolt survival studies. During this period, the USFWS' conservation hatchery program will continue producing smolts for the Penobscot River to ensure the persistence of Atlantic salmon in the Penobscot River SHRU. All of these factors will ensure the persistence of Atlantic salmon with sufficient numbers, reproduction, and distribution within the Penobscot River SHRU for the potential recovery from endangerment.

Once the performance standards are met, we will consider the habitat above the dam fully accessible; thus, by year 11 of the license we expect any effects to distribution between a future with the proposed action and a no dam scenario would also be negligible.

Based on the analysis provided above, the loss of Atlantic salmon smolts, kelts, and prespawn adults resulting from the operation of the Mattaceunk Project consistent with the terms of the proposed new license, will not appreciably reduce the likelihood of survival of the GOM DPS (i.e., the likelihood that the species will continue to exist in the future while retaining the potential for recovery) because:

- Over the life of the license, the action is expected to result in an increase in survival of smolts and adults in the action area and an increase in the number of smolts outmigrating from the action area
- The loss of Atlantic salmon in the action area attributable to the proposed action will not cause the total abundance in the GOM DPS to fall below 100 adults or result in fewer than 150 adult females being collected for broodstock in the Penobscot Bay SHRU, which means that it will not prevent the species from persisting in the action area or the Penobscot Bay SHRU. The loss of individual Atlantic salmon due to the Project is not expected to impact the genetic heterogeneity of the Penobscot River SHRU or the species as a whole; and

- The Project will result in an increase in distribution of Atlantic salmon in the Penobscot River and restoration of access to a significant portion of habitat in the Penobscot River SHRU.

8.2. Recovery Analysis

The second step in conducting our jeopardy analysis is to assess the consequences of the proposed project on the recovery of the species. Recovery is defined as the improvement in the status of listed species to the point at which listing is no longer appropriate under the criteria set out in section 4(a)(1) of the ESA (50 CFR 402.02). In certain instances, an action may not appreciably reduce the likelihood of a species survival (persistence) but may affect its likelihood of recovery or the rate at which recovery is expected to occur. According to the 2019 Atlantic Salmon Recovery Plan, the GOM DPS of Atlantic salmon will be considered recovered once: a) 2,000 wild adults return to each SHRU, for a DPS-wide total of at least 6,000 wild adults; b) each SHRU has a population growth rate of greater than 1.0 in the 10-year period; and c) sufficient suitable spawning and rearing habitat for the offspring of the 6,000 wild adults is accessible and distributed throughout the designated Atlantic salmon critical habitat, with at least 30,000 accessible and suitable habitat units in each SHRU.

As with the survival analysis, there are three criteria that are evaluated under the recovery analysis: reproduction, numbers and distribution. The DIA model is also used here to help inform whether FERC's issuance of a new license together with GLHA's proposed action to minimize or mitigate for project-related impoundment effects of Atlantic salmon smolts will result in a condition that appreciably reduces the likelihood of Atlantic salmon recovery in the wild by reducing the reproduction, numbers, or distribution of the species. Unlike the survival analysis above, the recovery analysis in the DIA model assumes two different factors including: 1) an improvement in existing freshwater and marine survival rates to allow for a population that has a positive growth rate; and 2) a phased transition from conservation hatchery dependence. Both of these factors are discussed below in detail.

At existing freshwater and marine survival rates (the medians have been estimated by us as 1.1% and 0.4%, respectively), it is unlikely that Atlantic salmon will be able to achieve recovery. As indicated in the survival analysis above, at current survival rates wild spawners are having a very small effect on the number of returning salmon. If hatchery supplementation were to cease, the population would decline rapidly, and recovery would not be possible. Therefore, a significant increase in either freshwater or marine survival (or a lesser increase in both) will be necessary to achieve recovery.

We anticipate that over the term of the new license that Atlantic salmon produced in conservation hatcheries will continue to be stocked in all three habitat units, including the Penobscot SHRU. As long as the hatchery continues to produce Atlantic salmon, the species will not go extinct in the wild. However, recovery of the species requires a self-sustaining population of wild-reared fish with a positive growth rate.

As described above the condition of the GOM DPS of Atlantic salmon is dire. Adult return rates continue to be extremely low, and it is unlikely that the species can recover unless there is a significant improvement in both marine and freshwater survival. At existing freshwater and marine survival rates (the medians have been estimated by NMFS as 1.1% and 0.5%, respectively), it is unlikely that Atlantic salmon will be able to achieve recovery. A significant increase in either one of these parameters (or a lesser increase in both) will be necessary to overcome the significant obstacles to recovery. The Atlantic Salmon Recovery Team (ASRT) created a conceptual model to indicate how marine and freshwater survival rates would need to change in order to recover Atlantic salmon (ASRT 2010). In Figure 17, the red dot represents current marine and freshwater survival rates; the blue line represents all possible combinations of marine and freshwater survival rates that would result in a stable population with a growth rate of zero. If survival conditions are at or above the blue line, the population is growing, and, thus, trending towards recovery (lambda greater than one). The red lines indicate the rates of freshwater survival that have been historically observed (Legault 2004). This model indicates that there are many potential routes to recovery; for example, recovery could be achieved by significantly increasing the existing marine survival rate while holding freshwater survival at existing levels, or, conversely, by significantly increasing freshwater survival while holding marine survival at today's levels. Conceptually, however, the figure makes clear that an increase in both freshwater and marine survival will lead to the shortest and, therefore, most likely to occur, path to achieving a self-sustaining population that is trending towards recovery.

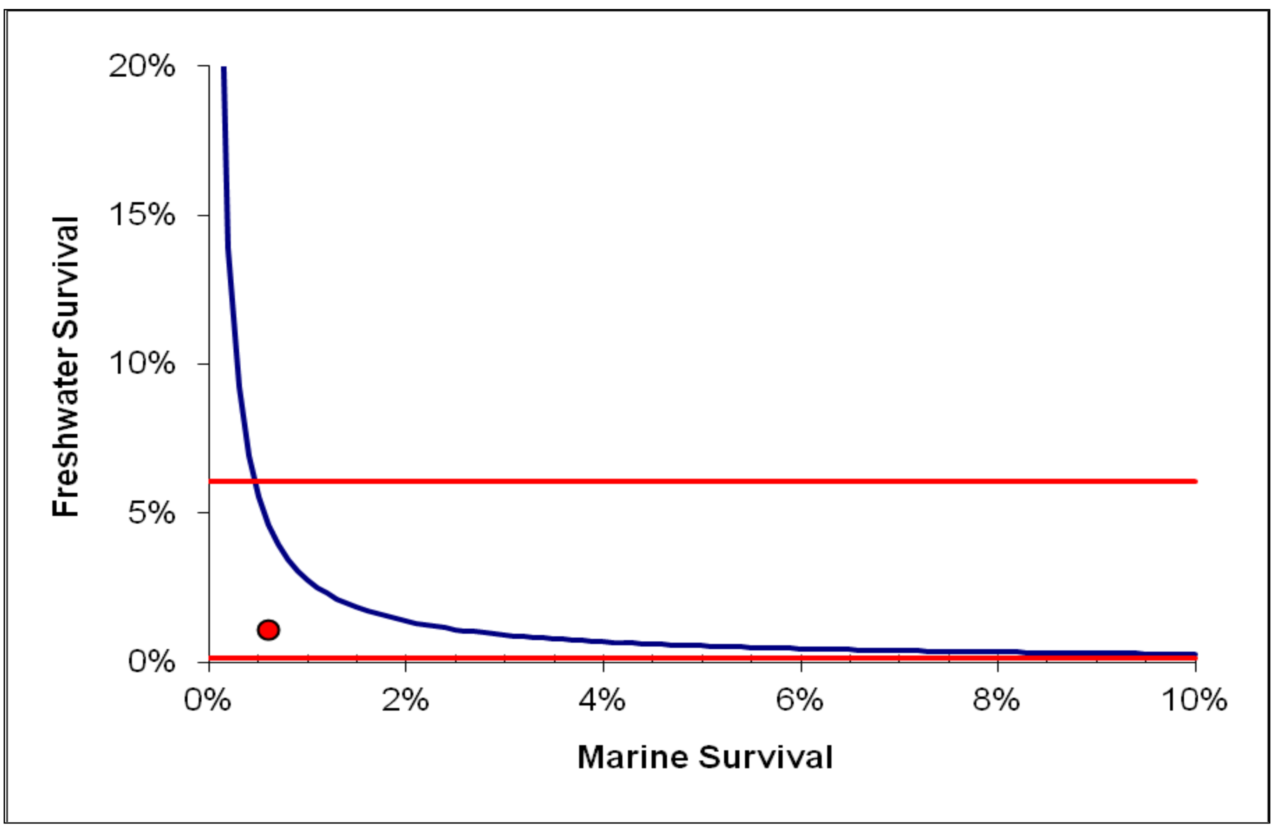

Figure 17. A conceptual model constructed by ASRT (2010) that demonstrates how changes in marine and freshwater survival will be necessary to recover the GOM DPS of Atlantic salmon.

(Note: The dot represents current conditions, the curved line represents recovery, and the straight lines are the historic maximum and minimum freshwater survival).

Here, we consider two things. The effect that the proposed action has on the likelihood that the species can recover, and secondly, the effect it has on achieving and maintaining the recovery criteria if freshwater and/or marine survival rates improve sufficiently to allow for recovery. The proposed action, while resulting in the mortality of smolts and a small number of adults, ensures access to upstream habitat that can support spawning and rearing and increases the potential for increases in abundance in the action area and increased reproduction in the upper Penobscot River. While recovery is not possible without significant improvements in freshwater and marine survival, the amount of mortality anticipated as a result of the proposed action will not appreciably reduce the likelihood of achieving the recovery criteria. This is because, even considering the injury and mortality of smolts, kelts, and adults in years 1-10 and then following achievement of the performance standards, the proposed action will allow the action area and the upper Penobscot River to support a viable, self-sustaining population of Atlantic salmon that will be capable of having a positive growth rate. The proposed action will adversely affect freshwater survival (through the direct effects of dam passage) and marine survival (through hydrosystem delayed mortality) of salmon in the Penobscot River. We anticipate that these effects will be reduced through the required reductions in mortality and delay necessary to meet the upstream and downstream performance standards. We anticipate an increase in smolt outmigration and commensurate increase in potential adult returns over the life of the license. During the first 10 years of the project license, the number of smolts surviving in the project area is expected to improve. While in the first ten years of the proposed action we anticipate smolt mortality of up to 25% annually and pre-spawn adult mortality of up to 0.29% annually as a result of the proposed action, we expect that level of mortality to go down starting in year two as a result of a number of operational changes in the proposed action. First, in year two, the installation of new 1” trashracks, will result in a decline in smolt mortality. In addition, improvements to upstream and downstream passage over the first ten years of the license will allow for more smolts to outmigrate, and more adults to access upstream spawning habitat and potentially for more adult returns. As a result, even in the first 10 years, the proposed action will not appreciably diminish the likelihood of recovery because the proposed action will not affect the status and trend of the Penobscot River SHRU or the DPS as a whole. The proposed action will not diminish spawning, rearing and foraging habitat. The proposed action will not appreciably diminish the ability of Atlantic salmon to migrate upstream and downstream particularly as the project moves toward achieving the performance standards. The proposed action will not impact future reproductive output to the extent that it would preclude a self-sustaining population that could sustain an increasing trend towards recovery and decreasing reliance on the conservation hatchery program over time. Moreover, because we anticipate continuation of the conservation hatchery program and continued stocking above the project in years 1- 10, we anticipate the persistence of Atlantic salmon in the action area. This will allow the action area and the Penobscot SHRU to support the production, distribution and potential adult returns, all necessary for the GOM DPS to achieve recovery. Once the upstream and downstream performance standards are achieved at the Mattaceunk Project, we expect that these improved conditions will lead to increased stocking upstream of the dam, which will ultimately lead to increased abundance and distribution of wild fish. Thus, the proposed action provides conditions that would allow for the action area to support a viable, self-sustaining population of

Atlantic salmon capable of having a positive growth rate. This will allow the action area to contribute to the recovery of the Penobscot River population and the Penobscot SHRU. The proposed action will also result in access to 55,700 units of rearing habitat, which will further facilitate the recovery of the population.

The DIA model can help inform the future effects of the proposed action in a "recovery" scenario; that is, a future where freshwater and marine survival are improved to levels that would support recovery. For this analysis, marine and freshwater survival rates were increased in the DIA model to a point that will allow for the recovery of the species. To do this, assumptions are made about what constitutes a realistic increase in these parameters. To estimate the increase in egg-to-smolt and marine survival rates needed to reach 2,000 wild adults, the DIA model ran a base case scenario with variable increases in egg-to-smolt and marine survival rates and changes in the number and locations of smolts stocked and the number of 2SW females removed for use as broodstock. The DIA used many combinations of egg-to-smolt and marine multipliers that could result in 2,000 wild adults. Ultimately, the DIA model selected a combination where the multipliers were approximately the same due to a lack of information needed to determine if increases to either survival rate would be more likely. The DIA ran 100,000 iterations, selecting random draws from the uniform distributions. From this set of iterations, the combination of multipliers that were approximately equal and resulted in the median number of wild adults closest to and greater than 2,000. The resulting multipliers for the increased egg-to-smolt and marine survival rates were 2.2 and 1.8, respectively. Separately, the DIA model determined what increases in survival were needed at the Mattaceunk Project to achieve recovery and those survival rates were used in the model. DIA model also transitions from the dependence on use of hatcheries to wild smolt production consistent with the 2019 Atlantic Salmon Recovery Plan. The DIA model uses a conceptual timeframe for transitioning from hatchery dependence to illustrate the effect that it would have on population growth. To transition from hatchery supplementation to wild smolt production, baseline smolt stocking numbers and locations were used in generations 1–3, reduced numbers of smolts were stocked in altered stocking locations in generations 4–7, and no smolts were stocked in generations 8–15 (Figure 18). Starting in generation 4, the number of smolts stocked was reduced by 20% of the original number in every generation until no smolts were stocked in generation 8. Smolt stocking locations were also changed to areas of higher quality spawning and rearing habitat that were underutilized in the current (i.e., baseline) stocking strategy (Figure 19). Removal of 2SW females for use as broodstock occurred only in generations 1–7 because no broodstock were needed when smolt stocking ceased (Figure 20).

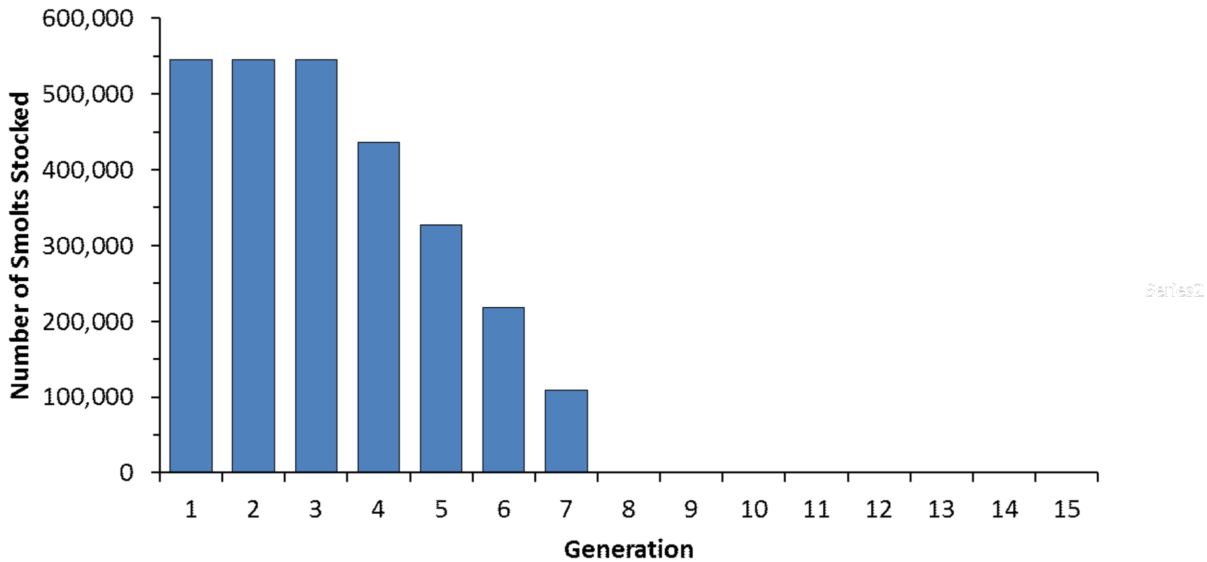

Figure 18. Number of Atlantic salmon smolts stocked in the Penobscot Salmon Habitat Recovery Unit in generations 1 – 15 in the DIA recovery analysis.

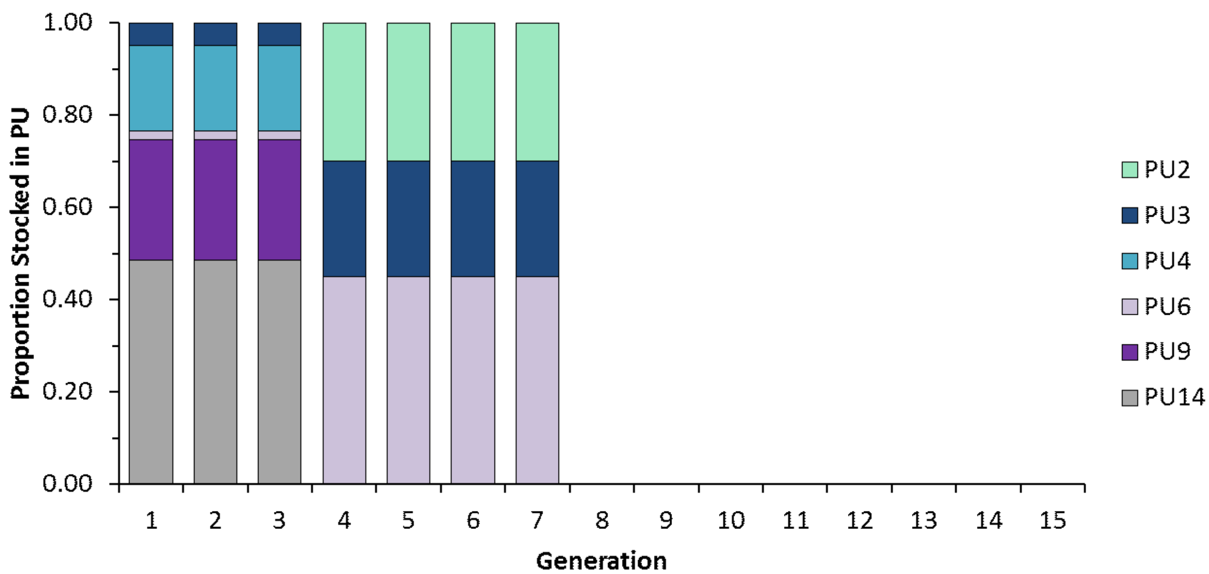

Figure 19. Atlantic salmon smolt stocking locations in the Penobscot Salmon Habitat Recovery Unit in generations 1 – 15 in the DIA recovery analysis.

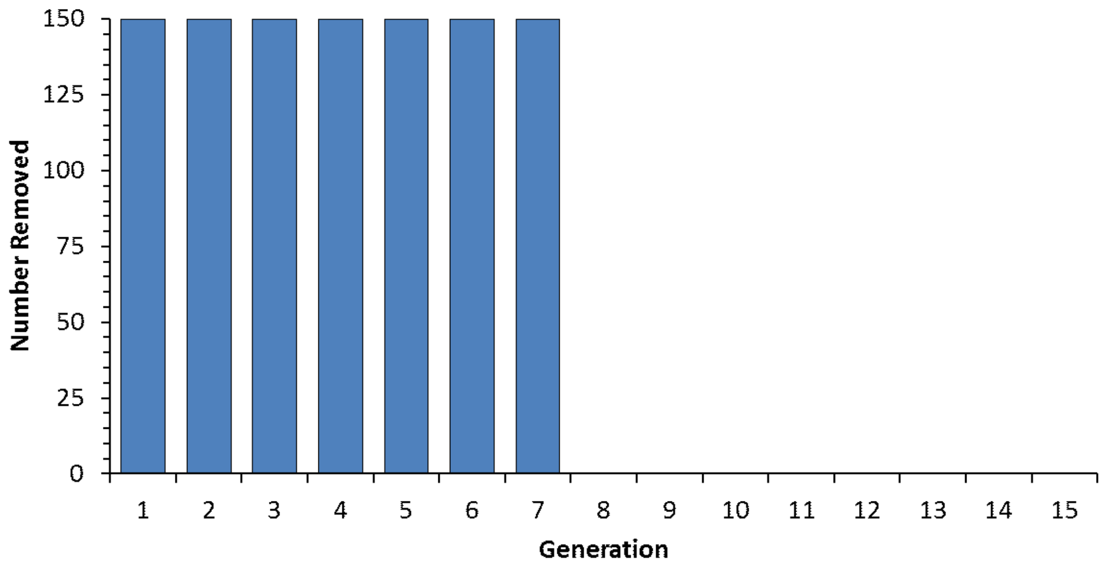

Figure 20. Number of two sea-winter Atlantic salmon females removed for use as broodstock in the Penobscot Salmon Habitat Recovery Unit in generations 1 – 15 in the DIA recovery analysis. In generation 1, the removal of 150 two sea-winter females was included in the calculation of the initial number of adults.

Abundance

For the recovery analysis, the DIA model compares adult Atlantic salmon abundance between three scenarios including: 1) baseline conditions of Atlantic salmon survival in the action area and Penobscot SHRU ("Existing"); 2) conditions whereby the Mattaceunk Project is achieving the 95% upstream performance standard for pre-spawned fish and the 96% downstream performance standard for smolts[12] and existing project related impoundment mortality of smolts is occurring ("Proposed w/ Impound"); 3) proposed conditions whereby the Mattaceunk Project is achieving the 95% upstream performance standard for pre-spawned fish and the 96% downstream performance standard for smolts and project-related impoundment mortality of smolts is mitigated ("Proposed"). For comparison purposes, two additional scenarios were also modeled in the DIA including: 4) the Mattaceunk Project removed (Weldon Removed), and (5) all hydroelectric dams in the watershed removed, except those in the West Branch (No Dams). These model runs are not analyzed herein as they are not part of the proposed action under consideration.

As can be seen in Figure 21, the DIA model output indicates that the proposed action ("Proposed") would allow the Penobscot Bay SHRU to achieve the recovery threshold of 2,000 wild adult Atlantic salmon by generation three assuming marine and freshwater survival rates improve in the GOM DPS of Atlantic salmon. Median adult abundance in the Penobscot River watershed was highest in the scenario with no dams and was similar in all other scenarios;

[12] Kelts (i.e., potential repeat spawners) were not included in the model due to limited quantitative information for model inputs and the limited number of kelts in the present-day Penobscot population (USASAC 2018).

however, adult abundance in the scenario considering the proposed action is sufficient to allow for achievement of recovery criteria tied to abundance. Adult abundance decreased from generations 6 to 15 as the recovery program transitions to no stocking of Atlantic salmon in the Penobscot Bay SHRU but remains self-sustaining, which allows for the potential of the population to meet downlisting and delisting goals outlined in the 2019 Recovery Plan.

Figure 22 depicts median adult Atlantic salmon abundance in the action area under the five modeled scenarios in the DIA Model. Median adult abundance in the action area increased under improved freshwater and marine survival. Adult abundance in the action area remained low while existing stocking conditions were in place, increased as smolts were stocked higher in the watershed, and then decreased as the number of smolts stocked decreased to zero.

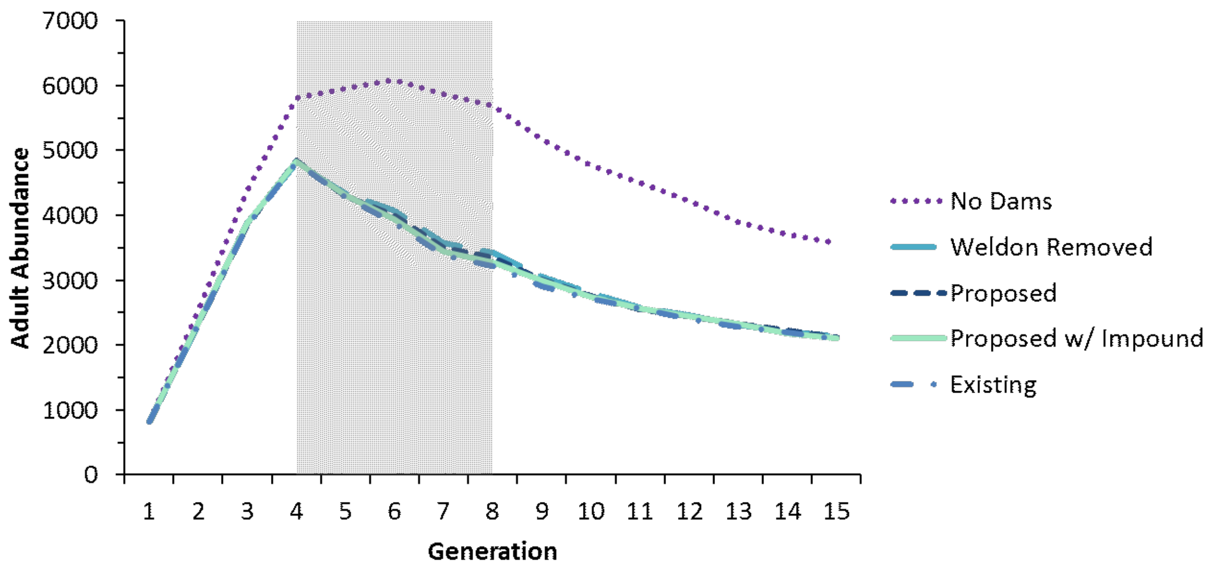

Figure 21. Median adult Atlantic salmon abundance in the Penobscot Salmon Habitat Recovery Unit in generations 1 – 15 under five modeled scenarios in the DIA Model). Note the gray box highlights the period of changing model inputs for freshwater/marine survival and discontinued stocking and broodstock collections.

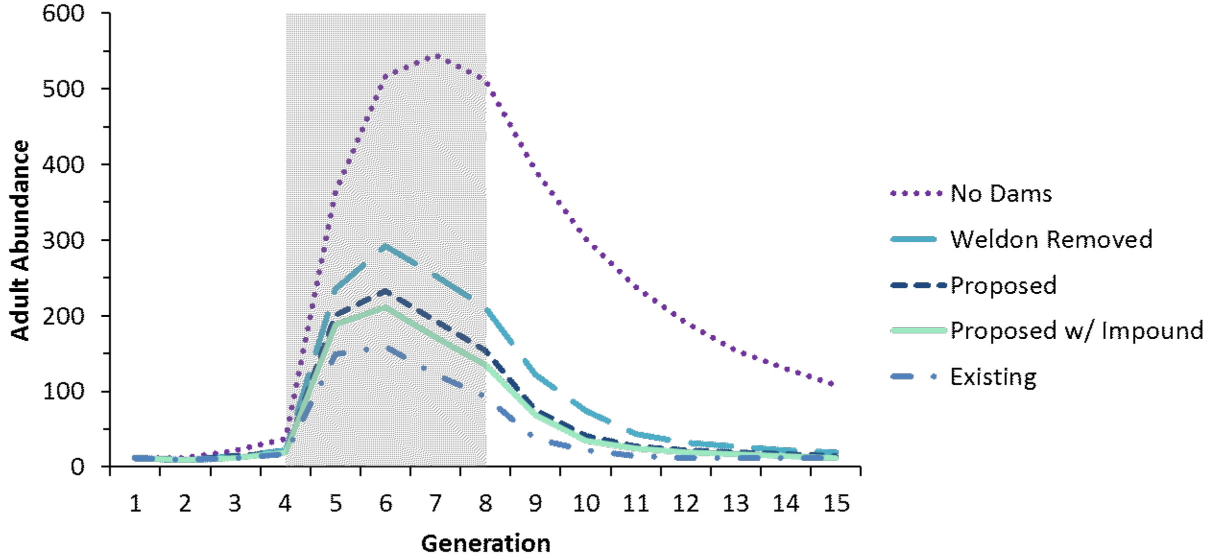

Figure 22. Median adult Atlantic salmon abundance in the Action Area (Production Unit 2) in generations 1 – 15 under five modeled scenarios in the DIA Model (see Attachement B). Note the gray box highlights the period of changing model inputs for freshwater/marine survival and discontinued stocking and broodstock collections.

Distribution

For the recovery analysis, the DIA model compares adult Atlantic salmon distribution between three scenarios including: 1) baseline conditions of Atlantic salmon survival in the action area and Penobscot SHRU ("Existing"); 2) conditions whereby the Mattaceunk Project is achieving the 95% upstream performance standard for pre-spawned fish and the 96% downstream performance standard for smolts[13] and existing project-related impoundment mortality of smolts is occurring ("Proposed w/ Impound"); 3) proposed conditions whereby the Mattaceunk Project is achieving the 95% upstream performance standard for pre-spawned fish and the 96% downstream performance standard for smolts and project-related impoundment mortality of smolts is eliminated ("Proposed"). For comparison purposes, two additional scenarios were also modeled in the DIA including: 4) the Mattaceunk Project removed (Weldon Removed), and (5) all hydroelectric dams in the watershed removed, except those in the West Branch (No Dams).

Figure 23 depicts the distribution of wild, adult Atlantic salmon for each of the five scenarios in generation 15 with modified stocking or broodstock collections in the Penobscot River and improved freshwater and marine survival. This figure suggests that salmon distribution in the Penobscot Bay SHRU is best under a no dam scenario; but is not significantly different between a "Weldon Removed" scenario and the proposed action, due to the anticipated high passage rates of upstream and downstream migrants.

[13] Kelts (i.e., potential repeat spawners) were not included in the model due to limited quantitative information for model inputs and the limited number of kelts in the present-day Penobscot population (USASAC 2018).

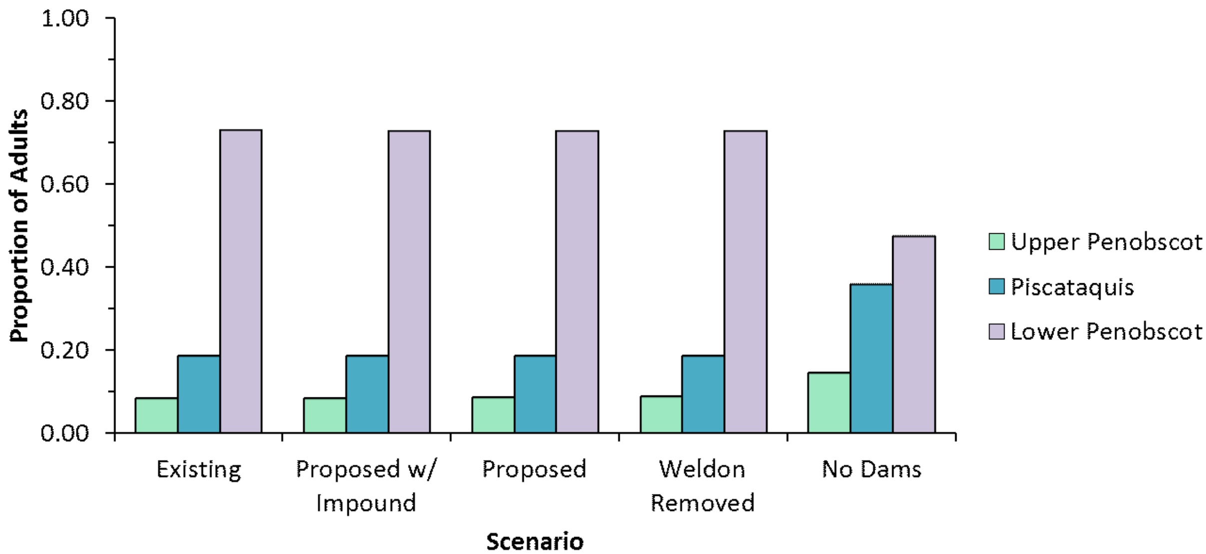

Figure 23. Median proportion of wild- (solid borders) and hatchery-origin (dashed borders) adult Atlantic salmon in the Upper Penobscot, Piscataquis, and Lower Penobscot areas of the Penobscot River watershed in generation 15 under five modeled scenarios in the DIA Model. Note the figure incorporates changing inputs for freshwater/marine survival and no stocking or broodstock collections.

The results of the DIA model support the conclusions reached above that the proposed action will not appreciably reduce the likelihood of recovery. Because the action will not reduce appreciably the likelihood that the Penobscot Bay SHRU population of Atlantic salmon can recover, it will not reduce the likelihood that the GOM DPS as a whole can recover. Based on the information provided above, the proposed action will not reduce appreciably the likelihood of recovery for Atlantic salmon in the wild (i.e., it will not decrease the likelihood that the species will continue to persist into the future with sufficient resilience to allow for the potential recovery from endangerment). While juvenile and adult Atlantic salmon mortality associated with passage at the Mattaceunk Project will continue to have an adverse effect on Atlantic salmon in the Penobscot River, the DIA model indicates that the loss will not be sufficient to reduce appreciably the species ability to achieve recovery. As such, there is not likely to be an appreciable reduction in the likelihood of recovery of the GOM DPS of Atlantic salmon.

Summary of Consequences of the Proposed Action to the Survival and Recovery of Atlantic Salmon

In this section, we summarize the consequences of the proposed action on the GOM DPS of Atlantic salmon in conjunction with the environmental baseline. Based on the information provided above, the proposed action is not likely to reduce appreciably the likelihood of survival and recovery for Atlantic salmon in the wild (i.e., it will not decrease the likelihood that the species will continue to persist into the future with sufficient resilience to allow for the potential recovery from endangerment). The proposed action is expected to result in the mortality of smolts and adults as a result of dam passage and impoundment effects. Over the life of the project, we anticipate an increase in numbers and distribution of Atlantic salmon in the action area and an increase in reproduction upstream of the action area as performance standards are met and smolt mortality in the impoundment is minimized and mitigated. In years 1-10, up to 25% of smolts, 24.2% of kelts, and 0.29% of adults may be killed passing the project. However, over that period the percentage of smolts killed is expected to trend downward as operational and structural changes are made. With the continuation of the conservation hatchery program and stocking continuing upstream of the project, we expect that salmon will continue to persist in the action area at a stable level over this period. These losses will not change the status or trend of the DPS over this period. In years 11- 40 of the license, the action is expected to result in conditions that would support a positive population growth rate in the action area and the ability of the action area to support a self-sustaining run of Atlantic salmon of sufficient size, reproductive potential, and distribution to support the continued survival of the DPS and an improved recovery potential. As described by the authors of the DIA model report, adult abundance at the watershed level was not affected by increased survival at Weldon Dam or its impoundment when early-life-stage and marine survival rates were low. Current stocking locations have been set to minimize the negative effects of dams, such as Weldon Dam, and, therefore, few fish are stocked high in the watershed. From 2008 to 2017, an average of 48% of smolts were stocked below all dams in the watershed and less than 5% of smolts were stocked into the Upper Penobscot drainage (as defined in Figure 3.19.1; USASAC 2018). From 2014 to 2017, 100% of smolts were stocked below all dams in the watershed. Few or no fish are located in the upper watershed because of these management decisions, and so few fish will be affected by changes at Weldon Dam until a change in stocking is made to increase stocking above the dam or natural reproduction increases sufficiently to allow for an increase in adult returns. In the model scenarios where the population was recovering under increased survival rates and the stocking strategy had been modified, our results showed further increased abundance when survival at Weldon Dam and its impoundment were increased. Atlantic salmon were located above Weldon Dam in these scenarios, and so increased survival at the dam and impoundment did benefit the population.

The proposed action will not affect Atlantic salmon in a way that prevents the species from having a sufficient population, represented by all necessary age classes, genetic heterogeneity, and number of sexually mature individuals producing viable offspring and it will not result in consequences to the environment which would prevent Atlantic salmon from completing their entire life cycle, including reproduction, sustenance, and shelter. The proposed action will not reduce numbers, reproduction, or distribution of Atlantic salmon to such an extent that will reduce the likelihood that recovery of the species will occur.

8.3. Designated Critical Habitat

We consider the impacts of the proposed action on critical habitat in the action area and then consider how those will affect the conservation value of critical habitat designated in the Penobscot Bay SHRU and then consider those consequences in the context of critical habitat designated for the GOM DPS to determine whether the proposed action is likely to result in the destruction or adverse modification of critical habitat designated for the Gulf of Maine DPS of Atlantic salmon. On August 27, 2019, NMFS and USFWS published a revised regulatory definition of "destruction or adverse modification" (84 FR 44976). Destruction or adverse modification “means a direct or indirect alteration that appreciably diminishes the value of critical habitat as a whole for the conservation of a listed species.

According to the 2019 Atlantic salmon recovery plan (USFWS/NMFS 2019), recovery of Atlantic salmon will require at least 30,000 accessible and suitable spawning and rearing habitat units in each SHRU including the Penobscot Bay SHRU. Presently, only approximately 18,600 units are currently considered fully accessible in the Penobscot Bay SHRU. Habitat upstream or downstream of a hydro dam will be considered “accessible” by the Services if Atlantic salmon passage performance standards necessary to avoid jeopardizing the species are achieved at any particular dam. As such, we expect an additional 141,500 units of habitat will become accessible within the Penobscot Bay SHRU once upstream and downstream performance standards are achieved at the Milford and West Enfield Projects. Once the upstream and downstream performance standards are achieved at the Mattaceunk Project, an additional 55,700 units of rearing habitat will be made accessible in the Penobscot River. Therefore, the proposed action is expected to facilitate the goal of achieving a minimum of 30,000 units of accessible and suitable spawning and rearing habitat in the Penobscot Bay SHRU and this goal is expected to be achieved by year 11 of the project license.

As explained in Section 6.4, we have determined that the action is likely to adversely affect PBFs M1, M2, M3, and M4. Here, we summarize those adverse effects and consider whether the adverse effects to the PBFs in the action area result in a direct or indirect alteration of the critical habitat that appreciably diminishes the value of critical habitat as a whole for the conservation of the Gulf of Maine DPS of Atlantic salmon (i.e., we determine whether the proposed action is likely to result in the destruction or adverse modification of critical habitat). This analysis takes into account the geographic and temporal scope of the proposed action, recognizing that “functionality” of critical habitat necessarily means that it must now and must continue in the future to support the conservation of the species as a whole and progress toward recovery. The analysis takes into account any changes in amount, distribution, or characteristics of the critical habitat that will be required over time to support the successful recovery of the species. Destruction or adverse modification does not depend strictly on the size or proportion of the area adversely affected, but rather on the role the action area and the affected critical habitat serves with regard to the function of the overall critical habitat designation, and how that role is affected by the action. This analysis ties directly to the recovery objective of “access to sufficient suitable habitat” that is found in both the reclassification and delisting objectives.

As explained in the Consequences of the Action section of this Opinion, features M5 and M6 are fully functional in the action area and the proposed action will maintain that functionality. That is, even with the proposed action, the action area has sufficiently cool water temperatures and water flows that coincide with diurnal cues to stimulate smolt migration. Operating the

Mattaceunk Project in run-of-river mode provides nearly natural flows and prevents rapidly fluctuating water levels from occurring downstream of the project, which prevents stranding of migrating Atlantic salmon or dewatering of habitat downstream the project. During spring months, high flows and low water temperatures in action area will continue to be protective of the features of M5. Operation of the Mattaceunk Project does appears to have minimal effects on water temperatures during the spring migration season of smolts. Also, run-of-river operations mimic a natural hydrograph which allows for stimulation of smolt migration. PBF M6 in the action area is fully functional; the action area has the water chemistry needed to support sea water adaptation of smolts. During spring months when smolts are present in the action area, water quality in the action area is protective of the features of M5. Operation of the Mattaceunk Project does not affect water chemistry in the Penobscot River. Therefore, we anticipate that these features will remain fully functional in the action area over the life of the license.

Features M1, M2, M3 and M4 are not fully functioning in the action area largely because of effects of the current operations of the project. The proposed action will continue to adversely affect these features, however the consequences will be significantly reduced from current conditions over time. PBF M1 requires 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. PBF M4 requires freshwater and estuary migration sites free from physical and biological barriers that delay or prevent emigration of smolts to the marine environment. The Weldon Dam is a barrier for adults seeking access to the 35% of the estimated rearing habitat in the Penobscot watershed that is upstream of the dam and is a barrier to smolts out-migrating from habitats above the dam. Operation of the project in compliance with the identified upstream and downstream performance standards will allow the action area to function as migratory habitat and ensures access to upstream and downstream habitats for adults and smolts.

PBF M2 requires 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. The Weldon Dam does not significantly affect water temperature and the suitability of habitat for holding and resting of upstream migrating adult salmon somewhat by maintaining the impoundment but will allow for the functioning of this migration feature as the action area will be able to provide both temporary holding and resting areas during upstream migration of adult salmon.

PBF M3 calls for freshwater and estuary migration sites with abundant, diverse native fish communities to serve as a protective buffer against predation. The installation of a new fishway for alosines in year 15 of the project license, combined with measures to reduce downstream mortality, is expected to result in a significant increase in the abundance and diversity of native fish in the action area which will improve the functioning of this feature.

We anticipate that the consequences of the action will allow for the functioning of migration habitat in the action area, although not immediately. Once the upstream and downstream performance standards are fully achieved at the Mattaceunk Project and project-related impoundment losses of smolts are eliminated or mitigated, the issuance of a new license for a term of 40-years under these conditions improve the PBFs of M1, M2, M3, and M4 in the action area whereby the consequences to the species should be insignificant. Because the proposed action will allow for the features of critical habitat in the action area to function for Atlantic salmon, and the existing conditions, while limiting, still provide some conservation value in the action area, the proposed action will not have a significant effect on the conservation value of that habitat. Therefore, because the consequences to the migratory corridor PBF of critical habitat will not appreciably diminish the value of critical habitat in the action area or the Penobscot River critical habitat unit as a whole, it will not diminish the value as a whole for the conservation of the Penobscot Bay SHRU; therefore, it is not likely to result in the destruction or adverse modification of critical habitat designated for the Gulf of Maine DPS of Atlantic salmon.

9. CONCLUSION

After reviewing the best available information on the status of the GOM DPS of Atlantic salmon and designated critical habitat, the environmental baseline for the action area, the consequences of the action and associated actions to be undertaken by GLHA, and the cumulative effects, it is our biological opinion that the proposed action may adversely affect but is not likely to jeopardize the continued existence of the GOM DPS of Atlantic salmon. Furthermore, the proposed action is not likely to destroy or adversely modify critical habitat designated for the GOM DPS.

10. INCIDENTAL TAKE STATEMENT

Section 9 of the ESA prohibits the take of endangered species of fish and wildlife. "Fish and wildlife" is defined in the ESA "as any member of the animal kingdom, including without limitation any mammal, fish, bird (including any migratory, non-migratory, or endangered bird for which protection is also afforded by treaty or other international agreement), amphibian, reptile, mollusk, crustacean, arthropod or other invertebrate, and includes any part, product, egg, or offspring thereof, or the dead body or parts thereof" (16 U.S.C. §1532(8)). "Take" is defined as to harass, harm, pursue, hunt, shoot, wound, kill, trap, capture or collect, or to attempt to engage in any such conduct. Harm is further defined by NMFS to include any act that actually kills or injures fish or wildlife. Such an act may include significant habitat modification or degradation that actually kills or injures fish or wildlife by significantly impairing essential behavioral patterns including breeding, spawning, rearing, migrating, feeding, or sheltering. On December 21, 2016, we issued *Interim Guidance on the Endangered Species Term "Harass."*[14] In this guidance, we interpret "harass" to mean to "…create the likelihood of injury to wildlife by annoying it to such an extent as to significantly disrupt normal behavioral patterns which include, but are not limited to, breeding, feeding, or sheltering." Incidental take is defined as take that is incidental to, and not the purpose of, the carrying out of an otherwise lawful activity. "Otherwise lawful activities" are those actions that meet all State and Federal legal requirements except for the prohibition against taking in ESA Section 9 (51 FR 19936, June 3, 1986), which would include any state endangered species laws or regulations. Section 9(g) makes it unlawful for any person "to attempt to commit, solicit another to commit, or cause to be committed, any offense defined [in the ESA]" (16 U.S.C. § 1538(g)). See also 16 U.S.C. § 1532(13) (definition of "person").

14 http://www.nmfs.noaa.gov/op/pds/documents/02/110/02-110-19.pdf

An incidental take statement (ITS) exempts action agencies and their permittees from the ESA's section 9 penalties and prohibitions if they comply with the reasonable and prudent measures and the implementing terms and conditions of the ITS. An ITS must specify the amount or extent of any incidental taking of endangered or threatened species. It also provides reasonable and prudent measures that are necessary and appropriate to minimize and/or monitor incidental take and sets forth terms and conditions with which the action agency must comply in order to implement the reasonable and prudent measures. The measures described in this section are nondiscretionary. If FERC fails to include these conditions in the license articles or GLHA fails to assume and carry out the terms and conditions of this ITS, the protective coverage of section 7(a)(2) may lapse. To monitor the effect of incidental take, FERC must require GLHA to report the progress of the action and its effect on the GOM DPS to us, as specified in this incidental take statement (50 CFR §402.14(i)(3)).

10.1. Amount or Extent of Take

The following sections describe the amount or extent of take that we expect will result from the anticipated consequences of the proposed action. If the proposed action results in take of a greater amount or extent than that described, FERC would need to reinitiate consultation immediately. The exempted take includes only take incidental to the proposed action.

Smolts

We assume it could take up to 10 years of monitoring and adaptive management to achieve the downstream smolt performance standard of 96%. While we expect downstream passage for smolts to improve at the project during this period, the best available information suggests that smolt survival at the project could be as low as 89.3% during the 10-year adaptive management period.

The best available information suggests that 8.7% of all smolts migrating through the Mattaceunk Project impoundment could be injured or killed during the first 10 years after license issuance. GLHA will implement a plan to identify the sources of mortality of smolts in the impoundment. Following that study, GLHA will reduce and/or eliminate sources of mortality. If that is not possible, GLHA will identify and implement habitat enhancement projects designed to increase productivity of habitats upstream of the project with the goal of increasing the number of smolts migrating through the impoundment. In this case, the percentage of smolts dying in the impoundment may not be reduced.

Therefore, this ITS exempts the following amount of annual take for smolts in the action area:
Years 1-10 of the License:

- The death or injury of up to 10.7% (10.2% immediate and 0.5% indirect) of smolts passing the Mattaceunk (Weldon) Dam.
- The harassment of up to 8.8% of salmon smolts due to significant delays in passing the project dam.
- The death or injury of up to 8.7% of smolts migrating through the project impoundment.

- The death of up to 6% of smolts passing the Mattaceunk Project due to dam related mortality experienced in the estuary.

Years 11-40 of the License:

- The harassment, death or injury of up to 4% of smolts passing the Mattaceunk (Weldon) Dam.
- The death or injury of up to 8.7% of smolts migrating through the project impoundment. We note that during this period, operational and/or mitigation measures will be required to result in “no net loss” of smolts.
- The death of up to 6% of smolts passing the Mattaceunk Project due to dam related mortality experienced in the estuary.

Pre-Spawned Adults

We assume it could take up to 10 years of monitoring and adaptive management to achieve the upstream adult salmon performance standard of 95%. The best available information indicates the existing upstream fishway at the project has a minimum efficiency of 71%. Therefore, up to 29% of pre-spawn Atlantic salmon run in the action area could be impacted during the 10 year adaptive management period. Of the 29% of Atlantic salmon that do not successfully use the upstream fishway during this period, 1% (or 0.29% of the run) will die based upon an expert panel convened by us in 2010. As an example, for Years 1-10 of the license, for every 100 adults that attempt to pass upstream, we expect that up to 29 will fail to pass and to spawn successfully elsewhere in the river (we consider this to be harassment, with the exception of 1% of those 29 adults that will die); we expect 71 to pass upstream of the dam and access upstream spawning habitat, but up to 50% of those adults will take longer than 48-hours to pass (harassment). In Years 11-40 of the license, for every 100 adults that attempt to pass upstream, we expect up to 5 to fail to pass and to spawn successfully elsewhere in the river (harassment, with the exception of 1% of those 5 adults that will die); we expect 95 to pass upstream of the dam and access upstream spawning habitat, with 75% of those adults passing in less than 48 hours and up to 25% taking up to 96 hours (harassment).

Therefore, this ITS exempts the following amount of annual take for pre-spawned, adult Atlantic salmon in the action area for Years 1-10 of the license:

- The harassment of up to 29% of Atlantic salmon adults that attempt to pass the existing fishway but are unsuccessful and instead spawn elsewhere in the river or return to the ocean.
- The death of up to 1% of the adult salmon that do not pass upstream of the project (i.e., no more than 0.29% of the total adults attempting to pass upstream of the project each year).
- The harassment of up to 50% of adult Atlantic salmon that pass upstream of the project; with the trigger for harassment being met when passage takes longer than 96 hours.

In Years 11-40 of the license, we expect 95% of adults to pass upstream of the dam within 96 hours; of those, no more than 25% will take longer than 48 hours. Of the 5% that fail to pass within 96 hours, some will eventually pass, some will spawn in downstream areas, and 1% will die. The ITS exempts the following amount of annual take for pre-spawned adult Atlantic salmon in the action area for Years 11-40 of the license:

- The harassment of up to 23.75% (25% of the 95% that pass within 96 hours) of Atlantic salmon adults (with harassment considered when a passage attempt takes longer than 48 hours)
- The harm or harassment of up to 4.95% of Atlantic salmon adults (99% of the 5% of salmon that fail to pass) and the death of no more than 0.05% of the total adults attempting to pass upstream. We consider harm to have occurred when a passage attempt takes longer than 96 hours and harassment is considered to have occurred if a fish fails to pass and spawns successfully downstream.

Kelts

The best available information indicates that 75.8% of kelts survive passage at the Mattaceunk Project under no-spill conditions. Therefore, this ITS exempts the death or injury of up to 24.5% of kelts migrating in the action area annually during Years 1-10 of the license. In years 11-40 of the license, this ITS exempts the death or injury of up to 4% of kelts passing the Mattaceunk Project under any flow condition in the Penobscot River.

Fish Passage Monitoring

To assess whether the upstream passage standard for pre-spawned Atlantic salmon is being achieved at the Mattaceunk Project, GLHA will tag up to 50 adults (if/when sufficient adults are available for study) for three years to measure upstream passage efficiency. GLHA will also conduct three years of kelt downstream studies likely using up to 50 post-spawned Atlantic salmon each year. We anticipate that all 300 adults used in adult studies will handled, tagged, and injured and that up to 2% (six fish) will be killed.

To assess whether the downstream smolt performance standard is being achieved at the Mattaceunk Project, GLHA will tag up to 2,000 hatchery smolts over ten year adaptive management period All of these fish are anticipated to be injured due to the effects of handling and tag insertion. Up to 2% of the smolts may die due to the effects of handling and tagging. We will consider take to be exceeded if more than 2% of the tagged fish die prior to release.

GLHA will also conduct studies to assess project-related losses of smolts migrating through the Mattaceunk Project impoundment. For purposes of this analysis, we assume this study will be combined with the downstream passage studies such that no additional take needs to be exempted.

We believe this level of incidental take is a reasonable estimate of incidental take that will occur given the seasonal distribution and abundance of Atlantic salmon in the action area. In the accompanying biological opinion, we determined that this level of anticipated take is not likely to result in jeopardy to the species.

10.2. Reasonable and Prudent Measures

The following reasonable and prudent measures are necessary and appropriate to minimize and monitor incidental take of Atlantic salmon. These reasonable and prudent measures and terms and conditions are in addition to the requirements set forth under the Commission's "Staff Alternative with Mandatory Conditions" as presented in FERC's September 2018 Final Environmental Assessment (FEA) for Hydropower License for the Mattaceunk Project.
As those measures will become requirements of any new license issued, we do not repeat them here as they are considered to be part of the proposed action.

The following RPMs are applicable to the FERC:

1. FERC must ensure, through enforceable conditions of the Project license, that the licensee measure and monitor the effectiveness of the proposed fish passage measures as well as measure and monitor the amount and extent of take exempted in the ITS of this Opinion.
2. FERC must ensure, through enforceable conditions of the Project licenses, that the licensee complete an annual monitoring and reporting program to confirm that they are minimizing incidental take and reporting all project-related observations of dead or injured salmon to us.
3. FERC must ensure, through enforceable conditions of the Project license, that the licensee measure and monitor the mortality rate for smolts moving through the project impoundment for a sufficient period of time and through a sufficient variety of in-river conditions (e.g., low flow and high flow springs) to verify the mortality rate of smolts attributable to the impoundment and identify the causes of that mortality. This information will be used to inform the impoundment mortality minimization and/or mitigation program to be implemented by Year 10 of the license.
4. FERC must ensure, through enforceable conditions of the Project license, that the licensee completes an annual monitoring and reporting program to confirm that they are minimizing incidental take for smolt in the project impoundment and reporting all project-related observations of dead or injured salmon to us.

The following RPMs are applicable to GLHA:

5. GLHA must develop and implement a plan to identify the sources of mortality of smolts in the impoundment and develop and implement a plan to minimize the mortality of smolts in the impoundment to a mortality rate equivalent to natural mortality in an appropriate un-impounded reach of the Penobscot River. If it is not possible to reduce the mortality rate, GLHA must develop and implement a plan to carry out mitigation to result in "no net loss" of smolts in the project impoundment by year nine of the license.

10.3. Terms and Conditions

In order to be exempt from prohibitions of section 9 of the ESA, FERC and GLHA must comply with the following terms and conditions, which implement the reasonable and prudent measures

described above and which outline required reporting/monitoring requirements. These terms and conditions are non-discretionary.
To implement reasonable and prudent measure #1, FERC must require GLHA to do the following:

1. Prepare in consultation with NMFS a plan to measure the survival performance standard for downstream migrating Atlantic salmon smolts and kelts at the Mattaceunk Project. The plan must be prepared within two years of license issuance. The need for studies will be confirmed in annual consultation with NMFS.
    a. Require GLHA to measure the survival of downstream migrating Atlantic salmon smolts and kelts at the Mattaceunk Project using a scientifically acceptable methodology.
        i. Measure the survival of downstream migrating smolts approaching within 200 meters of the trashracks downstream to the point where delayed effects of passage can be quantified. GLHA must coordinate with us in selecting an adequate location for the downstream receivers.
        ii. A Cormack-Jolly-Seber (CJS) model, or other acceptable approach, must be used to estimate survival rates and associated error bounds.
        iii. GLHA must consult with us concerning the application of appropriate statistical methodology and must provide an electronic copy of model(s) and data to us.
    b. All tags released in the system should have codes that are not duplicative of tags used by other researchers in the river, including university, state, federal and international tagging programs.
    c. FERC must only consider the downstream performance standards achieved if, based upon an average of three-years, 96% (point estimate) of smolts and kelts survive downstream passage at the Mattaceunk Project. When analyzing telemetry test data, smolts 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).
2. Prepare, in consultation with us a plan to measure the survival performance standard for upstream migrating pre-spawned Atlantic salmon at the Mattaceunk Project. The plan must be prepared within two years of license issuance. The need for studies will be confirmed in annual consultation with us.
    a. Require GLHA to measure the survival of migrating pre-spawned adult Atlantic salmon using a scientifically acceptable methodology.
        i. A Cormack-Jolly-Seber (CJS) model, or other acceptable approach, must be used to estimate survival rates and associated error bounds.
        ii. GLHA must consult with us concerning the application of appropriate statistical methodology and must provide an electronic copy of model(s) and data to us.
    b. All tags released in the system should have codes that are not duplicative of tags used by other researchers in the river, including university, state, federal and international tagging programs.

c. FERC must only consider the upstream performance standard achieved if, based upon an average of three-years, 95% (point estimate) of pre-spawned adult Atlantic salmon approaching the project survive upstream passage. When analyzing telemetry test data, at least 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 order to maximize the likelihood of having adult salmon available for upstream effectiveness studies, FERC must require GLHA to coordinate with resource agencies to develop and implement a plan to stock uniquely marked Atlantic salmon upstream of the Mattaceunk Project annually for three years (to support up to three years of studies). Stocking should be implemented following the installation of the new 1" rack, which is expected by 2023. As such, stocking is anticipated to be needed in 2024-2026. These fish would then serve as a source of imprinted adult fish (i.e., fish homing to areas upstream of Weldon Dam) for up to three years of upstream effectiveness testing of the fishway and upstream fish passage monitoring. GLHA must submit a plan to NMFS and the U.S. FWS describing their proposal for this stocking; dependent on resource needs GLHA may be responsible for costs associated with raising fish, marking, and stocking these fish; we note that a stocking permit will be needed from the Maine DMR. GLHA must also work with the resources agencies to develop an alternative plan to be implemented in the event that hatchery resources are not available to support the proposed stocking in one or more years. In all cases, a stocking plan must be developed and submitted to NMFS, U.S. FWS, and Maine DMR at least one year prior to any planned stocking.

To implement reasonable and prudent measure #2, FERC must require GLHA to do the following:

1. Inspect the upstream and downstream fish passage facilities at the Project daily when they are open. The licensee must submit summary reports to us weekly during the fish passage season.
2. Operate and maintain a PIT system at upstream fishways to monitor Atlantic salmon movements in the project area annually throughout the term of the new license. GLHA must provide all PIT tag data to NMFS annually by December 30.
3. Notify us of any changes in operation including maintenance activities and debris management at the project during the term of the new license.
4. Remove any debris that could affect the ability of fish to pass either the downstream or the upstream fish passages immediately upon inspection.
5. Consult with us annually concerning the replacement of flashboards.
6. Prepare an Operations and Maintenance plan for the upstream and downstream fishways in consultation with resource agencies within the first year of license issuance. The Operations and Maintenance plan should be reviewed each year by resource agencies and the licensee and updated as necessary to accurately reflect any changes in operation and upcoming maintenance scheduling.
7. Submit as-built drawings to us for the current configuration of the upstream and downstream fishways within one year of license issuance.

8. Require that GLHA seek comments from us on any new fish passage design plans at the 30%, 60%, and 90% design phase.
9. Allow us to inspect the upstream and downstream fishways at reasonable times, including but not limited to annual engineering inspection.
10. Contact us within 24 hours of any interactions with Atlantic salmon, including non-lethal and lethal takes (Jeff Murphy: by email (Jeff.Murphy@noaa.gov) or phone (207) 866-7379 and to: incidental.take@noaa.gov.
11. In the event of any lethal takes, any dead specimens or body parts must be photographed, measured, and preserved (refrigerate or freeze) until disposal procedures are discussed with NMFS.

To implement reasonable and prudent measure #3, GLHA must do the following:

1. Prepare in consultation with us a plan to measure project-related loses of smolts in the Mattaceunk Project impoundment. The plan must be prepared within two years of license issuance. The need for studies will be confirmed in annual consultation with us.
2. A Cormack-Jolly-Seber (CJS) model, or other acceptable approach, must be used to estimate survival rates and associated error bounds.
   a. GLHA must consult with NMFS concerning the application of appropriate statistical methodology and must provide an electronic copy of model(s) and data to NMFS.
   b. All tags released in the system should have codes that are not duplicative of tags used by other researchers in the river, including university, state, federal and international tagging programs.

To implement reasonable and prudent measures #4 and #5, GLHA must to do the following:

1. Within one year of the completion of impoundment mortality studies, prepare a plan in consultation with us outlining plans to address project-related loses of smolts migrating though the project impoundment. This plan must: a) describe the mortality rate for smolts migrating through the project impoundment; b) describe the anticipated mortality rate for smolts migrating through an appropriately representative un-impounded reach of the Penobscot River (i.e., control reach); c) describe measures that will be implemented to reduce smolt mortality in the impoundment and the reductions in mortality anticipated to result from implementation of those measures; d) describe any measures that were considered but were determined to be infeasible; e) describe a plan, with associated timeline, for implementing measures to reduce mortality of smolts in the impoundment to background levels. If it is determined that measures can not be implemented to reduce mortality to background levels, Brookfield must consult with NMFS to determine the required amount of compensatory mitigation (i.e., the number of smolts that are expected to be killed annually due to impoundment mortality and the number of habitat units required for restoration of access or habitat improvement). The plan must describe habitat enhancement measures that will be taken to either: a) restore access to the identified number of habitat units, and/or b) improve productivity in the identified number of habitat units. The plan must include a monitoring component designed to evaluate

the effectiveness of the mortality reduction measures and/or the habitat productivity improvements. This plan must be implemented no later than Year 10 of the license.

Prepare a smolt stocking plan in consultation with us if enhancement and mitigation measures cannot be fully implemented by the 10-year milestone to serve as an interim mitigation solution. The final plan must be submitted at least one year prior to the 10-year milestone. Given the significant consultation necessary to develop and implement the stocking plan with various state and federal resource agencies and the Penobscot Indian Nation, GLHA must submit a draft of the plan to NMFS (for coordination with the appropriate state and federal agencies and PIN) within 3 years of license issuance. The plan must address the source of the stocked fish and plans for tagging and stocking. GLHA will be responsible for any costs associated with sourcing, raising, tagging, transport, and stocking these fish. It should be noted that smolts stocked as part of any impoundment mitigation plan must not be reallocated from the conservation hatchery program already in place for the Penobscot River (e.g., it would not be acceptable to divert fish that would have been stocked below the project to the impoundment for purposes of mitigation). The final plan must be submitted at least one year prior to the 10-year milestone and shall not be implemented until approved by NMFS, which will be done in coordination with relevant state and Federal resource agencies and the PIN.

The reasonable and prudent measures, with their implementing terms and conditions, are designed to minimize and monitor the impact of incidental take that might otherwise result from the proposed action. If, during the course of the action, the level of incidental take is exceeded, reinitiation of consultation and review of the reasonable and prudent measures are required. FERC must immediately provide an explanation of the causes of the taking and review with us the need for possible modification of the reasonable and prudent measures.

The discussion below explains why the RPM and Terms and Conditions are necessary and appropriate to minimize or monitor the level of incidental take associated with the proposed action and how they represent only a minor change to the action as proposed by FERC.

RPM #1 and its associated Term and Conditions for FERC are necessary and appropriate as they describe how FERC and GLHA will be required to measure and monitor the success of the proposed performance standards. These procedures represent only a minor change to the proposed action as following these procedures should not increase the cost of the project or result in any delays or reduction of efficiency of the project.

RPM #2 and its associated Term and Conditions for FERC and GLHA are necessary and appropriate a to ensure the proper documentation of any interactions with listed species as well as requiring that these interactions are reported to us in a timely manner with all of the necessary information. This is essential for monitoring the level of incidental take associated with the proposed action. This RPM and the Terms and Conditions represent only a minor change as compliance will not result in any increased cost, delay of the project or decrease in the efficiency of the project.

RPM #3 and its associated Terms and Conditions for GLHA are necessary and appropriate as they describe how GLHA will be required to measure and monitor impoundment losses of smolts at the Mattaceunk Project. These procedures represent only a minor change to the proposed action as following these procedures should not increase the cost of the project or result in any delays or reduction of efficiency of the project.

RPM #4 and its associated Terms and Conditions for GHLA are necessary and appropriate to ensure the proper documentation of any interactions with listed species and to ensure GLHA prepares a plan for addressing and minimizing project-related losses of smolts in the project impoundment. This is essential for monitoring the level of incidental take associated with this activity. This RPM and the Terms and Conditions represent only a minor change as compliance will not result in any increased cost, delay of the project or decrease the efficiency of the project.

RPM#5 and its associated Terms and Conditions for GHLA are necessary and appropriate to ensure that GLHA minimizes the mortality of smolts in the impoundment and to ensure that any mitigation plan is appropriately designed to carry out the goals of "no net loss" of smolts in the impoundment. by year nine of the license .

11. CONSERVATION RECOMMENDATIONS

Section 7(a)(1) of the ESA directs Federal agencies to utilize their authorities to further the purposes of the ESA by carrying out conservation programs for the benefit of endangered and threatened species. Conservation recommendations are discretionary agency activities to minimize or avoid adverse effects of a proposed action on listed species or critical habitat, to help implement recovery plans, or to develop information. We have determined that the proposed action is not likely to jeopardize the continued existence of endangered Atlantic salmon in the action area. To further reduce the adverse effects of the proposed project on Atlantic salmon, we recommend that FERC implement the following conservation measures.

1. FERC should require that the licensee compensate for all unavoidable effects of their actions by requiring the licensee to carry out activities that improve the environmental baseline in the action area or in the larger Penobscot Bay SHRU. This could involve the removal of other barriers to fish migration in the Penobscot River watershed, or the construction of fishways. FERC and the licensee should work closely with the state and federal fisheries agencies to identify suitable projects that are likely to contribute to the recovery of Atlantic salmon and address the effects of degradation of designated critical habitat, over the duration of the new license.

12. REINITIATION NOTICE

This concludes formal consultation concerning FERC's proposal to issue a new, 40-year license for the Mattaceunk Project. As provided in 50 CFR §402.16, reinitiation of formal consultation is required where discretionary federal agency involvement or control over the action has been retained (or is authorized by law) and if: (1) the amount or extent of taking specified in the incidental take statement is exceeded; (2) new information reveals effects of the action that may not have been previously considered; (3) the identified action is subsequently modified in a manner that causes an effect to listed species; or (4) a new species is listed or critical habitat designated that may be affected by the identified action. In instances where the amount or extent of incidental take is exceeded, section 7 consultation must be reinitiated immediately. Reinitiation of section 7 consultation is also required should either FERC or GLHA not carry out the non-discretionary RPMs or associated Terms and Conditions contained within this Opinion.

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APPENDIX A

Atlantic Salmon Fate and Straying at Upstream Fish Passage Facilities on the Penobscot River

Atlantic Salmon Fate and Straying at Upstream Fish Passage Facilities on the Penobscot River

Date: February 16, 2011

On December 8, 2010, NOAA's National Marine Fisheries Service (NMFS) convened a panel of experts in Atlantic salmon (*Salmo salar*) biology and behavior to develop the best available scientific information concerning the fate of Atlantic salmon that are unable to pass certain upstream fishways in the Penobscot River watershed. The purpose of this paper is to document the decisions of the expert panel that were made in relationship to data inputs for the Penobscot River dam impact analysis modeling effort. This report is a work in progress and should not be considered an official policy paper issued by the National Marine Fisheries Service. Any comments and questions regarding any of the information in this draft are welcomed and should be directed to Jeff Murphy at 207-866-7379.

Summary: Few, if any, upstream fishways provide 100% safe, timely, and effective passage for migratory fish including Atlantic salmon. Although multiple studies have been conducted in the Penobscot River to measure the effectiveness of fishways at various hydroelectric facilities, very little data is available concerning the fate of adult Atlantic salmon that are unsuccessful in locating or negotiating upstream fishways at dams.

In order to carry out its responsibilities for recovering the Gulf of Maine (GOM) Distinct Population Segment (DPS) of endangered Atlantic salmon, NMFS is constructing a life history model of Atlantic salmon populations in the Penobscot River that will be used to explore a variety of survival scenarios and to help define levels of take that the GOM DPS could accommodate without appreciably reducing survival and recovery. The model will be used to establish survival performance standards at hydroelectric projects on the Penobscot River for use in upcoming Section 7 consultations for Federal Energy Regulatory Agency (FERC) licensed hydroelectric projects. Pursuant to Section 7 of the Endangered Species Act (ESA), the FERC cannot issue a license for a hydroelectric project that jeopardizes the continued existence of the species. Explanations of the process of determining jeopardy and destruction or adverse modification of critical habitat are set forth in Section 7(a)(2) of the ESA and as defined by 50 CFR §402.02 (the consultation regulations).

To develop the Penobscot River model, it is necessary to define the fate of adult salmon that are unsuccessful in passing individual fishways in the Penobscot River watershed. In the absence of site specific data, NMFS determined that an expert panel could be convened to provide the best available scientific information regarding this subject.

The expert panel was represented by state, federal, and private sector biologists and engineers with expertise in Atlantic salmon biology and behavior at fishways. The expert panel consisted of the following participants: Alex Haro (U.S. Geological Survey), Joe Zydlewski (U.S. Geological Survey), Randy Spencer (Maine Department of Marine Resources), Norm Dube (Maine Department of Marine Resources), Scott Hall (Black Bear Hydro), Kevin Bernier(Brookfield Power), Steve Gephard (Connecticut Department of Environmental Protection) Ross Jones (Fisheries and Oceans Canada), Steve Sheppard (Aquatic Science Associates), Jeff Murphy (NMFS), Tim Sheehan (NMFS), Don Dow (NMFS), and Tara Trinko Lake (NMFS).

Issue:

Do Atlantic salmon that are unsuccessful in locating and negotiating upstream fishways at FERC-licensed hydroelectric projects in the Penobscot River: a) die; b) return to the ocean un-spawned; or c) stray and spawn in downstream reaches.

Decision:
Through best professional judgment, the expert panel reached consensus regarding the fate of adult Atlantic salmon that are unsuccessful at locating and negotiating upstream fishways at FERC-licensed hydroelectric projects in the Penobscot River watershed (Table 1). Note that hydroelectric projects upstream of the first impassable dam were not were not evaluated by the group (e.g., dams upstream of the Medway Project on the West Branch of the Penobscot River). Regarding staying and fitness of adults spawning in non-natal productivity units, the panel was unable to reach consensus. Instead, the panel suggested: 1) a general straying rate for each production unit could not be developed; 2) a graduated rate for straying to higher quality habitat higher in the system should be considered; 3) straying into Production Unit #2 (East Branch Penobscot drainage) is probably at the highest level for the drainage and straying into Production Unit #3 (Mattawamkeag drainage) is probably at the next highest level and so on down river; 4) generally, fish will tend to stray within a HUC8 watershed (i.e. fish in the Piscataquis drainage tend to stay within the Piscataquis (Production units 4-8)); 5) Atlantic salmon stocked low in the Penobscot River are probably not straying to production units high up in the system. The group committed to working on this issue in the near future to reach some resolve.

Rationale:
The Penobscot Watershed was separated into 15 discrete production units for analysis. The geographic extent of each production units was based on locations of hydroelectric projects in the watershed as such (see Figure 1):

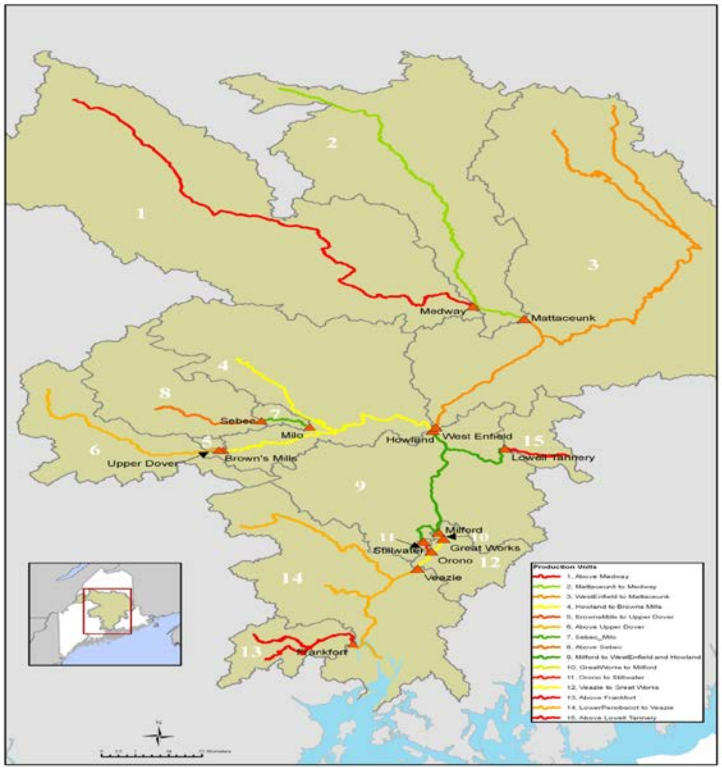
The expert panel addressed two topics including: 1) defining the fate of adult Atlantic salmon unsuccessfully passing upstream fishways in the Penobscot River; and 2) the effect of upstream straying. Notes from the workshop are provided in Attachment A.

For each topic, NMFS provided simple worksheets in which the expert panel was requested to populate (Attachment B). For each worksheet NMFS provided a listing and definition of the fields. The first row of each worksheet was populated with dummy values (*in gray/italics font*) for demonstration purposes.

Based upon best professional judgment, the expert group modified the worksheet #1 to reflect a baseline proportion of adult salmon mortality expected due if a fish was unable to locate and negotiate an upstream fishway (1%) and an additional proportion of mortality (1-2%) at fishways due to site specific factors (e.g., poaching, lack of thermal refugia, etc.). A baseline mortality was not established for those dams currently operating without upstream fishways. Following this analysis, the expert panel estimated the proportion of unsuccessfully passed fish that were likely to return to the ocean un-spawned or stray to other production units. The expert panel was able to populate all the attributes of the modified worksheet #2.

After much discussion, the expert panel could not populate the worksheet #2.

Figure 1. Location of production units within the Penobscot River watershed.



Production Unit Definitions - Downstream to Upstream boundaries

1. Medway to the West Branch headwaters
2. Mattaceunk to Medway-East Branch headwaters
3. West Enfield to Mattaceunk-Mattawamkeag River headwaters
4. Howland to Brown's Mills-Milo-Pleasant River headwaters
5. Brown's Mills to the Dover Upper Dam
6. Dover Upper Dam to the Piscataquis River headwaters
7. Milo to Sebec
8. Sebec to the Sebec River headwaters
9. Stillwater-Milford to Lowell-Howland-West Enfield
10. Great Works to Milford
11. Orono to Stillwater
12. Veazie to Orono-Great Works
13. Frankfort to the Marsh Stream headwaters
14. Verona Island to Frankfort-Veazie
15. Lowell to the Passadumkeag Headwaters

Table 1. Summary of upstream passage inefficiency and straying decisions made by expert panel.

							Destination of straying fish (fish that fail to pass fishway)														
Dam	Baseline Proportion Dead (%)	Additional %age Dead (%)	Total Proportion Dead (%)	Proportion out to Sea (%)	Reasons for fallback to Ocean	Proportion to Stray (%)	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Medway	0	0	0	0	.	100	-	100	-	-	-	-	-	-	-	-	-	-	-	-	-
Mattaceunk	1	0	1	0	.	99	-	-	100	-	-	-	-	-	-	-	-	-	-	-	-
West Enfield	1	1[a]	2	0	.	98	-	-	-	60[e]	-	-	-	-	40	-	-	-	-	-	-
Dover Upper Dam	1	1[b]	2	0	.	98	-	-	-	100	-	-	-	-	-	-	-	-	-	-	-
Brown's Mills	1	1[c]	2	0	.	98	-	-	-	100	-	-	-	-	-	-	-	-	-	-	-
Sebec	0	0	0	0	.	100	-	-	-	10	-	-	90	-	-	-	-	-	-	-	-
Milo	0	0	0	0	.	100	-	-	-	100	-	-	-	-	-	-	-	-	-	-	-
Howland	1	1[a]	2	0	.	98	-	-	40[e]	-	-	-	-	-	60	-	-	-	-	-	-
Lowell Tannery	1	0	1	0	.	99	-	-	1	1	-	-	-	-	98	-	-	-	-	-	-
Stillwater	0	0	0	0	.	100	-	-	-	-	-	-	-	-	-	-	-	100	-	-	-
Milford	1	0	1	0	.	99	-	-	-	-	-	-	-	-	-	-	-	80	-	20	-
Great Works	1	1[c]	2	10	.	88	-	-	-	-	-	-	-	-	-	-	-	80	-	20	-
Orono	0	0	0	0	.	100	-	-	-	-	-	-	-	-	-	-	-	100	-	-	-
Veazie	1	2[d]	3	15	proximity to ocean + handling	82	-	-	-	-	-	-	-	-	-	-	-	-	10	90	-

Frankfort	1	1[d]	2	10	proximity to ocean	88	-	-	-	-	-	-	-	-	-	-	-	10	-	90	-	

[a] high%age of fall back

[b]poaching

[c]lack of thermal refugia

[d]seal predation and/or handling

[e]confirm with Gorsky report

- **Attachment A: Expert Panel Workshop Notes December 8, 2010**
-

Adult Atlantic salmon Upstream Passage Workshop-

December 8, 2010 Maine Field Station

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- **Participants**
- *Alex Haro (USGS), Joe Zydlewski (USGS, UMaine), Randy Spencer (MDMR), Norm Dube (MDMR), Scott Hall (Black Bear Hydro), Kevin Bernier(Brookfield Power), Steve Gephard (Connecticut DEP) Ross Jones (DFO), Don Dow (NOAA), Steve Sheppard (Aquatic Science Associates), Jeff Murphy (NOAA), Tim Sheehan (NOAA), Tara Trinko Lake (NOAA)*
- **Introduction /Overview**–Jeff Murphy
- **Model Overview-** Jeopardy Analysis Model (JAM) run through- Tim Sheehan
- **Questions about the JAM**
  - Why is Sebec included when W. Branch is not, will they be removed from future versions?
    - Both Sebec and the West Branch are included within the current version of the model. It is being developed to have the capacity to model the entire drainage, regardless of it there is passage at any one facility. This may allow for future scenarios to be model where passage may be created where it previously didn't exist.
  - Where do upstream/downstream passage numbers come from?
    - They are from Penobscot Multi Species Management Plan- Greg Mackey (compiled from Holbrook studies, studies referenced in Holbrook's thesis and best professional judgment)
  - Does the broodstock take account for hatchery fish being preferentially taken and wild adults are released?
    - Currently, no. We will need to discuss if this detail needs to be incorporated into the model.
  - Does this scheme account for actual stocking practices today? (Kevin B.)
    - Yes, we can change the input values based on what is happening with stocking regimes.
  - Are we going to assume that all fish spawn?
    - Yes
  - Will there be a 50/50 sex ratio?
    - There can be any sex ration that we desire. We will determine the appropriate sex ratio to use base on the best available information from the ME DMR and USFWS.
  - Upstream passage
    - Several studies have been conducted in the Penobscot River watershed which assess upstream passage effectiveness at various dams. The plan is to use existing data to develop upstream effectiveness ranges at dams where robust data exist.

Absent robust data, NFMS will use best professional judgment to assign upstream effectiveness. It should be noted that, in general, upstream effectiveness is less affected by river flows than downstream effectiveness, and therefore passage across dams within a year will not be correlated.

- Is there a need to model flow data for parts of the catchment where we don't have stream gages?
  - We are going to correlate flow amongst production units,
  - USGS uses Stream Stats to calculate flow based on any area in the basin (Alex)
- What numbers are you using for average number of eggs per female? (Steve G.)
  - Legualt PVA
  - Norm suggested that we take this number from Craig Brook fish
- Where does the marine survival estimate come from?
  - Current version is from the Salmon PVA
  - Will likely use more recent estimates with Penobscot and Narraguagus numbers
- Why 2000 initial adults? And why were they assigned to specific production units
  - We can initiate the model with any number of adults, 2,000 was just what we used for this run. We set 2000 fish as the interim recovery criteria.
  - We assigned them to the production units based on the proportion of habitat.
- One option to determine the distribution of adults throughout the Production Units is to run model for 50yrs and then start the model with the final numbers to make sure that it is realistic. (Joe Z.)
  - We can consider doing this but we would need to modify our input values substantially as stocking plans currently the determining factor as to where fish originate from. Also, we would need to artificially increase our survival estimates to make sure our population is sustain 50 years into the future. We aren't set on the "proportional" approach listed above and will consider alternatives as appropriate. (Tim S.)
- What is the end product from the modeling exercise?
  - Timeline is to finalize the model by spring 2011, develop a Northeast Fisheries Science Center Lab Reference Document by late spring/early summer and pursue a peer reviewed journal publication after.

- **Round Table Discussion on Upstream Passage Behavior**
  - Alex H.
    - No one documents what happens to fish that fail, we ignore those fish, Jim McCleave impressed this point on Alex, the fish that fail have value, the failure is difficult to document
    - Sometimes downstream passage studies note fish that were tossed out of dataset
    - Passage is not absolute, fish stop and spawn before they get to the next dam, often times this is not documented, if fish didn't nose into fishway they weren't documented, studies not properly set up to study this
    - There are various levels of passage such as: made it halfway to fishway; made it up, but fell back; could not find fishway.

    - There was a pre-dam condition, most dams were built on falls or existing cascades, hard to document, often times passage was not absolute, this is a source of contention with negotiations
- Joe Z.
    - Provided an overview of previous studies investigating issues related to this but did not provide any general insights into the question.
- Randy S.
    - Doesn't think that generalization is possible given location specific factor - estimates will need to be determined on a site-specific basis
    - Also stressed that the estimates will need to be determined based on any and all available information and our best guesses
- Norm D.
    - Telemetry studies have used fish of unknown stocking locations, how do you understand where fish decide to move?
    - Depending on hydro situation fish may spend weeks below the dam, what happens to those fish?
- Kevin B.
    - Three years of telemetry work below Mattaceunk Dam
        - Stomach tags, release 60 fish .25 miles below dam, used any fish that they could, not only origin from above dam
        - Adults do use smaller streams to spawn
        - 1984,1985, all fish stayed in production unit, 1986 some fish dropped down,
        - Feels that fish will stay in production unit if they don't pass fishway
- Steve G.
    - 10% of all adults that return to Holyoke are released upriver – all from fry stocking - don't know where these fish came from (however, with new genetic marking program, they will begin to be able to answer those questions)
        - Migratory rates between the dams are consistent, slowest right after Holyoke, after that they move from 1 dam to the next in less than one day
        - Very few seem to wander, migration is fast, directed and unequivocal
        - Some exceptions, in the middle river some fish will sample different streams but stay in the same general area
        - If a fish that has passed one fishway does not pass the next, it is located within the lower production unit
    - Fish stocked in tributary rivers were more often captured at Holyoke
    - Net enclosure, fish would spawn in terrible habitat because they were raised there, imprinting is very important
        - Some evidence showed that for smolts held in a tide water area, they came back, didn't go up river (some did) and spawned in the crappy area around the tide water. When they stopped holding fish in the tide water area, the subsequent spawning there stopped.

- We can't assume that hatchery fish will imprint where we stock them. Where do the fish truly imprint?
- Doesn't think that upstream migration results in large amount of mortality
  - However, wandering fish are moving downstream, and mortality is introduced here
- Upstream migration motivation relies heavily upon instream flows, some variability is to be expected, however impounding dams decrease flow
- Mortality on adult returns is likely very low – however downstream movements of adults may have a significant mortality factor

- Ross J.
  - Salmon in the St. John River, low discharge river, tagged wild salmon at the Mactaquac dam, fish showed up at a counting fence on tributary at a lower trib.
    - Highlights wandering and straying
    - Acoustic tagging of fish on Big salmon pool, lots of downstream/upstream movement, exploring and looking for tribs
  - Highlighted mortality at upstream fishways, basket fishway resulted in mortality because fish become stranded behind the basket.
  - Mentioned a St. John acoustic study where hatchery fish were less likely to use fishways or find fishways.
- Don D.
  - Encountered problems with interpreting previous studies. It was hard for him to pinpoint the exact number of fish that actually try to use fishway in the studies.
    - Most studies didn't follow all fish to all destinations, so not passing doesn't mean that a fish tried (it possibly spawned elsewhere) – Dimitry's study came close as he reported the number of fish that nosed into a fishway, however he didn't report how many came up to the dam but didn't find the tailrace.
    - Mattaceunk (from Kevin) if fish found the tailrace, they used the fishway
    - Hard to interpret the fall back issue from the completed studies.
- Steve S.
  - Reiterated homing issue, radio tagged 150 fish, didn't always have ability to select fish with upstream origin, comprised the study and migratory behavior
  - Imprinting occurs as early as fall when fish is a parr, so hatchery fish may have already imprinted.
  - Hatchery fish probably didn't move as fast as wild fish, or seek out a particular area
  - What happens to fish that don't pass and remain in mainstem
    - Mainstem is fairly poor habitat, there is some good tributary habitat, but not much for adult spawning
    - Assign some portion of non-passage to tributary habitat and account for quality and quantity in those tribs
    - Fish that remained in mainstem died

    - Penobscot system is artificially regulated
  - Jeff M.
    - Are there generalities for ATS that don't reach natal area? Do they have general behavior (always spawn, always head out to ocean, etc)

-
- **Table 1** (see also Table 1 Excel sheet)
- ***General Discussion***
  - May consider incorporating flow as an informative variable in determining straying, path choice… In the absence of detailed flow data could use a proxy such as river depth and bank full width for the areas of interest (Joe Z.)
  - We need to know what the current stocking regime is in order to identify where straying fish are going. (Steve G.)
    - No necessarily the case as this exercise assumes that fish are stocked into each Production Unit and we are evaluating the eventual fate these fish for each Unit independently of any other.
  - Could consider incorporating a penalty for non-passage based on habitat above vs. habitat below instead of fecundity? (Joe Z.)
  - What about death due to seal predation?
    - This can be incorporated into the proportion dead column
  - For one trap on the St John's, estimate dead is 1-5% annually (Ross J.)
  - Dead fish at Veazie is mostly due to weather events, hot weather
  - Holbrook data for Milford called into question by Steve Sheppard (n=3)
  - Brown's Mills doesn't have proximate thermal refugia
    - waste treatment facility is nearest refugia
  - Note of Guilford Dam due to its impacts on high quality and quantity of spawning and rearing habitat (Norm D. and Randy S.)
    - Tim explained that we aren't explicitly including it, but that other dams (culverts, etc.) are all part of the environmental baseline
- ***Decisions for Total Proportion Dead***
  - *Group decided that 1% would be the standard proportion dead*
  - *An additional 1% will be added on a site-specific bases according for the following reasons:*
    - *Seals – increased likelihood of seal predation*
      - *Frankfort and Veazie due to location in the drainage*
    - *Handling – increased mortality due to handling*
      - *Veazie*
    - *Stalling and lack of thermal refugia – increased stalling due to poor attraction couple with a lack of appropriate thermal refugia*
      - *Great Works and Brown's Mills (**???**)*
    - *High%age of fall back – increased likelihood of fall back behavior*
      - *Howland and West Enfield due to location in the drainage*
    - *Poaching – increased likelihood of poaching*
      - *Dover Upper Dam (**???**)*
- ***Decisions for Proportion out to Sea***
  - If above Great Works, fallback likelihood to Ocean is 0%,
  - *Assume 10% for fish at Great Works*

        - Joe Z. observed up to 50% leaving out to sea
        - Steve G. countered that these fish have been handled and cannot be equated
    - Assumed 15% for Veazie
        - Due to proximity to the ocean and increased fall back due to handling
            - Is this our fault or the dam owner's fault?
            - Is it appropriate to included this if it is due to science?
    - Assumed 10% for Frankfort
        - Due to proximity to the ocean
- ***Decisions for Destination of straying***
    - Completed via group discussion
    - Need to verify assignments for West Enfield and Howland based on Dimitry's data
- ***Decisions for discounting fish that are forced into a downstream production unit due to failure to pass dam/fishway***
    - Should we discount fish that are not able to make it to their natal spawning habitat?
    - *Folks considered it important to consider a discount*
        - *If we don't we are suggesting that when fish aren't allowed to pass and spawn elsewhere that all is good with the world.*
    - *Difficult to assess and even more difficult to estimate a discount*
        - *Hard to come up with reproductive costs for not passing*
        - *Could also suffer reproductive costs from passing a long fishway*
    - <u>*Option 1*</u> *- Literature search on effects on fitness for unsuccessful passage?*
        - *Might be some evidence from West Coast Chinook, possibly from Scotland*
        - *However, the affect might be so minimal it wouldn't be worth incorporating*
    - <u>*Option 2*</u> *- Could add in a straw man and then do sensitivity analysis to evaluate the effect (and need)*
    - <u>*Option 3*</u> *- Incorporate the habitat quality either in terms of Production cap – higher cap for higher quality habitat*
        - Possibly incorporate a penalty based on habitat potential immediately above and immediately below the dam
    - <u>*Option 4*</u> *- Some sort of discount based on the ratio of where you started from to where you ended up (via the habitat quality scores)*
- **Table 2. Discussion**
    - ***General Discussion***
        - River reared fish generally have high fidelity - >90%
        - Dimitry's thesis/database contains raw data homing%age
        - In 1986, ~440 out of 476 adults captured at Weldon were no from the East Branch as identified by lack of fin clip. (Kevin B.)
            - Could be that they were from fry stocking or wild spawners, but these #ers are assumed to be low.
            - There were a lot of deformed dorsal fins.
            - The majority of these fish are assumed to be smolt stocked strays
        - In 2009, there were 300+ fish through Weldon but there were only 87 wild fish captured at Veazie. (Kevin B.)

            - There wasn't any smolt stocking up above Weldon for those cohorts of returns
        - Straying occurs, greater for wild fish than hatchery fish (Steve S.)
        - Straying is production unit specific (Randy S.)
        - Homing numbers in literature available for fry, smolts are difficult (Joe Z.)
        - One rate for the whole river is not palatable, perhaps a graduated rate for the production units (Tim S.)
        - Data may be available for the St. John River at the Mactaquac (Ross J.)
        - Data may be available for the East Branch - to tell East Branch vs. non East Branch fish, can't be more specific (Steve S.)
        - East Branch examples identified above have data that can be provided (Kevin B.)
            - DMR trucked adults up river, even to the East Branch, this may confound straying information (Norm D.)
- ***Decisions***
    - Suggestion of using some combination of guesses, but also using some rules as defined by strength of homing and attraction strength based on flow (depth and full bank width) plus using any available data to estimates numbers where we can
    - General consensus was that specific straying # was hard to come up with and group was hesitant to put forward any #s.
        - A general straying % for each production unit is not acceptable as we do not think it reflects reality (Tim S.)
    - Group agreed to the following general tendencies to help guide our efforts in populating Table 2
        - Group agreed to use a graduated rate for straying to higher quality habitat higher in the system
            - Straying into Production Unit #2 is probably at the highest level for the drainage and straying into 3 is probably the next highest level and so on down river
                - More fish will stray to these high quality areas
                - Kevin B.'s data may help inform rates to apply in this part of the drainage (Units 2 and 3)
        - Group decided that there was some fidelity, such as within each HUC8.
            - For example, fish in Piscataquis tend to stay in Piscataquis
            - Fish that make it to the Piscataquis or come from there probably stray at a lower rate
        - Fish stocked low in the river, say below Veazie, are probably not straying up to Production Units high up in the system (i.e. PU 2)
- ***Miscellaneous Notes***
- West Enfield is a vertical slot
- Moosehead Dam – in between Dover upper and Brown's Mills – need to footnote it in the report and consider adding in some sort of discount for this segment
- Joe suggested creating a schematic of the model in Stella to be a separate, for public use, version of the model to help people see the flow of it and be able on click on it and see the calculations behind it

- We will need to consider the possibility of keeping hatchery origin fish separate from wild origin fish within the model due to the effects of straying and poor homing for the two different origins.
  - This may cause a problem in terms of CPUE power and limits of Excel.
    - Could possibly keep track within the current model, run two separate models, wild and hatchery, and add the outputs together at the end…
  - Will need to evaluate the need for this in regards to the task at hand the final products needed for the analyses.
    - We may not need to incorporate this as the current state of affairs includes very little wild inputs and the restored population may have very little hatchery input
    - More discussion is needed within NOAA

Worksheet #1. Upstream passage inefficiency worksheet used during expert panel.

Dam	Proportion unsuccessful*	Proportion dead	Proportion out to sea	Proportion to stray and spawn downstream	Final destination (according to Productivity Units and the proportion to each unit)				
West Enfield	*20%*	*2%*	*2%*	*16%*	*PU 9 (85%)*	*PU 15 (15%)*			
Medway									
Mattaceunk									
West Enfield									
Dover Upper Dam									
Brown's Mills									
Sebec	**100%**								
Milo	**100%**								
Howland									
Lowell Tannery									

Stillwater									
Milford									
Great Works									
Orono									
Veazie									
Frankfort									

*Based upon best available data from existing fish passage studies

Worksheet #1 Fields

- Dam
  - Identifies the dam in question
- Proportion unsuccessful
  - What proportion of fish will not successfully pass this dam, will not spawn in Productivity Unit directly above that dam and instead will be forced into an alternate fate?
  - This number will equal (1 minus “the upstream efficiency”).
- Proportion dead
  - Of the ‘Proportion unsuccessful’, what proportion of them will die prior to spawning and therefore will not contribute any eggs to the next generation?
- Proportion out to sea
  - Of the ‘Proportion unsuccessful’, what proportion of them will migrate downstream to the ocean, not spawn in the Penobscot River (they may spawn in a different river system, but that is not being considered within our modeling efforts) and therefore will not contribute any eggs to the next generation?
- Proportion to stray and spawn downstream
  - Of the ‘Proportion unsuccessful’, what proportion of them will spawn in a lower reach (Productivity Unit)?
  - NOTE – the ‘Proportion dead’, ‘Proportion out to sea’ and ‘Proportion to stray and spawn downstream’ will add up to the ‘Proportion unsuccessful’ for each row.
- Final destination (according to Productivity Units AND the proportion to each unit)
  - Of the ‘Proportion to stray and spawn downstream’, where will they end up downstream and in what proportions?
  - NOTE – The ‘Final destination (according to Productivity Units AND the proportion to each unit)” will add up to 100% for each row. In the example provided, 85% of the 16% that stray will migrate to PU 9 and the remaining 15% will migrate to PU 15.

Worksheet #2. Upstream straying worksheet used during the expert panel.

Productivity Unit	Proportion straying upstream	Final destination (according to Productivity Units and the proportion to each unit)				
4	*20%*	*PU 6 (70%)*	*PU 7 (10%)*	*PU 8 (20%)*		
1						
2						
3						
4						
5						
6						
7	**0%**	-	-	-		
8	**0%**	-	-	-		
9						
10						
11						
12						

13						
14						
15						

Worksheet #2 Fields

- Productivity Unit
  - Natal river reach of interest.
  - The table just lists the Productivity Units by numbers. Feel free to modify these labels/names if desired.
- Proportion straying upstream
  - What proportion of the fish from a particular Productivity Unit will stray to an upriver Productivity Unit?
- Final destination (according to Productivity Units AND the proportion to each unit)
  - Of the fish that stray upstream, where will they end up and in what proportions?

NOTE – The 'Final destination (according to Productivity Units AND the proportion to each unit)' will add up to 100% for each row. In the example provided, 70% of the 20% that stray will end up migrating to PU6, 10% will migrate to PU 7 and 20% will migrate to PU 8.

Document Content(s)