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 01930-2276

FEB 27 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 Ellsworth Project (FERC No. 2727-092)

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 Ellsworth Project (FERC No. 2727) on the Union River in Maine. This Opinion considers the effects of operating the project for a term of up to 50 years, and is based on the FERC's July 29, 2019, Final Environmental Assessment and other sources of information. 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 Ellsworth 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 modification or destroy the critical habitat designated for the GOM DPS of Atlantic salmon. We also concluded that the proposed action is not likely to adversely affect shortnose sturgeon or any DPS of Atlantic sturgeon.

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 take level for Atlantic salmon was estimated based on the likelihood of the species occurring in the action area during the time period proposed for the project.

The ITS specifies two RPMs necessary to minimize and monitor take of listed species. 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 Ellsworth 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 provides 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 urges FERC to carry out this program.

This Opinion concludes consultation for the FERC's proposed relicensing of the Ellsworth 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 Dan Tierney of my staff at (207) 866-3755 or Dan.Tierney@noaa.gov for any questions involving this consultation.

Sincerely,

Jennifer Anderson
Assistant Regional Administrator
for Protected Resources

ec: Capone, GCNE
McDermott, F/GAR HCD
Maine DMR
U.S. FWS

File Code: FERC P-2727 Ellsworth Project
ECO: GARFO-2019-02030

NATIONAL MARINE FISHERIES SERVICE
ENDANGERED SPECIES ACT
BIOLOGICAL OPINION

Agency:	Federal Energy Regulatory Commission
Activity Considered:	Issuance of a new license to the Ellsworth Hydroelectric Project (P-2727-092)
	GARFO-2019-02030
Conducted by:	National Marine Fisheries Service Greater Atlantic Regional Fisheries Office
Date Issued:	FEB 27 2020
Approved by:	

Contents

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) concerning the effects of the Federal Energy Regulatory Commission's (FERC) proposed issuance of a new 30 to 50 year license for the Ellsworth Project (P-2727) on the Union River, Maine. The Ellsworth Project (Ellsworth Project or Project) is an 8.9-megawatt (MW) hydroelectric project operated by Black Bear Hydro Partners, LLC (Black Bear). The Project is located on the mainstem of the Union River in the town of Ellsworth, Maine. The existing license expired on December 31, 2017. On January 19, 2018, FERC issued an annual operating license for the Ellsworth Project for a period effective until a new license is issued.

This Opinion is based on information contained in FERC's July 2019 Final Environmental Assessment (FEA) for the Ellsworth Project (which also serves as FERC's Biological Assessment (BA)). A complete administrative record will be maintained at our Maine Field Station in Orono, Maine. We initiated consultation on August 29, 2019.

1.1. Consultation History

- On September 14, 2011, FERC designated Black Bear as its non-federal representative for ESA consultation for the relicensing of the Ellsworth Project.
- From June 2017 to August 2018, Black Bear conducted informal consultation with us to identify potential project effects on listed Atlantic salmon and designated critical habitat and to develop a draft BA and Species Protection Plan (SPP). Informal consultation with Black Bear entailed many meetings and conference calls with various stakeholders to assess the status of Atlantic salmon in the project area and to identify measures to reduce or eliminate impacts of the project on the species and its designated critical habitat in the action area.
- On July 27, 2018, Black Bear submitted a draft SPP and BA to us for review and comment. We provided comments on August 17, 2018, and they filed the final with FERC on September 28, 2018.
- FERC requested formal consultation with us after the issuance of the draft EA on November 26, 2018.

- On December 21, 2018, we filed a letter indicating that we did not have the information we needed to consult and that we would wait until the issuance of the Final EA to initiate formal consultation.
- FERC issued the final EA on July 29, 2019, and once again requested consultation with us.
- We filed a letter with the FERC on Augusta 29, 2019, initiating formal section 7 consultation for shortnose sturgeon, Atlantic sturgeon, Atlantic salmon, as well as designated critical habitat for Atlantic salmon.

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, March 1998, issued jointly by NMFS and the USFWS and the section 7 regulations as revised in 2019 (84 FR 44976; August 27, 2019). In conducting analyses of actions under section 7 of the ESA, we take the following steps, as directed by the consultation regulations:

- Describes the proposed action and identifies the action area (Section 2);
- Evaluates 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);
- Evaluates the current status of the species and essential features of designated critical habitat within the recovery unit of the action area (Section 3.5);
- Evaluates 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);
- Evaluates the relevance of climate change on environmental baseline and status of the species (Section 5);
- Determines whether the proposed action affects the abundance, reproduction, or distribution of the species, or alters any physical or biological features of designated critical habitat (Section 6);
- Determines and evaluates any cumulative effects within the action area (Section 7); and,
- Evaluates whether the effects 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 is likely to destroy or adversely modify their 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 the action does 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 (50 CFR 402.02), destruction or adverse modification "means a direct or indirect alteration that appreciably diminishes the value of critical habitat for the conservation of a listed species. Such alterations may include, but are not limited to, those that alter the physical or biological features essential to the conservation of a species or that preclude or significantly delay development of such features (81 FR 7214, Feb.11, 2016)."

Updates to the regulations governing interagency consultation (50 CFR part 402) became effective on October 28, 2019 (84 Federal Register 44976). As the preamble to the final rule adopting the regulations noted, "[t]his final rule does not lower or raise the bar on section 7 consultations, and it does not alter what is required or analyzed during a consultation. Instead, it improves clarity and consistency, streamlines consultations, and codifies existing practice." We have reviewed the information and analyses that were relied upon to complete this biological opinion in light of the updated regulations and conclude the opinion is fully consistent with the updated regulations.

2. Description of the Proposed Action

The proposed action that we are consulting on is the proposed relicensing of the Ellsworth Project for a term of 30 to 50 years. Under the terms of the new FERC license, Black Bear will be required to operate the Ellsworth Project and to maintain the dams and project impoundments to meet the 8.9 MW generation capacity of the powerhouse.

The Ellsworth Project is located on the Union River in the City of Ellsworth and the Towns of Mariaville, Otis, and Waltham in Hancock County Maine. The Project consists of two dams; the Ellsworth Dam (also known as Leonard Lake Dam) and the Graham Lake Dam, approximately 3.5 miles further upstream. The Ellsworth Dam impounds the 90-acre Leonard Lake impoundment and the Graham Lake Dam impounds the approximately 10,000-acre Graham Lake impoundment. There are no generating facilities at the Graham Lake Dam. The Ellsworth Dam and powerhouse are at the head of tide approximately three miles upstream of the Union River Bay, which flows into the Atlantic Ocean. The drainage area of the watershed at the Ellsworth dam is 547 square miles (Figure 1).

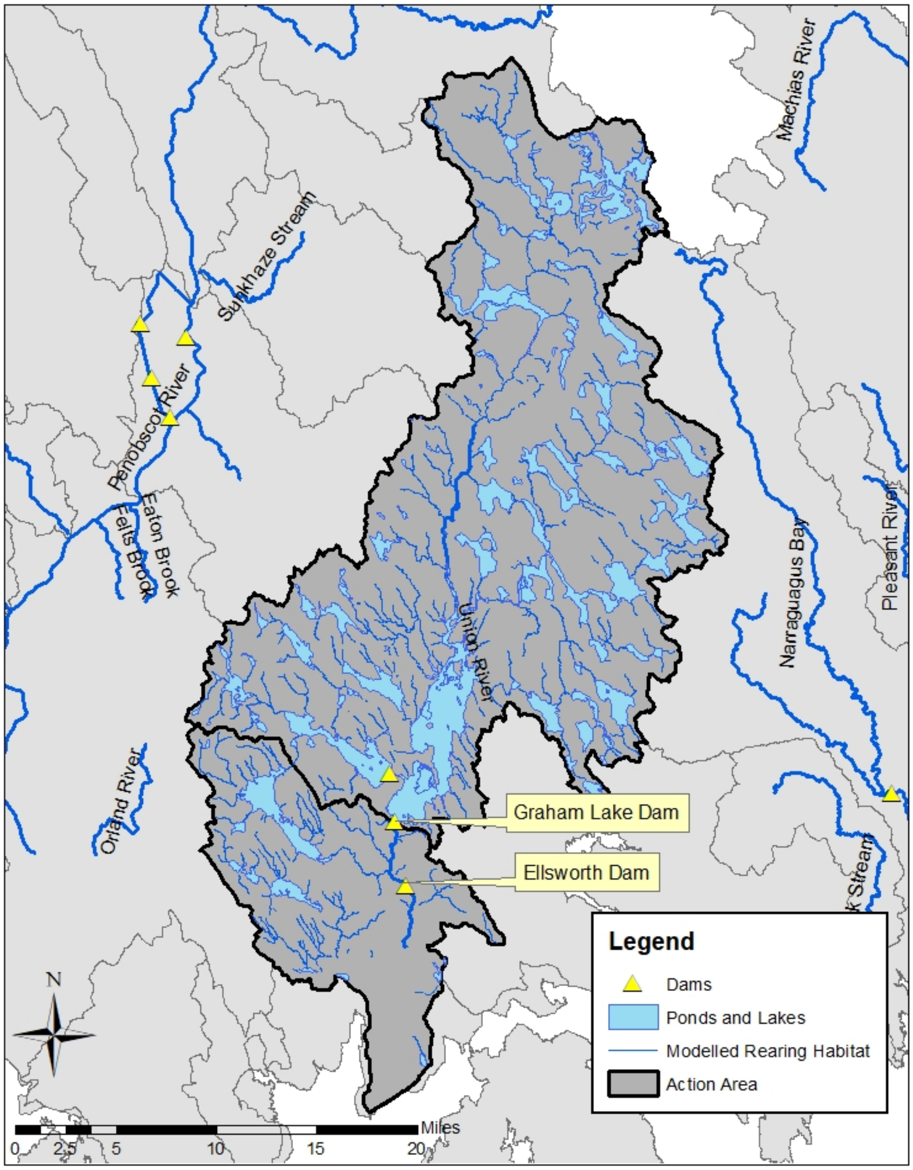

Figure 1. Map of the Union River Basin in the State of Maine. This map also depicts modelled rearing habitat for Atlantic salmon within the Union River watershed (Wright et al 2008).

2.1. Project Description

The Ambursen-style Ellsworth Dam and powerhouse was constructed in 1907 by the Bar Harbor and Union River Power Company. The original facilities of the Ellsworth Dam consisted of two generation units (now termed Units No. 2 and 3). A third generation unit (now termed Unit No. 1) was added in 1919 and a fourth unit (Unit No. 4) was added in 1923 at the same time as construction of Graham Lake Dam. The horizontal turbines for Units No. 2 and 3 were replaced with vertical turbines in 1938, and the majority of the associated penstocks were also replaced at that time. The open forebay was replaced with a new intake structure and longer penstocks in 1990.

An Ambursen dam is otherwise known as a slab and buttress dam and consists of an inclined concrete slab on the upstream side of a series of buttresses. The force of the impounded water acts downward onto the slab and the vertical component of the force is transferred downward to the buttresses and to the ground beneath the dam. A gravity dam is a dam that is filled with material such as concrete and not only relies on the force of the water but mainly on the gravity force of the fill material to prevent sliding and overturning. The Ellsworth Dam was partially filled with concrete in the early 1990s creating a gravity type dam in the non-overflow section of the dam.

The dam is 377 feet long including a 275-foot spillway, and has a maximum height of 60 feet. The overflow spillway has a top of flashboard elevation of 66.7 feet. The permanent crest of the overflow spillway is at elevation 64.5 feet, thus the flashboards are 2.2 feet high. There is no other means to spill water at the dam other than over the spillway. The capacity of the overflow spillway is approximately 17,000 cubic feet per second (cfs) at a water surface elevation of 71.0 feet. Adjacent to the overflow spillway, the non-overflow section includes a gatehouse and a 10-foot diameter vertical penstock that serves turbine-generator Unit No. 1. Adjacent to the housed intake for Unit No. 1, the non-overflow section also connects to an intake structure containing three additional penstocks: two 8-foot diameter penstocks serving turbine-generator Units No. 2 and 3, and one 12-foot diameter penstock serving turbine-generator Unit No. 4. Each intake includes trashracks and slide gates. The four turbine-generator units contained in the Ellsworth powerhouse have a total FERC-authorized nameplate capacity of 8.9 megawatts and an average annual generation of 30,511 Megawatt-hours. Unit 1 turbine is a four bladed vertical propeller with a speed of 200 rpm and a runner diameter of 4.65 feet rated at 2,850 kW. The Unit 1 generator is rated at 3,125 kVA @ power factor 0.8; 2,500 kW. Unit 2 turbine is a vertical shaft Kaplan with four blades and a speed of 360 rpm and a runner diameter of five feet rated at 2,175 kW. The Unit 3 generator is rated at 2,500 kVA @ power factor 0.8; 2,000 kW. The Unit 3 turbine is vertical shaft Kaplan identical to Unit 2. The Unit 3 generator is identical to the Unit 2 generator. The Unit 4 turbine is identical to Unit 1 turbine. The Unit 4 generator is rated at 3,000 kVA @ power factor 0.8; 2,400 kW. This rating for the Unit 4 generator is different since the Unit 1 generator was rewound in recent years. The total hydraulic capacity of all four units is 2,460 cfs.

The Graham Lake Dam was completed in 1924. The dam is 58 feet high and consists of a 670-foot long earthen dike and a concrete gate structure. It is a non-generating (i.e. no turbines) facility located approximately 3.5 miles upstream from the Ellsworth Dam. The concrete gate structure contains three 20-foot wide by 22.5-foot tall radial gates and an eight-foot wide sluice used for downstream fish passage. A flood control structure is located immediately downstream of Graham Lake Dam. The flood control structure consists of a concrete flood wall approximately 720 feet long, a 65-foot diameter steel cell (formerly part of the construction coffer dam) and a 71-foot-long wing wall extension that connects to the gate structure and serves as an emergency overflow spillway.

2.2. Project Operations

The Ellsworth Project is licensed as a peaking plant, with water being released from the Graham Lake impoundment for generating electricity at the downstream Ellsworth powerhouse. However, typical recent historical operation of the plant by Black Bear has been to open the gates at Graham Lake Dam to maintain pond elevations at target levels regardless of peak or non-peak generating hours and generate with whatever water is available. During periods of high inflows, primarily in the spring and fall, the project may generate at full capacity for up to 24 hours a day. The Project is operated remotely using a Programmable Logic Controller (PLC) system. This system monitors and controls project operations including headpond levels. The project is operated remotely from a control center operated by Brookfield Renewable Energy Group (Brookfield) in Marlborough, Massachusetts. The Project is monitored on a 24-hour basis and is typically visited three to five times each week by a roving operator. Daily logs document water elevation, flow and outages for the Project. The current license for the Ellsworth Project requires a continuous minimum flow of 105 cfs from July 1 through April 30 and 250 cfs from May 1 through June 30. FERC has proposed modifications to the minimum flow requirements as part of their proposed action (section 2.4). The minimum flow requirements support fish habitat, facilitate fish migration, and protect downstream water quality.

Water surface elevations in the Graham Lake impoundment are regulated by the amount of flow released at the Dam and are maintained according to an approved rule curve (Figure 2). Water levels are maintained between elevations 93.4’ and 104.2’ under the existing license. In general, the impoundment is filling (storing more water) from March 1 to May 30; is drawn down (releasing more water) from June to September; is filled again from October to December; and, is drawn down again during January and February.

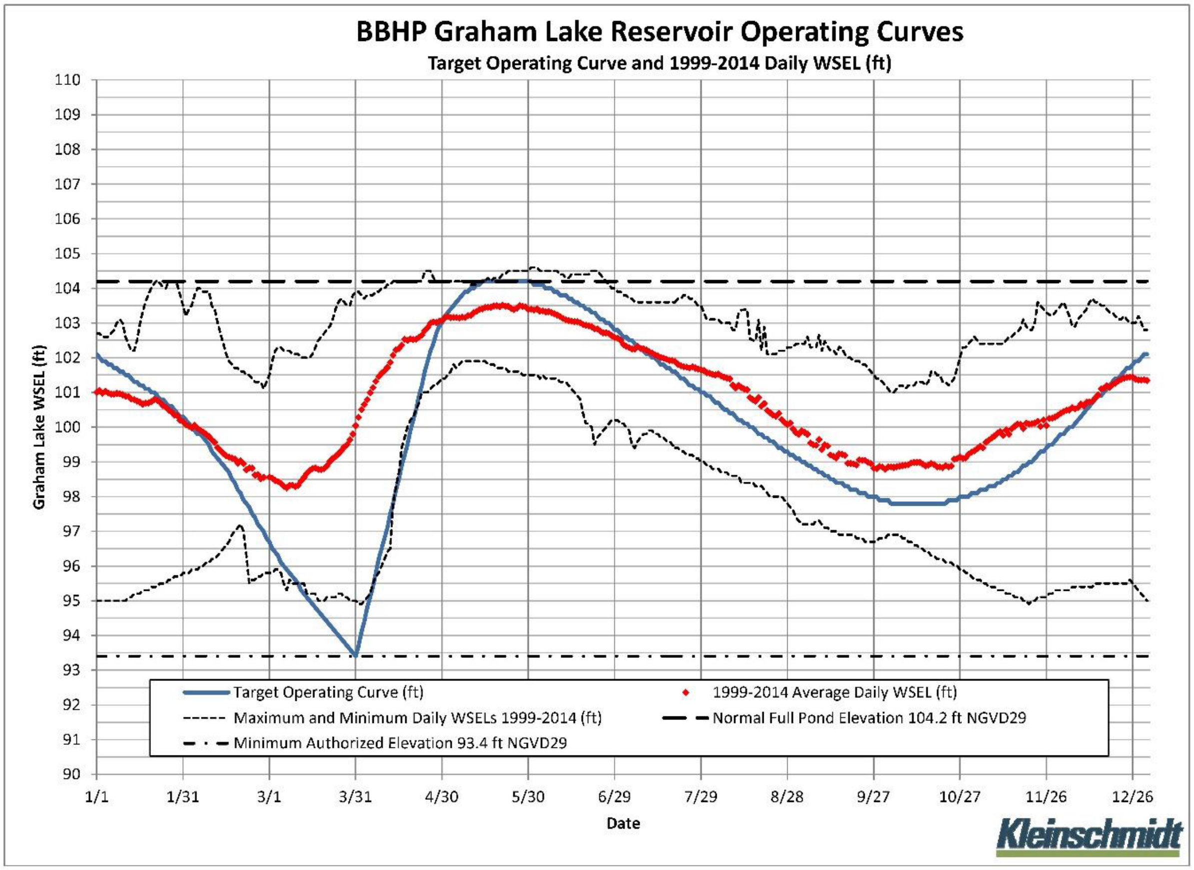

Figure 2. Graham Lake Target Operating Curve (Black Bear's Final License Application)

2.3. Project Fishways

2.3.1. Ellsworth Upstream Fish Passage

A fish passage facility was constructed at the Ellsworth Dam in 1972 to support the restoration of migratory fish to the Union River, and to support a commercial harvest of river herring (URFCC, 2000). The fishway is comprised of a 120-foot long, 8-foot wide vertical slot fishway that leads to a trap and lift. The 3-foot wide entrance passes up to 50 cfs. There is no swim-through option at the Ellsworth Dam; all target fish species (i.e., Atlantic salmon and river herring) that are trapped are either harvested or driven to their upstream stocking location in trucks. River herring are stocked into Graham Lake until the target escapement (currently 315,000) has been met. The remainder of the herring run is harvested for use as bait by the lobster industry. All sea-run Atlantic salmon trapped at the Ellsworth Project are released into the West Branch upstream of Graham Lake Dam.

The entrance gate is adjusted, if required, to maintain a wave ripple effect that extends as far as possible out in the tailrace. This usually requires about an 18-inch differential between the fishway and tailrace water levels. The tailwater of the Ellsworth dam is influenced by tidewater. The entrance gate is manually adjusted with a handwheel or with an electric actuator with local controls. The entrance runs into a single gallery that runs along the driveway of the powerhouse. The first attraction pump is a Worthington Model 20KLD24 attraction water pump that is capable of passing up to 28 cfs through a pipe to the diffusion chamber above the trap. The second attraction pump, Flygt Model 4451, takes water from the tailrace and pumps it into the fishway just above the entrance gate area through a diffuser system with a capacity of approximately 22 cfs. This simulates more flow in the fishway for attracting fish to the entrance areas. The head differential between the attraction flow chamber and the tailwater should not exceed five feet. The fishway conveyance flow is approximately 50 cfs under normal operating conditions (BBHP, 2018b).

There are two fish trap hoppers used depending on whether it is being operated to support a commercial harvest of river herring (primarily alewife), or to capture herring to stock in the Graham and Leonard Lake impoundments. One is of mostly solid metal construction, which allows water to remain in the hopper tank when lifted for stocking. The second hopper is constructed with metal screen material that allows for the water to drain off when the hopper is lifted from the hopper pit when the City of Ellsworth is selling alewives for lobster bait. When stocking or transporting, fish are lifted out of the hopper pit in the metal hopper tank, and are then transferred into one of two different transport tank types. Two round tanks are used for river herring, and a separate rectangular tank is used for Atlantic salmon. The round transport tanks have a volume of 99.5 cubic feet and the rectangular tank has a volume of 66 cubic feet. The river herring transport tanks are used in tandem as necessary, thereby allowing one to be en-route to the stocking location while the other is available at all times for fish entering the fishway.

The existing license for the project was issued on December 28, 1987. That license included a requirement to develop a plan and schedule for fish passage installation, consistent with any prescription made by the Secretary of the Interior pursuant to Section 18 of the FPA. This initiated a series of actions leading to the “Comprehensive Fisheries Management Plan for the Union River” and formation of the Union River Fisheries Coordinating Committee (FERC, 2002; URFCC, 2000). The overall management goal of the Comprehensive Fisheries Management Plan was defined as “Management of all sport and commercial fish species in the Union River for optimum habitat utilization, abundance and public benefit.” The fish trap was identified as an interim measure “until such time as the information resulting from the assessments incorporated in the Plan allow for decisions regarding permanent fish passage measures at the Ellsworth Hydroelectric Project” (URFCC, 2000).

2.3.2. Graham Lake Dam Upstream Fish Passage

There are no upstream passage facilities at the Graham Lake Dam. Currently, river herring and Atlantic salmon that are trapped at the Ellsworth Dam are driven around the dam and are stocked either in the impoundment itself (alewife) or upstream at the Route 181 bridge over the West Branch of the Union River (salmon).

2.3.3. Ellsworth Downstream Fish Passage

The downstream fish passage facility at Ellsworth Dam has three entrance weirs. Two entrance weirs are located at either end of the top of the turbine intake area for Units 2 through 4. The entrance weirs are three feet wide. The flow from these two weirs flow through a pipe and connects to the downstream sluiceway, which is located below the third entrance weir and is located on the overflow section of the dam. Each weir has stoplogs that control the flow of water through the entrance. The entrances are operated with about 21 inches of water over each entrance (approximately 20 cfs each). A variable speed recirculating pump, Flygt Model 4501, located in the pump pit in the downstream migrant pipe, is designed to send approximately 35 cfs back into the headpond. The recirculating pump is located beside the flume area before water enters the pipe and is conveyed to the sluiceway. The transportation flow from the pump pit is about 5 cfs. The third weir is beside the turbine intake for Unit 1, which is located on the overflow section of the dam and passes about 20 cfs. The total fishway attraction flow is 60 cfs, which is comprised of 5 cfs from weirs 1 and 2, 35 cfs pumped back into the headpond, and 20 cfs through weir 3.

The trashracks at the intakes for Units 2 to 4 have 1-inch clear spacing for first 14 feet of depth, and 2.37-inch spacing from 14 feet down the substrate. The trashracks at the intake for Unit 1 have 2.44 inch clear spacing for the entire length. The water velocity into trashracks 2 through 4 is very high, averaging between 2 and 3 fps. The water velocity into trashracks for Unit 1 is normally less than 2 fps.

2.3.4. Graham Lake Dam Downstream Fishway

The downstream fishway at Graham Lake Dam consists of 4-foot wide gate inset to a larger 8-foot wide stop log gate slot. In 2017, an Alden type weir was installed in the gate slot to improve passage. The elevation of the weir does not adjust with the changes in pond elevation so at lower pond levels there is no flow over the weir. All downstream fishways are operated from April 1 to December 31 as weather permits.

2.4. Proposed Action

FERC is proposing to issue a new 30 to 50 year license to Black Bear for the Ellsworth Project consistent with the *Staff Alternative with Mandatory Conditions* as presented in FERC's July 2019 Final Environmental Assessment (FEA) for Hydropower License for the Ellsworth Project.

The *Staff Alternative with Mandatory Conditions* is the staff alternative plus the section 18 fishway prescriptions filed by USFWS on April 10, 2018 and NMFS on April 23, 2019.

The FEA for the Ellsworth Project does not provide a clear, concise, or single description of the proposed action that forms the basis of this consultation. In our August 29, 2019, letter to FERC initiating formal consultation, we described what we believe the major components of proposed action to be, based on guidance provided by FERC staff on a different project in the State of Maine (FERC Accession #: 20190522-3017). Here, we identify the relevant requirements of the proposed license.

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

- Operate Graham Lake between the elevations of 98.5 and 103.0 feet msl during normal operation instead of operating Graham Lake between the elevations of 93.4 and 104.2 feet msl;

- Continue to operate Lake Leonard between the elevations of 65.7 and 66.7 feet msl;

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

- Provide minimum base flow under the following schedule:
  1. From January 1 to March 31, release 105 cfs;
  2. From April 1 to April 30, release 123 cfs;
  3. From May 1 to June 30, release 250 cfs; and,
  4. From July 1 to December 31 (or ice in), release 123 cfs.

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

- Continue to operate and maintain the existing upstream fish passage facility for Atlantic salmon at the Ellsworth Development from May 1 to November 15 until the prescribed upstream fish passage facilities at the Ellsworth and Graham Lake developments are operational. This includes the trapping, handling, and transport of salmon from the Ellsworth Dam to the West Branch of the Union River;

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

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

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

- Continue to provide downstream passage for out-migrating Atlantic salmon and river herring at the Ellsworth Project between April 1 and December 31 of each year until the proposed modifications are operational;

- Construct the proposed modifications to the temporarily-installed Alden weir at Graham Lake Dam to allow at least 3 feet of water to flow over the weir under all headpond conditions. Construction will be completed within two years of license issuance, and all construction activities will occur outside of the downstream migration season of April 1 to December 31 (or ice-in);

- Construct the following modifications to the downstream fish passage system at the Ellsworth Dam within two years of license issuance:
    a. Installation of a fish guidance system leading to a bypass surface entrance. The guidance system shall be comprised of a rigid hanging curtain or boom. Unless modified during agency consultation, the boom will be constructed as follows: (1) place the guidance boom in the headpond of Ellsworth Dam so that it extends at an angle from the western shore of the impoundment to a point on Ellsworth Dam that is located between the east end of the eastern powerhouse intake structure and the eastern surface weir; (2) design the curtains/panels of the guidance boom to have a maximum clear 0.12-inch spacing; and (3) construct the curtains out of lightweight yet rigid panels;
    b. Modification of the existing spillway downstream fish passage weir entrance to increase the depth to a minimum of three feet, install tapered walls similar to an Alden weir, and increase the spillway downstream fish passage weir capacity to pass up to five percent of station hydraulic capacity (approximately 123 cfs),
    c. Increase the height of the sides of the spillway flume to contain the increased conveyance flow and reduce spillage;
    d. Eliminate discharge from the flume to the ledges at the toe of the dam;
    e. Realign the end of the downstream fish migrant pipe so that water discharges downward to the spillway flume and fish do not impact the spillway when exiting the pipe; and
    f. Install full-depth trashrack overlays with 1-inch clear spacing over the intakes of generating Units 2, 3, and 4.

- Curtail operation of Unit 1 and prioritize operation of Unit 4 over Units 2 and 3 at the Ellsworth Development throughout the downstream passage season for Atlantic salmon, alosines, and American eel (April 1 – December 31), unless alternative timing is confirmed through consultation with the resource agencies.

  a. Unless alternative timing is confirmed through consultation with the resource agencies, cease operation of Unit 1 for 15 days when the Union River water temperature reaches 10°C in spring to protect outmigrating salmon smolts.

- During the interim period between license issuance and implementation of the proposed modifications to the downstream fish passage facilities, monitor the forebay of Graham Lake Dam and the tailrace of Ellsworth Dam for out-migrating alosines during the downstream passage season (June 1 – November 30) and implement generation shut down procedures at the Ellsworth Development if: (1) a school of out-migrating alosines is observed at Graham Lake following a storm event that exceeds 17 percent of the total average monthly rainfall; or (2) dead or injured alosines are observed in the tailrace of Ellsworth Dam.

- If the measures described above do not achieve the 90% (95% per dam) downstream performance standard for Atlantic salmon smolts, then Black Bear will modify the facility to reduce fish injury and mortality:
  a. At the Ellsworth Dam, proposed measures include:
     i. add panels or curtains to deepen the fish guidance system;
     ii. increase flows over the spillway by reducing generation or shutting down turbines at night for two weeks during May; and
     iii. modify the plunge pool, or spillway surface to reduce injury to fish passing over the spillway.
  b. At the Graham Lake Dam, additional adaptive management measures will be developed in consultation with resource agencies, as necessary to improve downstream fish passage effectiveness.

Fish Passage Monitoring

- Monitor upstream and downstream fishways at the Ellsworth and Graham Lake dams to ensure fish passage protection measures are constructed, operated, and functioning as intended for the safe, timely and effective passage of migrating fish, based on a performance standard of 90 percent effectiveness for total project downstream and upstream passage (i.e., at least 95 percent effectiveness, on average, per development) for alosine and Atlantic salmon;

  a. Test passage effectiveness of the upstream and downstream fishways for salmon;

     i. Upstream-1) Up to three study years to test the effectiveness of the existing fishway entrance for adult salmon, 2) Up to three years to test the effectiveness of the new swim through fishways constructed at the

Ellsworth and Graham Lake Dams for Atlantic salmon. These studies will be conducted after downstream passage improvements have been implemented and smolts stocked upstream of Ellsworth Dam have had a chance to return as upstream migrating adults.

ii. Downstream-Up to three study years to test the effectiveness of the proposed modifications. If needed, an additional one to three years of evaluation will occur to test the additional measures.

Sturgeon Handling Plan

The proposed strugeon handling plan will include the following measures:

- Healthy sturgeon would be weighed, measured, scanned for PIT tags, and immediately released downstream of the project. Black Bear Hydro personnel would be responsible for handling sturgeon;

- Injured sturgeon would be measured, photographed, and released, and NMFS would be notified within 24 hours;

- Badly injured fish would be retained by Black Bear Hydro, if possible, until obtained by a NOAA-recommended facility for potential rehabilitation;

- Dead sturgeon would be photographed, measured, scanned for tags, and stored in a refrigerator or freezer until NMFS could take possession of the specimen for analysis; and

- Black Bear will not schedule the dewatering of generation units or draft tubes during April or May, unless there is an emergency.

It should also be noted that the State of Maine has not issued a 401 Water Quality Certificate for the Ellsworth Project. The issuance of the 401 Water Quality Certificate could contain mandatory requirements that will force FERC to modify the "Staff Alternative with Mandatory Conditions." If operation of the Project in compliance with the 401 Water Quality Certificate requirements would cause effects to listed species or critical habitat that were not considered in this Opinion, reinitiation of this consultation would be required (50 CFR 402.16).

2.4.1. 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 both the direct and indirect effects of the proposed action would affect listed species and critical habitat. Operation of the Ellsworth

Project under the terms of a new license will continue to result in effects to Atlantic salmon and their critical habitat in a portion of the Union River as described here.

In addition to the immediate footprint of the project (i.e. dams, powerhouse), the action area encompasses the area of the Union River and its tributaries that are impounded by the two dams, as well as areas downstream of the dams that are affected by flow alterations. Therefore, we consider the action area of this project to extend from Union River Bay upstream to the upper extent of the Graham Lake impoundment.

3. Status of the Species and Critical Habitat Rangewide

We have determined that the action being considered in this Opinion may affect the following endangered or threatened species and critical habitat under our jurisdiction (Table 1):

Table 1. ESA-listed species and critical habitat in the action area

ESA-Listed Species	**Scientific Name**	**Distinct Population Segment (DPS)**	**Federal Register (FR) Citation**	**Recovery Plan**
Atlantic Salmon	*Salmo salar*	Gulf of Maine	74 FR 29344	Final Recovery plan: (USFWS & NMFS, 2019)
Atlantic Sturgeon	*Acipenser oxyrinchus oxyrinchus*	Gulf of Maine	77 FR 5880	N/A
Shortnose Sturgeon	*Acipenser brevirostrum*	Range-wide	32 FR 4001	NMFS 1998
Designated Critical Habitat (species)	**Scientific Name**	**Distinct Population Segment (DPS)**	**Federal Register (FR) Citation**	**Recovery or River Unit**
Atlantic Salmon	*Salmo salar*	Gulf of Maine	74 FR 29300	Downeast Coastal Salmon Habitat Recovery Unit

3.1. Listed species in the action area that will not be adversely affected by the action

We have determined that the actions being considered in the Opinion are not likely to adversely affect listed shortnose sturgeon (*Acipenser brevirostrum*) or any DPS of Atlantic sturgeon *Acipenser oxyrinchus*). Below, we present our rationale for these determinations.

There is insufficient freshwater habitat downstream of the Ellsworth Dam to allow for spawning of either shortnose or Atlantic sturgeon; therefore, we would not expect early life stages of either species to occur in the action area (NMFS, 2017). Although adult sturgeon may enter the Union River estuary for a few hours to a few days (Dionne et al., 2013), there is no information to indicate that they would attempt to pass upstream of the dam. Neither shortnose sturgeon nor Atlantic sturgeon have ever been documented at the fishtrap at Ellsworth. Although shortnose and Atlantic sturgeon are known to enter fish lifts and traps (e.g., Holyoke Dam on the Connecticut River, Milford Dam on the Penobscot River), use of fish ladders is extremely rare, with only one documented occurrence (a single shortnose sturgeon in the Denil ladder at the West Springfield Dam, Westfield River, Massachusetts). As described above, there is a 120-foot long vertical slot fishway at the Ellsworth Dam that fish must navigate prior to entering the trap. Given the limited amount of accessible habitat for shortnose and Atlantic sturgeon in the Union River, the lack of suitable spawning habitat (the presence of which could provide motivation to seek upstream passage), the limited use of the Union River by shortnose or Atlantic sturgeon, and the lack of any sturgeon using the fishway in the past, we do not anticipate any sturgeon to attempt to pass upstream of the dam. Therefore, we do not anticipate any sturgeon will attempt to enter the existing fishway or any new or modified fishway that is installed over the term of the new license. Any sturgeon that do occur in the lower Union River are likely resting or foraging during coastal migrations. The continued existence of the dam and operations of the project over the term of the new license are not expected to have any effect on the ability of sturgeon to use the lower Union River for resting or foraging.

Black Bear’s proposal to implement a sturgeon handling plan is appropriate as it will ensure the safety of individual sturgeon in the unlikely event that a sturgeon is trapped at the Project. The plan requires that Black Bear staff quickly and safely release trapped sturgeon back into the project tailrace. They have not proposed any actions (e.g. trucking, scale collection, tag insertion) that would result in any additional effects to the trapped fish. As explained above, any interactions with sturgeon are not expected over the term of the license and the handling plan will be in place in the event that such an unexpected event does occur. As no adverse effects to shortnose sturgeon or any DPS of Atlantic sturgeon are anticipated, we conclude that the proposed action is not likely to adversely affect these species and they will not be considered further in this Opinion. If an interaction with a sturgeon does occur over the term of the new license, this would represent new information revealing an effect that was not considered in this Opinion and consultation would need to be reinitiated (50 CFR 402.16).

3.2. Atlantic Salmon (Gulf of Maine DPS)

The GOM DPS of anadromous Atlantic salmon was initially listed by USFWS and us (collectively, the Services) as an endangered species on November 17, 2000 (USOFR, 2000) . A subsequent rule issued by the Services (USOFR, 2009b) expanded the geographic range for the GOM DPS of Atlantic salmon. The GOM DPS of Atlantic salmon is defined as 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. The marine range of the GOM DPS extends from the Gulf of Maine, throughout the Northwest Atlantic Ocean, to the coast of Greenland. 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 Hatcheries (CBNFH), both operated by the USFWS, as well as private watershed-based facilities (Downeast Salmon Federation's East Machias and Pleasant River facilities). Excluded from the GOM DPS are landlocked Atlantic salmon and those salmon raised in commercial hatcheries for the aquaculture industry (USOFR, 2009b).

Coincident with the June 19, 2009 endangered listing, we designated critical habitat for the GOM DPS of Atlantic salmon (USOFR, 2009b).

3.2.1. Atlantic Salmon Life History

Atlantic salmon spend most of its adult life in the ocean and returns to freshwater to reproduce. Atlantic salmon have a complex life history that includes territorial rearing in rivers to extensive feeding migrations on the high seas (Figure 3). During their life cycle, Atlantic salmon go through several distinct phases that are identified by specific changes in behavior, physiology, morphology, and habitat requirements.

<u>Spawning</u>

Adult Atlantic salmon return to rivers in Maine from the Atlantic Ocean and migrate to their natal streams to spawn. Although spawning does not occur until late fall, the majority of Atlantic salmon in Maine enter freshwater between May and mid-July (Baum, 1997a), but may enter at any time between early spring and late summer. Early migration is an adaptive trait that ensures adults have sufficient time to reach spawning areas (Bjornn & 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.

From mid-October to mid-November, adult females select sites in rivers and streams for spawning. 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 and water velocity is increasing (McLaughlin & Knight, 1987; White, 1942). The female salmon creates an egg pit (redd) by digging into the substrate with her tail and then deposits eggs while male salmon release sperm to fertilize the eggs. After spawning, the female continues digging upstream of the last deposition site, burying the fertilized eggs with clean gravel. Females 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 (SW) female (an adult female that has spent two winters at sea before returning to spawn) (Baum & Meister, 1971).

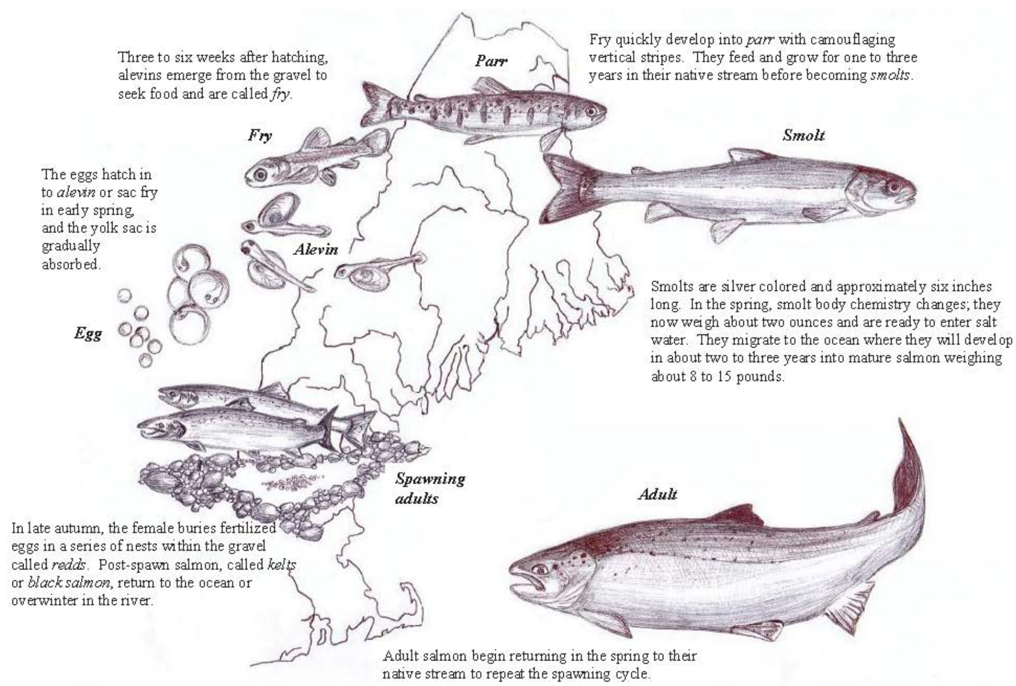

Figure 3. Life Cycle of the Atlantic salmon (diagrams courtesy of Katrina Mueller)

After spawning, the adults ("kelts") move downstream toward the sea. Increased water temperatures or flows may trigger movement. Some migrate toward the sea immediately, either moving partway downstream or returning to the ocean (Don Pugh, U.S. Geological Survey (USGS) personal communication). Most kelts, however, overwinter in the river and return to the sea in the spring. Kelts that remain in the river appear to survive well through the winter (Jonsson et al., 1990; Ruggles, 1980). The relative survival of kelts, however, has not been calculated for Maine rivers. After reaching the ocean, few kelts survive as indicated by the lack of repeat spawners in the GOM DPS (USFWS & NMFS, 2005).

<u>Eggs</u>

The fertilized eggs develop in the redd for a period of 175 to 195 days, hatching in late March or April (Danie et al., 1984).

Alevins and Fry

Newly hatched salmon, also referred to as sac fry, remain in the redd for approximately six weeks after hatching and are nourished by their yolk sacs (Gustafson-Greenwood & Moring, 1991). In three to six weeks, they consume most of their yolk sac, travel to the surface to gulp air to fill their swim bladders, and begin to swim freely; at this point they are called “fry.” Survival from the egg to fry stage in Maine is estimated to range from 15 to 35% (Jordan & Beland, 1981).

Parr

When fry reach approximately 4 cm in length, the young salmon are termed “parr” (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.”

Smolts

During the smoltification process, 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).

The spring migration of smolts to the marine environment takes 25 to 45 days. Most smolts migrate rapidly, exiting the estuary within several tidal cycles (Hyvärinen et al., 2006; Lacroix & McCurdy, 1996; Lacroix & Knox, 2005; Lacroix et al., 2004). 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 4). Data collected from four rivers in the GOM DPS (including two rivers from the Downeast SHRU; the Narraguagus and the East Machias) between 2011 and 2015 show that migration could last between one and five weeks depending on river conditions.

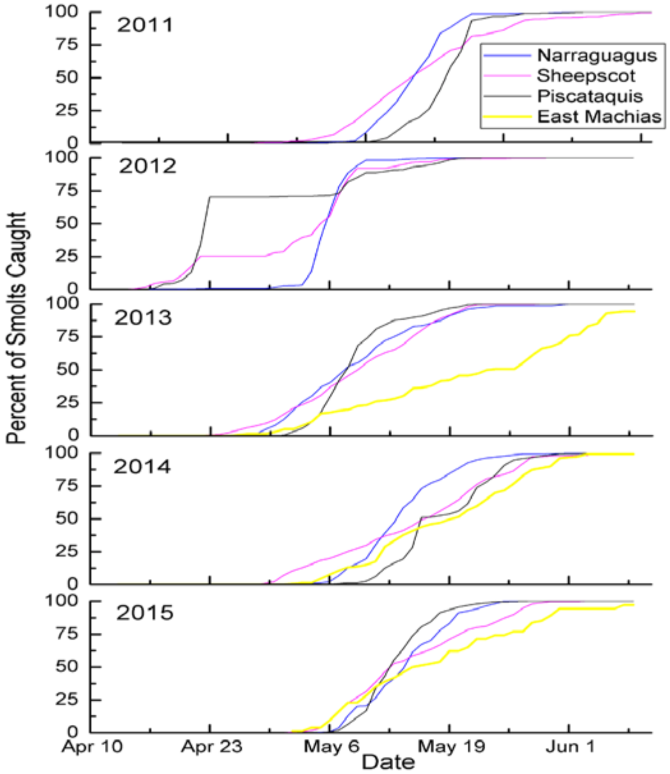

Figure 4. Cumulative percent smolt capture of all origins by date (run timing) on the Narraguagus (blue line), Sheepscot (pink line), Piscataquis (black line), and East Machias (yellow line) rivers, Maine (2011-2015)(USASAC, 2016).

Post-smolts

Smolts are termed post-smolts after ocean entry to the end of the first winter at sea (Allan & Ritter, 1977). Post-smolts generally travel out of coastal systems on the ebb tide and may be delayed by flood tides (Hyvärinen et al., 2006; Lacroix & McCurdy, 1996; Lacroix & Knox, 2005; Lacroix et al., 2004). 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 some aggregation and common migration corridors related to surface currents (Hyvärinen et al., 2006; Lacroix & McCurdy, 1996; Lacroix et al., 2004). Post-smolt distribution may reflect water temperatures (Reddin & Shearer, 1987) and/or the major surface-current vectors (Lacroix & Knox, 2005). Post-smolts travel mainly at the surface of the water column (Renkawitz et al., 2012) and may form shoals, possibly of fish from the same river (Shelton *et al.* 1997). Post-smolts grow quickly, achieving lengths of 30-35 cm by October (Baum, 1997a). Smolts can experience high mortality during the transition to saline environments for reasons that are not well understood (Kocik et al., 2009; Thorstad et al., 2012).

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 & Friedland, 1993; Reddin & Short, 1991; Renkawitz et al., 2012). Atlantic salmon located off Greenland are primarily composed of non-maturing first sea winter (1SW) fish, which are likely to spawn after their second sea winter (2SW), from both North America and Europe, plus a smaller component of previous spawners who have returned to the sea prior to their next spawning event (Reddin, 1988; Reddin et al., 1988). The following spring, 1SW and older fish are generally located in the Gulf of St. Lawrence, off the coast of Newfoundland, and on the east coast of the Grand Banks (Dutil & Coutu, 1988; Friedland et al., 1999; Reddin, 1985; Reddin & Friedland, 1993; Ritter, 1989).

Adults

Some salmon may remain at sea for another year or more before maturing. After their second winter at sea, the salmon likely over-winter in the area of the Grand Banks before returning to their natal rivers to spawn (Reddin & Shearer, 1987). Reddin and Friedland (1993) found non-maturing adults located along the coasts of Newfoundland, Labrador, and Greenland, and in the Labrador and Irminger Sea in the later summer and autumn.

The average size of Atlantic salmon is 71-76 cm (28-30 inches) long and 3.6-5.4 kg (8-15 pounds) after two to three years at sea. Although uncommon, adults can grow to be as large as 30 pounds (13.6 kg). The natural life span of Atlantic salmon ranges from two to eight years (ASBRT 2006).

3.2.2. 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 (Foster & 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 over the past decade. 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 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 1990s and early 2000s. 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 may suggest otherwise. Despite consistent smolt production, there has been extreme variability in annual returns.

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 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.

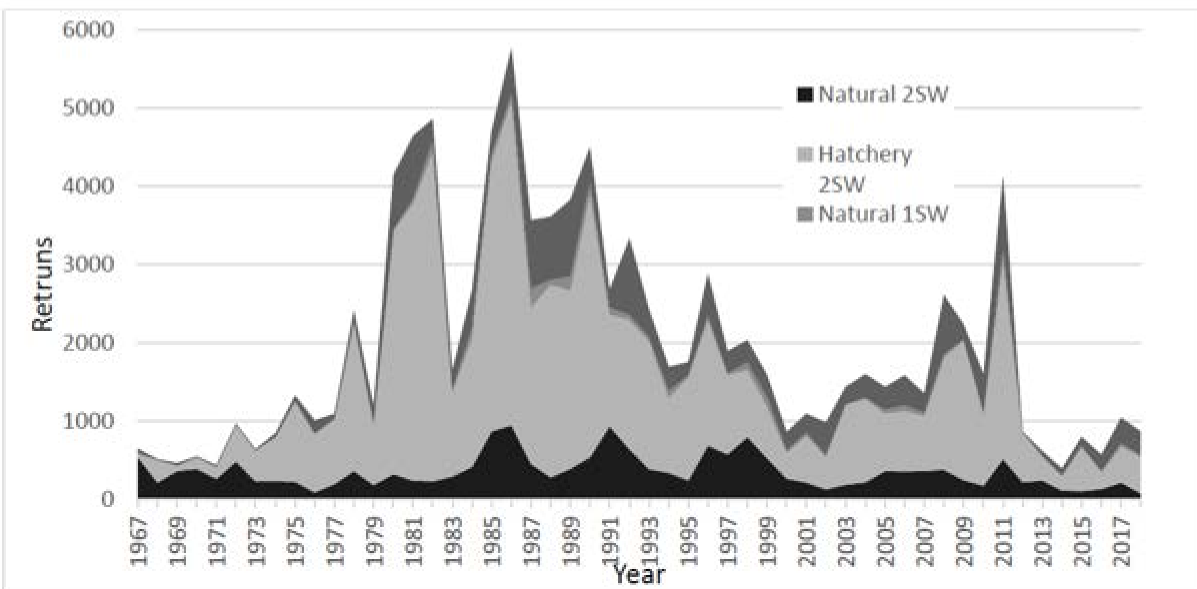

Figure 5. Summary of natural vs. hatchery adult salmon returns to the GOM DPS Rivers between 1967 and 2018 (USASAC, 2019).

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 hatchery fry and smolts 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 (Baum, 1997a; Beland, 1984). 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 distribution of Atlantic salmon is limited by obstructions to passage and low abundance levels. Within the range of the GOM DPS, the Kennebec, Androscoggin, Union, Narraguagus, and Penobscot Rivers contain dams that severely limit passage of salmon to significant amounts of spawning and rearing habitat.

Salmon Habitat Recovery Units

In describing the GOM DPS, we have divided the DPS into three Salmon Habitat Recovery Units (SHRUs). The three SHRUs are the Downeast Coastal SHRU, Penobscot Bay SHRU, and Merrymeeting Bay SHRU (Figure 6). The SHRU delineations 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.

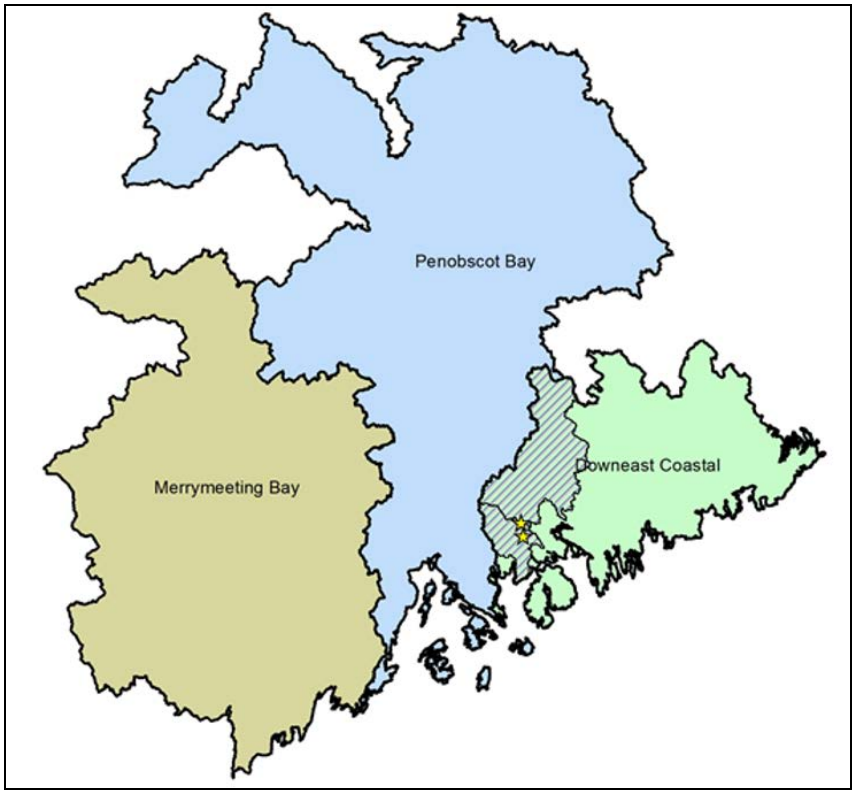

Figure 6. Location of Salmon Habitat Recovery Units (SHRU) in the GOM DPS. The Union River watershed is shown (crosshatched) for reference, as are the Ellsworth and Graham Lake Dams.

3.2.3. Survival and Recovery of the GOM DPS

In light of the 2009 GOM DPS listing and designation of critical habitat, the USFWS and NMFS issued a new recovery plan for Atlantic salmon on February 12, 2019 (USFWS & NMFS, 2019). The Recovery 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 plan is based upon a planning approach recently endorsed by the USFWS and, for this plan, by NMFS. The new approach, termed the Recovery Enhancement Vision (REV), focuses on the three statutory requirements in the ESA, including site-specific recovery actions; objective, measurable criteria for delisting; and time and cost estimates to achieve recovery and intermediate steps. The Recovery Plan is based on two premises: first, that recovery must focus on rivers and estuaries located in the GOM DPS until the Services have a better understanding of the threats in the marine environment, and second, that survival of Atlantic salmon in the GOM DPS will be dependent on conservation hatcheries through much of the recovery process. In addition, the scientific foundation for the plan includes conservation biology principles regarding population viability, an understanding of freshwater habitat viability, and threats abatement needs.

Under the Recovery Plan, reclassification of the GOM DPS from endangered to threatened will be considered when all of following 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 two of the three 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; and
- 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.

Under the Recovery Plan, before a decision can be made to de-list the GOM DPS, the following criteria must be met:

- 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;
- 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; and
- 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.

3.2.4. 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 small and displays no sign of growth. 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 halt the decline 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.

3.3. Atlantic Salmon 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 7). 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).

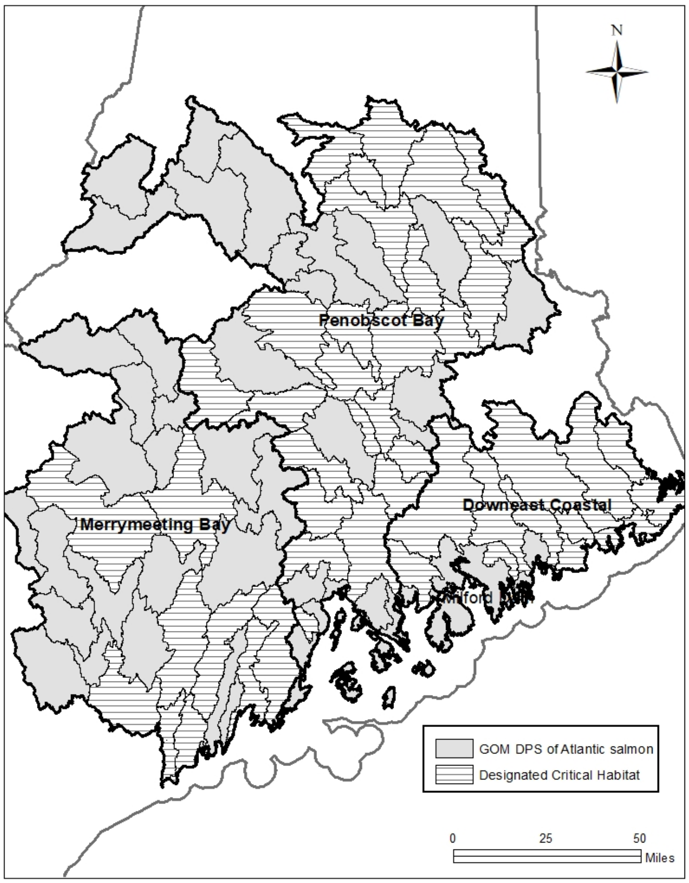

Figure 7. HUC-10 Watersheds Designated as Atlantic Salmon Critical Habitat and Salmon Habitat Recovery Units within the GOM DPS.

3.3.1. Physical and Biological Features of Atlantic Salmon Critical Habitat

Designation of critical habitat is based on the known physical and biological features within the occupied areas of a listed species that are deemed essential to the conservation of the species.

For the GOM DPS, the physical and biological features (PBFs; also known as primary constituent elements) essential for the conservation of Atlantic salmon are: 1) sites for spawning and rearing, and, 2) sites for migration (excluding marine migration[1]) (Table 2). We chose not to separate spawning and rearing habitat 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.

Table 2. The physical and biological features for Atlantic salmon critical habitat.

PBFs for Spawning and Rearing (SR) Habitat	
SR1	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.
SR2	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.
SR3	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.
SR4	Freshwater rearing sites with space to accommodate growth and survival of Atlantic salmon parr.
SR5	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.
SR6	Freshwater rearing sites with cool, oxygenated water to support growth and survival of Atlantic salmon parr.
SR7	Freshwater rearing sites with diverse food resources to support growth and survival of Atlantic salmon parr.
PBFs for Migration (M) Habitat	

[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.

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.

Habitat areas designated as critical habitat must contain one or more physical and biological features within the acceptable range of values required to support the biological processes for which the species uses that habitat (Table 3). 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 has only been designated in areas (HUC-10 watersheds) considered currently occupied by the species. 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.

Table 3. The factors that determine the suitability of habitat for the different life stages of Atlantic salmon, as well as the acceptable range of values required to support the these biological processes.

	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				
Fisheries			Many native fish species; few non-native fish species		
Food			Macroinvertebrates and small fish		

We have determined that spawning and rearing physical and biological features (PBFs) 1-7 are present in the action area; as are the migratory PBFs 1-6. We explain this determination and discuss these features and their current status in the action area in the Environmental Baseline (Section 4).

3.4. Factors Affecting Atlantic salmon and Critical Habitat

Atlantic salmon face a number of threats to their survival, which are outlined in the Recovery Plan (USFWS & NMFS, 2019). We consider the following to be the most significant threats to the GOM DPS of Atlantic salmon:

- Lack of access to spawning and rearing habitat due to dams and road-stream crossings
- Reduced habitat complexity
- Continued low marine survival rates for U.S. stocks of Atlantic salmon
- Degraded water quality
- Water withdrawl
- Incidental capture of adults and parr by recreational anglers
- Poaching of adults
- Intercept fishery

- Introduced fish species that compete or prey on Atlantic salmon
- Diseases
- Predation
- Inadequate regulatory mechanisms related to dams
- Aquaculture practices, which pose ecological and genetic risks
- Climate change
- Depleted diadromous fish communities
- Recovery hatchery program (potential for artificial selection/domestication)
- Sedimentation of spawning and rearing habitat.

Many types of activities have been implemented to protect and restore the GOM DPS of Atlantic salmon. These activities include hatchery supplementation, dam removal, fishway construction, upgrading road crossings, 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.

The final rule designating critical habitat for the GOM DPS identifies a number of activities that have and will likely continue to affect 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.

Intercept Fishery

Starting in the 1960s, Greenland implemented a mixed-stock fishery for Atlantic salmon off its western coast (Sheehan et al. 2015). The fishery primarily captures 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. Since 1984, the North Atlantic Salmon Conservation Organization (NASCO) has established catch regulations (Sheehan et al. 2015). In recent years, Greenland had limited the fishery to internal consumption only, which in the past has been approximately 20 metric tons per year.

In 2015, Greenland unilaterally set a 45-ton commercial quota for 2015, 2016, and 2017 (Sheehan et al. 2015). Based on historic harvest estimates, Sheehan et al. (2015) estimates 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 1,500 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 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, will now be required to obtain a license. All participants in the fishery will also be 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. These requirements provide increased confidence in the accuracy of the reported landings and fishing activities moving forward.

3.5. Status of the Species in the Downeast Coastal 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 Downeast Coastal recovery unit.

The Downeast Coastal SHRU represents an important link between two large river basins that once supported very large populations of Atlantic salmon – the Penobscot and the St. John. Therefore, the SHRU assures that the GOM DPS does not become too distant and isolated from other Atlantic salmon populations. The SHRU encompasses fourteen HUC 10 watersheds covering approximately 1,852,549 acres within Washington and Hancock Counties in Eastern Maine. It contains five of the seven remaining locally adapted genetic stocks in the GOM DPS, accounting for a significant component of the GOM DPS's genetic diversity.

As a complex, the Downeast rivers are typically small to moderate sized coastal drainages in the Laurentian Mixed Forest Province ecoregion (Bailey, 1995). This commonality of zoogeographic classification makes coarse level descriptions of watersheds very similar between the rivers. The geology within the Downeast Coastal SHRU and the geology to the north and west can be separated by a line running from the Penobscot River near Winterport, ME northeast towards Topsfield, ME (Norumbega Fault). North and west of this line the rocks are mostly derived from former marine sediments with some rocks containing a fraction of carbonate minerals. The rocks south and east of this line (the vast majority of the Downeast Coastal SHRU) are derived from volcanic and more recent intrusive igneous rocks. These rocks differ in their chemistry (especially calcium, magnesium, aluminum, and iron) and resistance to erosion or dissolution (Thompson & Borns, 1985) when compared to rocks north and west of this line.

As a result of the geology within the Downeast Coastal SHRU, surface water chemistry may be affected in several ways. Rocks, such as those present south and east of the Norumbega fault weather slowly and produce relatively fewer ions per unit time (i.e., less calcium, magnesium) under similar conditions of hydrology than those present north and west of the fault. In addition, the mantle of marine clay or wetland within the Downeast Coastal SHRU may hydrologically isolate bedrock or till from weathering. Therefore, surface waters within this basin have naturally low concentrations of major cations derived from chemical weathering, and experience a relatively high influence of vegetation on ion and nutrient chemistry.

3.5.1. Status and Trends of Atlantic Salmon in the Downeast Coastal SHRU

The number of returning adults to the Downeast SHRU are small but have remained relatively steady in recent years (Figure 8). The number of prespawn Atlantic salmon returning to all rivers in the Downeast SHRU combined has ranged between 53 and 305 annually; with an average return of 112 individuals (derived from data in USASAC 2019). Of these, approximately half are returning to a single river (i.e. the Narraguagus), and approximately 56% were naturally reared.

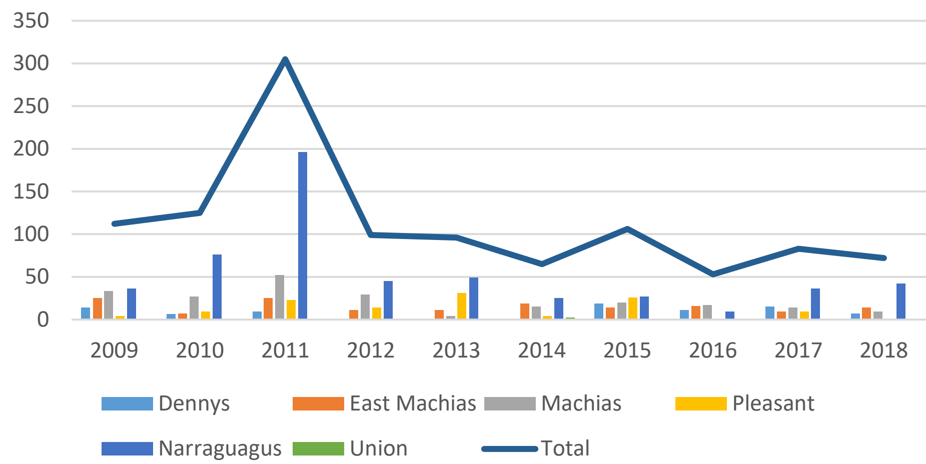

Figure 8. Adult Atlantic salmon returns to the rivers in the Downeast Coastal SHRU between 2009 and 2018 (derived from data in USASAC 2019).

One of the criteria for downlisting Atlantic salmon is the requirement that two of the three SHRUs exhibit a positive mean growth rate greater than 1.0 in the 10-year (two-generation) period preceding reclassification. While naturally-reared growth (or replacement) rates can be quite variable at these low levels of abundance, geometric mean population growth rates have stabilized at average estimates that are generally above 1.0 for all SHRUs since 2012 (Figure 9). However, there has been a decline in the last few years. In 2018, the Merrymeeting Bay SHRU had the highest growth rate (1.78; 95% CI: 1.12 – 2.83) and Penobscot Bay SHRU had the lowest growth rate (0.92; 95% CI: 0.47 – 1.80). The Downeast Coastal SHRU growth rate was 0.97 (95% CI: 0.53 – 1.76) (USASAC 2019). Given that the lower confidence limit for both the

Penobscot and Downeast SHRUs fall well below 1, it is possible that the actual rate is lower than the estimated mean; therefore, there are still concerns about the trajectories of these populations.

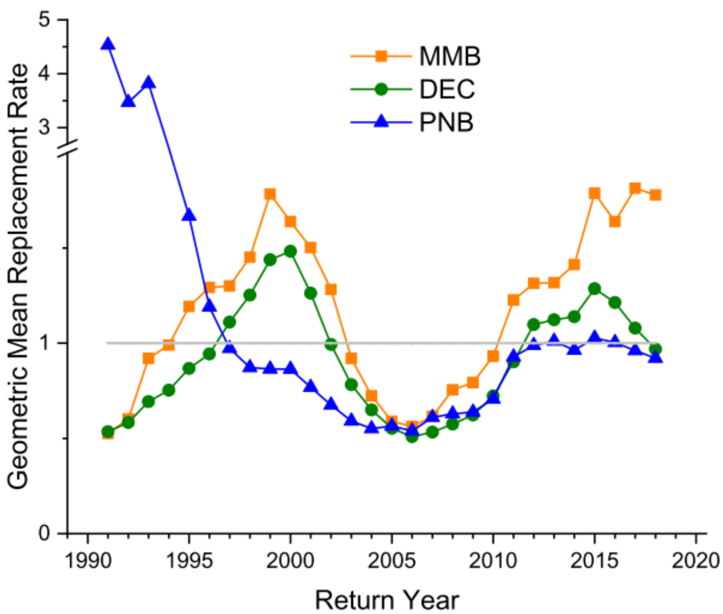

Figure 9. Ten-year geometric mean growth (or replacement) rates for the GOM DPS of Atlantic salmon for Merrymeeting Bay (Orange), Penobscot Bay (Blue), and Downeast Coastal (Green) for each SHRU individually (USASAC, 2019).

Smolts

Out-migrating Atlantic salmon smolts in the Downeast rivers 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 Downeast are the result of fry stocking, but egg, parr, and smolt stocking also occurs in the SHRU (Table 4).

Table 4. Stocking history by lifestage in the Downeast SHRU between 2009-2018 (derived from data in USASAC 2019).

Lifestage	Dennys	East Machias	Machias	Pleasant	Narraguagus	Union
Egg	0	0	261,000	295,000	79,000	0
Fry	2,183,000	799,000	2,782,000	1,072,000	3,206,000	169,000
Parr	0	1,003,400	5300	0	53,200	0
Smolt	1,000	0	59,100	183,800	534,900	400

3.5.2. Critical Habitat for Atlantic Salmon in the Downeast Coastal SHRU

In Section 3.3, we present the factors affecting critical habitat throughout the GOM DPS of Atlantic salmon. In this section, we examine the status of critical habitat within the Downeast Coastal SHRU. Areas designated as critical habitat within each SHRU 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 using a GIS-based salmon habitat model (Wright *et al.* 2008). For each SHRU, we determined that there were sufficient habitat units within the currently occupied habitat to achieve recovery objectives in the future; therefore, no unoccupied habitat (at the HUC-10 watershed scale) was designated as critical habitat. The Downeast SHRU is the smallest of the three SHRUs; containing only 15% of the habitat that occurs within either the Penobscot Bay or Merrymeeting Bay SHRUs. Based on the habitat prediction model developed by Wright et al. (2008), we estimate that approximately 55,000 of the 60,400 habitat units within the Downeast Coastal SHRU are within the designated critical habitat for Atlantic salmon (Table 5).

Table 5. The number and proportion modelled habitat units in designated critical habitat within the Downeast Coastal SHRU for Atlantic salmon (based on Wright et al. 2008).

Watershed	Habitat Units	% of Total
Union	14,341	26%
Narraguagus	7,174	13%
Pleasant	2,613	5%
Machias	15,927	29%
East Machias	6,666	12%
Dennys	2,166	4%
Minor Rivers*	6,046	11%
Total	54,933	100%

*HUC 10 watersheds: Grand Manan Channel, Roque Bluffs Coastal, Tunk Stream, Chandler River

3.5.3. Factors Affecting the Downeast Coastal SHRU

3.5.3.1. Dams

Dams are known to impact Atlantic salmon through habitat alteration, fish passage delays, and entrainment and impingement. There are approximately 65 dams in the Downeast SHRU watershed; 43 of which occur within critical habitat. Within the SHRU, approximately 40% of the habitat units are upstream of at least one dam. For comparison, the Penobscot Bay SHRU and the Merrymeeting Bay SHRU have approximately 110 and 200 dams, respectively.

Although the Downeast Rivers historically had several hydroelectric dams there are now only three, and two of those (i.e. Ellsworth and Graham Lake) comprise a single FERC-licensed project (P-2727). The Graham Lake Dam does not have turbines. The third hydro dam is the Green Lake Hydro Project (P-7189), which is on Reed Brook, a tributary to the Union River upstream of Graham Lake Dam. For comparison, the Penobscot Bay SHRU and the Merrymeeting Bay SHRU have approximately 26 and 37 FERC licensed or exempt dams, respectively.

The current number of accessible habitat units in the Downeast Coastal SHRU is approximately 28,500. This estimate does not include habitat upstream of dams that may not be accessible due to passage inefficiencies. Therefore, the habitat above the Union and Narraguagus dams is not included in this estimate.

3.5.3.2. Contaminants, Water Quality, Water Quantity

Pollutants discharged from point sources affect water quality within the Downeast Coastal SHRU. Common point sources of pollutants include publicly operated waste treatment facilities, overboard discharges, 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 Downeast River watersheds. TMDLs allocate a waste load for a particular pollutant for impaired waterbodies.

Water Withdrawals

Direct water withdrawals and groundwater withdrawals for crop irrigation and commercial, and public use can directly impact Atlantic salmon habitat by depleting streamflow (MASTF 1997, Dudley and Stewart 2006, Fay et al. 2006). Subsequently, reduced stream flow can reduce the quantity of habitat, increase water temperature and reduce dissolved oxygen. The cumulative effects of individual water withdrawal impacts on Maine rivers is poorly understood. Commercial wild blueberry growers irrigate with water withdrawn from Pleasant, Narraguagus, and Machias river watersheds. Adequate water quantity and quality are critical to all life stages of Atlantic salmon, and for specific behaviors especially adult migration and spawning, fry emergence, and smolt emigration. Survival of eggs, fry, and juveniles are also mediated by streamflow. Juvenile salmon, present in the stream throughout the year, are adapted to survive high flows by seeking refuge in the substrate. However, it is low flows that constrain available habitat and limit populations. During summer and winter, the two periods of low flow annually, juvenile salmon survival is directly related to discharge (Gibson 1993), with better survival in years with higher flows during these seasons (Ghent and Hanna 1999). Thus, summer water withdrawals have the potential to limit carrying capacity and reduce parr survival. In addition, withdrawals may dewater redds thus reducing egg survival; reduce flows in summer and impede adult migration; and reduce spring discharge and extend smolt emigration.

3.5.4. Summary of the Status of the Downeast Coastal SHRU

Adult returns for the Downeast recovery unit remain well below the biological criteria established for each SHRU in the 2018 Recovery Plan. The 2018 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 SHRU remains low. As indicated above, an average of 112 Atlantic salmon have returned annually to the Downeast SHRU over the last 10 years (USASAC 2019), which is only 7.4% of the total needed for downlisting, and 5.6% of what is needed for delisting. Although the proportion of naturally reared returns over the last decade is relatively high (56%) in the Downeast SHRU, the population growth rate has not been consistently over one. As indicated above, the population growth rate of the SHRU was greater than 1 between 2012 and 2015; but has been declining since 2015 and dropped below one in 2018 (Figure 9). 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 salmon and has not been able to halt the decline of the naturally reared component of the GOM DPS. 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.

A number of activities within the Downeast SHRU will continue to impact the biological and physical features of spawning, rearing, and migration habitat for Atlantic salmon. These include non-native fish predation, agriculture, forestry, changing land-use and development, hatcheries and stocking, roads and road-crossings and other instream activities, dams, dredging, and aquaculture.

4. Environmental Baseline in the Action Area

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 Ellsworth Project. The consequences to listed species or designated critical habitat from ongoing agency activities or existing agency facilities that are not within the agency's discretion to modify are part of the environmental baseline; however, there are no such activities or facilities in the case of this consultation. Specifically, we note that we do not consider future effects of the existence of the Graham Lake or Ellsworth 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 potentially require the removal of these structures, we consider the continued existence of the Ellsworth and Graham Lake dams over the term of the proposed new license to be effects of the action.

The environmental baseline for this biological opinion includes the effects of several activities that may have affected the survival and recovery of threatened and endangered species in the Action Area. As explained above, the action area extends from the upstream limit of the Graham Lake impoundment to where the river flows into Union River Bay. Past impacts of the operation of the Ellsworth Project are considered in the Environmental Baseline including the existence of the Graham Lake and Ellsworth dams as well as their associated impoundments. State, Federal and private actions in other areas of the Union River may impact Atlantic salmon that occur in the action area. Effects of those activities are addressed in the Status of the Species section above.

4.1. Status of Atlantic Salmon and Critical Habitat in the Action Area

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 action area.

The Union River is occupied by the federally endangered Atlantic salmon, and is within the designated critical habitat for the species. Several sources document that there was an abundant run of Atlantic salmon within the Union River historically (Foster & Atkins, 1869; Houston et al., 2007; MASRSC, 1982; MDIFG, 1961a, 1961b). The number of returning Atlantic salmon adults before the construction of dams has been estimated to be between 622 and 1,037 by the Maine Atlantic Sea-run Salmon Commission (MASRSC, 1982), and approximately 1,550 by the Department of Inland Fisheries and Game (MDIFG, 1961a). Prior to the construction of dams, Atlantic salmon could access habitat throughout the Union River watershed, including the East Branch (URFCC, 2016).

Adult returns to the Ellsworth trap during the first decade (1974-1983) of operation were as high as 263 (average of 144 per year), but quickly dropped off with the reduction of smolt stocking in the mid-1980s (Baum, 1997a). Adults trapped at the Ellsworth dam were primarily taken back to the hatchery as broodstock; resulting in limited opportunities for natural reproduction in the river.

The reduction in salmon stocking over the last few decades has led to a significant decline in returning salmon. However, we anticipate that salmon stray to the Union from other rivers within the GOM DPS. The final Recovery Plan for Atlantic salmon states (USFWS & NMFS, 2019):

Atlantic salmon have strong homing characteristics that allow local breeding populations to become well-adapted to a particular environment. At the same time, limited straying does occur among salmon populations; this helps maintain population diversity through exchange of some genes between populations and allows for population expansion and recolonization of extirpated populations. Accommodating these life history characteristics and distributional needs should provide protection from demographic and environmental variation.

Straying is a natural process that helps maintain population diversity through exchange of genes between populations and allows for population expansion and recolonization of extirpated populations. Atlantic salmon have a high degree of river of origin homing with straying rates of 1-3% (Baum, 1997b). This means that as many as three out of every 100 adult salmon may stray to a river other than the one where they were stocked or naturally reared.

The number of straying fish that enter a river is inversely proportional to the distance between that river and the source population (Pess et al., 2014). Thus, areas are more likely to receive strays if they are close to a source population. The Union River is close to both to the Penobscot (approximately 18 miles away) and Narraguagus (26 miles) rivers, which contain the two largest runs of Atlantic salmon in the GOM DPS. Because of this, we would anticipate prespawn salmon from either of these rivers to stray to the Union. However, this has not been reflected in the trap counts at the Ellsworth Dam. In 2011, there was a substantial increase in marine survival for salmon in the GOM DPS, which led to an unusually large number of returning salmon. In that year, the Narraguagus River had 196 returning salmon and the Penobscot had 3,125 returns; approximately a 250% increase in returns over the previous year (USASAC, 2011, 2012). With a 1 to 3% straying rate (Baum, 1997b), we would expect there to have been between 30 and 100 straying salmon between those two rivers, but none were trapped at Ellsworth. All the smolts that are stocked in the Penobscot drainage (~550,000 per year) (Baum, 1997b; USASAC, 2017) are raised from egg to smolt at the Green Lake National Fish Hatchery, which is within the Union River watershed upstream of the Ellsworth Dam. Atlantic salmon are believed to imprint to their natal river during the smolt stage. Since juvenile salmon destined to be stocked in the Penobscot River are raised in the Union River watershed until they are smolts, we would anticipate that some proportion of these fish would be more inclined to stray back to the Union, rather than to the Penobscot where they are stocked. All of this would suggest that Atlantic salmon are straying to the Union River on a regular basis, although they have not been successfully trapped at the Ellsworth Dam. For instance, no salmon returned to the Union River in 2018, and only two returned in 2019, which is the highest seen at the dam in a decade.

There is abundant suitable spawning and nursery habitat for Atlantic salmon above the Ellsworth Dam. According to a letter filed with FERC by MDMR (July 1, 2013), 288 captive-reared adult Atlantic salmon (134 females, 154 males produced from GOM DPS broodstock) were released to spawn in the West Branch in 2011. MDMR documented over 200 completed redds produced by those adults during a partial survey of spawning habitat. Juvenile salmon relative abundance from those redds was documented during single pass catch per unit effort electrofishing surveys in 2012 and 2013 (median of 2.6 young of year per minute in 2012, median of 0.6 parr per minute in 2013) in the West Branch (USASAC, 2013, 2014). This level of production was comparable to other productive rivers in 2013, including the Piscataquis (0.7 parr per minute) and Sandy Rivers (0.4 parr per minute). The successful spawning and rearing in the Union in 2011 and 2012 did not lead to the expected increase in adult returns at the Ellsworth trap; however, it demonstrates that suitable habitat to support spawning and rearing exists in the watershed. No adult salmon were trapped at the Ellsworth Dam in 2016 (the year we would anticipate adult returns from the 2011 stocking effort), which is in contrast to 39 adults returning to the Kennebec River in the same year as a result of stocking in the Sandy River in 2011 (USASAC, 2017). The difference was likely the result of high downstream mortality of smolts at the Ellsworth Project (high mortality of smolts means fewer adults available to return to the river), and potentially also related to low capture effectiveness at the trap.

In summary, there are very few Atlantic salmon returning annually to the Union River and the river is completely dependent on strays and limited hatchery supplementation (stocking of small numbers of fry). Substantial improvements in downstream passage survival of outmigrating smolts must be achieved in order to provide an opportunity for adults to return to the river. Improvements must be made to the efficiency of passage at the Ellsworth Dam and upstream passage must be provided at the Graham Lake Dam for adult salmon that do return to the river to be able to access spawning habitat. Suitable habitat for all life functions exists in the Union River as a whole, and the action area specifically. We expect that the potential for recovery of the Union River salmon population exists provided that upstream and downstream passage can be improved.

Critical Habitat

We have designated critical habitat for Atlantic salmon in the Union River, including the area that comprises the project action area. The PBFs for Atlantic salmon considered essential to the conservation of the species include features of spawning and rearing and migration habitat (as described in Section 3.3.1).

A complete Atlantic salmon habitat assessment of the Union River watershed was conducted in 1959-1960 by the Maine Department of Inland Fisheries and Game (MDIFG, 1961a). This survey confirmed the presence of habitat consistent with the Spawning and Rearing PBFs in the Union River watershed, as well as in the action area (Table 6). The estimates developed in this survey should be considered the minimum amount of available habitat, as the biologists were “extremely conservative in [their] calculations, and included only ideal areas” (MDIFG, 1961a). The modeling effort conducted by Wright et al. (2008) was less conservative in its approach, and identified approximately 14,000 units of spawning and rearing habitat in the Union River watershed, of which 5,400 occur within the West Branch (Wright et al., 2008). A more recent field study was conducted in 2001 by the Maine Department of Marine Resources[2]. This effort was limited to the mainstem of the West Branch (upstream of the action area), but still identified 1,533 units of rearing habitat, and 188 habitat units of spawning habitat. It should be noted that all of these habitat estimates were made after the Union River and its tributaries were inundated by the construction of the Ellsworth Dam in 1907 and the Graham Lake Dam in 1924. Prior to dam construction, we expect that the amount of habitat in the watershed was substantially higher.

In addition to identifying spawning and rearing areas, the MDIFG survey assessed the abundance and quality of resting pools. Such pools are critical for prespawn Atlantic salmon (PBF SR1 and M2) and were documented to occur in the action area.

Table 6. Field surveyed rearing and spawning habitat in the Union River watershed. Derived from information provided in MDIFG 1961.

	Habitat Units		Resting Pools	
Stream	Rearing	Spawning	Abundance	Quality
Flows into the West Branch of the Union River				
Haynes Brook	205	53	Scarce	Fair
Buffalo Stream	160	73	Numerous	Fair
Indian Camp Stream	44	34	Scarce	Poor
Alligator Stream	338	122	Scarce	Fair
Main Stream	221	1	Numerous	Fair
Flows into the Graham Lake Dam Impoundment				
West Branch	4870	1684	Numerous	Good
East Branch	1118	58	Abundant	Excellent
Tannery Brook	442	175	Numerous	Good
Middle Branch	294	36	Numerous	Good
Flows into the Union River/Union River Bay				
Branch Lake Stream	768	320	Numerous	Excellent
Union River below Graham Lake Dam	184	8	Numerous	Excellent

We have defined the action area for this project as the Union River from the upper extent of the Graham Lake impoundment downstream to where the Union River flows into Union River Bay; a distance of approximately 30-km. The action area also includes all portions of tributaries impacted by project operations (e.g. water level fluctuations). Neither FERC nor the Licensee specifically state in the FEA or the draft BA, respectively, what PBFs are present within the action area. Our analysis concludes that all of the migratory PBFs (M 1-6) occur in the action area, as well as the spawning and rearing PBFs (SR 1-7). PBFs SR 2 and 3 are associated with

[2] Maine Stream Habitat Viewer- https://webapps2.cgis-solutions.com/MaineStreamViewer/

spawning habitat, which is much less abundant within the action area than it is upstream in the West Branch and East Branch of the Union River. However, the Maine Department of Inland Fisheries and Game identified a small amount of habitat within the mainstem of the Union (i.e. 8 habitat units) that is suitable for spawning (MDIFG, 1961a). Therefore, we consider that all of the PBFs identified in section 3.2.1 occur within the action area for this project. The migration PBFs are not functioning adequately in the action area due to the effects of the two dam structures. Specifically, the Ellsworth and Graham Lake dams reduce the conservation value of migratory habitat in the action area by acting as physical barriers that delay or prevent access of adult salmon seeking spawning grounds (M1), and delaying or prevent emigration of smolts to the marine environment (M4). The dams also affect the abundance and diversity of the native fish communities that serve as a protective buffer against predation (M3). These effects are evidenced by the poor upstream passage at the Ellsworth Dam and nonexistent passage at the Graham Lake Dam. Downstream survival of Atlantic salmon smolts is extremely low, as demonstrated by Black Bear's smolt survival studies in 2016 and 2017. The spawning and rearing PBFs (1-7) are not functioning fully due to flow modifications caused by the Ellsworth Project's mode of operation (i.e., peaking), and habitat modification caused by the impounding of water, particularly in the 10-mile long Graham Lake impoundment. Spawning and rearing habitat units downstream of the Graham Lake Dam and in the tributaries that are inundated by the impoundment, are significantly affected by the store and release operation at the dam. The storage of water in Graham Lake (inflow is greater than outflow) leads to inundation, reduced velocities, and warmer water temperatures upstream of the dam; and reduced water levels downstream of the dam. During periods when outflow is greater than inflow, the effect is reversed; areas downstream of the dam are exposed to increased velocities and depths, whereas portions of the impoundment and its tributaries are dewatered. For these reasons, we expect that the altering of the natural hydrologic cycle affects the functioning of rearing habitat in the action area.

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 impacts of all proposed Federal actions in the action area that have already undergone formal or early section 7 consultation. We have not completed any formal or early section 7 consultations for other activities in the action area.

4.3. State or Private Activities in the Action Area

4.3.1. 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. 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 that 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 confer 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. 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-specific interactions between species 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.

Stocking of juvenile salmon in the Union River drainage has been limited in recent years, but between 1971 and 1990 over 600,000 smolts and 250,000 parr were stocked into the system to promote a put and take fishery (Baum, 1997a). Additionally, in several years, captive broodstock were transferred to the river from the Green Lake National Fish Hatchery (approximately 3,000 adults were transferred between 1982 and 1993). In recent years stocking has been limited to a relatively small amount of fry stocking (USASAC, 2019) (Table 7). Aside from a small number of fry (<1000) stocked annually through the Salmon in Schools Program, no stocking of Atlantic salmon has occurred in the Union since 2017.

Table 7. Atlantic salmon stocking summary for the Union River (USASAC 2019)

	Number of fish stocked by life stage							
	Egg	**Fry**	**0 Parr**	**1 Parr**	**2 Parr**	**1 Smolt**	**2 Smolt**	**Total**
1971-2008	0	485,000	371,400	0	0	379,700	251,000	1,487,100
2009	0	28,000	0	0	0	0	0	28,000
2010	0	19,000	0	0	0	0	0	19,000
2011	0	19,000	0	0	0	0	0	19,000
2012	0	1,000	0	0	0	0	0	1,000
2013	0	2,000	0	0	0	0	0	2,000
2014	0	24,000	0	0	0	0	0	24,000
2015	0	25,000	0	0	0	0	0	25,000
2016	0	26,000	0	0	0	0	0	26,000
2017	0	25,000	0	0	0	200	0	25,200
Totals:	**0**	**654,000**	**371,400**	**0**	**0**	**379,900**	**251,000**	**1,656,300**

4.4. Impacts of Other Human Activities in the Action Area

Other human activities that may affect listed species and critical habitat include direct and indirect modification of habitat due to hydroelectric facilities, management of non-native fish, and water withdrawals as described below.

4.4.1. Dams and Hydroelectric Facilities

Within the action area there are five dams of which three are FERC licensed dams used for power generation or storage. The effects of the proposal to issue a new license for the Ellsworth Project is the subject of this Opinion; therefore, we will analyze the future effects of the project over the term of the proposed new license in the *Effects of the Action* section (section 6.0). However, the Ellsworth and Graham Lake dams have been in place for more than a century, and have significantly affected the species and habitat within the action area. Therefore, here we consider the past effects of the project.

4.4.1.1. 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).

Compared to a natural hydrograph, the operation of the Ellsworth Project in a store-and-release mode results in reduced spring runoff flows, less severe flood events, and augmented 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 main stem. The extent to which these streamflow modifications in the Union River watershed impact salmon habitat (including migratory corridors during applicable seasons), and restoration efforts is unknown. However, increased embeddedness of spawning and invertebrate colonization substrates, diminished 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 Union River watershed.

There are two impoundments associated with the Ellsworth Project. The Ellsworth Dam impoundment, also known as Lake Leonard, is relatively small (only one mile long). Although it inundates Ellsworth Falls, the historical limit for some diadromous species, the habitat impacts are minimal. The dominant feature of the Union River drainage is the 10,000 acre, 10-mile long impoundment of the Graham Lake Dam. The impoundment is an artificial lake created by the construction of the Graham Lake Dam in 1924. Prior to dam construction, the now flooded area was a large low-gradient freshwater marsh (Figure 10). A comparison between USGS topographical maps from 1910 and 2011 suggests that the construction of Graham Lake Dam inundated approximately 75 kilometers of stream and riverine habitat.

Figure 10. A comparison of USGS topographical maps from 1910 (left) and 2011 (right) show the effect of the construction of the Graham Lake Dam. The red star indicates the location of Graham Lake Dam. The stream segments on the map on the right were inundated by the construction of the dam.

There is abundant information that demonstrates that large project impoundments, like the one created by Graham Lake Dam, have a negative effect on fish and their habitat (Havn et al., 2018; Jepsen et al., 1998; Keefer et al., 2012; Liew et al., 2016; Raymond, 1988; Stich et al., 2014; Todd et al., 2017; Venditti et al., 2000). 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. In the 2016 survival study smolts moved much slower through the Graham Lake impoundment (0.1 mph) than through the free flowing reaches of the lower Union River (0.60 to 0.77 mph) (FERC, 2019). 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 Graham Lake Dam impoundment is undoubtedly associated with the fact that the smolts are migrating through a 15.5-kilometer reach of river that has been converted to a large shallow lake by the dam.

4.4.1.2. Fish Passage

Downstream Passage Effects

Downstream Passage of Atlantic Salmon Smolts

The Ellsworth Project affects outmigrating diadromous fish by injuring and killing juveniles and adults directly though turbine entrainment and indirectly by creating stagnant water conditions in the impoundments that support fish and bird predation, as addressed above. The Project's impoundments also alter water quality, stream channel migratory routes, and the timing and behavior of outmigrating fish. It has been suspected that the threat that the Ellsworth Project poses to outmigrating fish in the Union River greatly limits its potential to support abundant runs of sea-run fish (MASRSC, 1982; MDIFG, 1961a). However, until recently there has been little empirical evidence to characterize that threat. In 2016 and 2017, Black Bear conducted an Atlantic salmon smolt survival study, as well as a turbine entrainment study using Hi-Z balloon tags. Study reports for these studies are available in the FERC library, and are summarized below. The studies demonstrate that downstream survival for diadromous fish at the Ellsworth Project is poor. This conclusion is further supported by information filed by the Downeast Salmon Federation (DSF) and other members of the public that documents alewife and eel kills at the project annually since 2014 (URFCC, 2018).

Atlantic salmon smolt survival study

In 2016 and 2017, Black Bear conducted downstream smolt survival studies at the Ellsworth Project (BBHP, 2016b, 2017a). Atlantic salmon smolts were radio tagged and released upriver of Graham Lake Dam. The survival estimates for both years are summarized in Table 8. The two study years cannot be compared directly, as the field methods, release locations, statistical methods, and river conditions varied between years. Additionally, structural and operational changes were made at the Project between the two study years. Primarily, an entrance weir was attached to the upstream side of the Graham Lake Dam, and four sections of flashboards were lowered at the Ellsworth Dam. These modifications were made in 2017 in an attempt to increase smolt survival at the project.

Table 8. Salmon smolt survival through the Ellsworth Project river reaches in 2016 and 2017 (BBHP, 2016b, 2017a). We consider the Graham Lake Dam estimate to encompass survival from a point 200 meters upstream of the dam to a point 3.4-km downstream of the dam. The survival estimates reported for the 2016 study do not include a correction for background mortality.

Reach	2016	2017
Graham Lake	86%	NA
Graham Lake Dam	14%	78%
Leonard Lake	99%	98%
Ellsworth Dam	74%	74%
Cumulative Survival	9%	58%

Although the results from the two study years cannot be compared directly, they do suggest that there was a substantial improvement in survival in 2017. The results from 2017 also show a marked decrease in the migratory delay experienced by smolts while passing the two dams. It is unknown if the improvements made at Graham Lake Dam (namely the new entrance weir), or the increase in river flow (2.5x higher in 2017) is the reason for the decrease in mortality and delay.

Impoundment Survival

In their smolt survival studies, Black Bear measured survival through two separate reaches within the Graham Lake impoundment. The first was the 15.5-kilometer reach that extends from where the West Branch of the Union River flows into the impoundment to a point approximately 200 meters upstream from the Graham Lake Dam. The second reach is defined as the 200 meter reach above the dam. In 2016, 86% of study smolts survived migration through the upper portion of the impoundment, while only 23% survived migration through the remaining 200 meters to the dam (BBHP, 2016b). Although the survival close to the dam is significantly lower, the effect of the rest of the impoundment is still substantial. Combined, the total survival of smolts in the impoundment was approximately 20% (0.86*0.23=0.20). That is, 80% of the study smolts were killed as they migrated through the Graham Lake Dam impoundment in 2016. In 2017, Black Bear installed a new entrance weir at Graham Lake Dam in order to increase attraction to the fishway. In addition to the new entrance, there was much higher flow in the river during the smolt survival study in 2017 (i.e., more than twice as much flow as in 2016). In 2017, survival through the 200-meter reach above the dam increased to 83% (BBHP, 2017a), likely due to a combination of the new entrance and the much higher flow in the river. Black Bear did not measure survival through the upper impoundment in 2017, but if we assume the same rate as 2016 (86%), then the total impoundment survival in 2017 was approximately 71% (0.86*0.83=0.71) (i.e. total mortality equals 29%). We consider the 2017 data to be the best available information regarding current smolt mortality through the Graham Lake impoundment, given the changes at the fishway in between the two study years and the anticipated continued deployment of the weir installed for 2017. As indicated, it is not apparent how much of the increase in survival between 2016 and 2017 was due to the new entrance weir at the Graham Lake fishway or to significantly higher flow in the second study year. The average flow during the 2016 and 2017 studies was 478 cfs (~70% flow exceedance) and 1,190 cfs (~40% flow exceedance), respectively. Flow in 2017 was not significantly different from the median flow (i.e., 900 cfs) in the Union in the month of May; and therefore is more representative of the expected flow at the project in any given year.

In order to understand the effect of the dams on the survival of salmon smolts it is necessary to have an estimate of background mortality. Background mortality is the expected mortality rate of smolts migrating through a reach of river attributable solely to natural causes unrelated to consequences of the existence of a dam or hydroelectric project operations. It is important to note that background mortality varies significantly by year and reach. Therefore, it should be measured over multiple years over a sufficiently long unimpounded reach to average out any stochastic effects. There were few reaches monitored in either the 2016 or 2017 smolt survival studies that are not impacted by the Project that could be used to estimate background survival in the Union River through an unimpounded reach. There is a 6.5-km reach between Graham Lake and the Ellsworth Dam (monitoring station U3 to U6), but it is heavily impacted by the dams on either end. The 3.4-km reach immediately downstream of Graham Lake Dam had a 41% mortality rate in 2016 and a 7% mortality in 2017. This would suggest that there are either latent effects of dam passage occurring in this reach, or else predators may be congregating downstream of the project to prey on disoriented smolts (which would also be a consequence of the existence of the dam). The reach immediately above Ellsworth Dam includes Leonard Lake (i.e., the Ellsworth Dam impoundment), which, although impacted by the dam, may be the most natural of the study reaches evaluated in 2016 and 2017. The background mortality through this 3-km reach was 1.4% per kilometer in 2016 and 1.0% per kilometer in 2017. The fact that the mortality rate in 2016 was higher than what was detected in the upper Graham Lake impoundment (1.0% per km) in the same year would suggest that the reach is either significantly affected by the dams, or else is too short to adequately assess background mortality throughout the Union River. Therefore, this information by itself is not sufficient to estimate background mortality in the Union River.

Studies have been conducted in unimpounded reaches of the Penobscot River and the Narraguagus River, the closest rivers to the Union to the west and east, respectively. Black Bear measured mortality through an unimpounded 31-km reach of the mainstem Penobscot between 2016 and 2018; documenting an average mortality of 1.0% per kilometer (2016: 0.8% per km, 2017:0.8% per km, 2018:1.5% per km) (BBHP, 2017b, 2018, 2019). Similarly, NOAA's Northeast Fisheries Science Center conducted a smolt survival study through an unimpounded 32-km reach of the Narraguagus River in 2017 and 2018, and determined that the average mortality was 0.2% per kilometer[3]. These mortality rates show that the 1% per km mortality rate detected in 2016 in the upper 15.5 km of the Graham Lake impoundment is within the range that has been documented in unimpounded reaches in nearby rivers (0.2% - 1.5%). However, the difference between a background mortality of 0.2% or 1.5% mortality per kilometer in terms of the number of smolts making it to the estuary is significant. Therefore, the limited information available may not be sufficient to accurately estimate survival rates through this reach of the river. Further studies will be needed to ascertain specifically how, and if, the Graham Lake

[3] J. Hawkes, NOAA's Northeast Fisheries Science Center, Preliminary data, December 18, 2018.

impoundment contributes to smolt mortality. However, based on the best available information on background survival specifically in the Union River (i.e., 1.4% in 2016, and 1.0% in 2017), it appears that smolt mortality through the upper reach of Graham Lake (i.e. 1.0% per kilometer) in 2016 is consistent with documented background survival rates in unimpounded reaches of other rivers in the Gulf of Maine DPS. Therefore, the effect of the Project on smolt survival through the 15.5 km reach downstream of the Route 181 crossing is expected to be minimal as it is similar to an unimpounded reach.

Assuming the same rate of background mortality as above (i.e., 1% per kilometer), it is apparent that the Graham Lake impoundment causes significant mortality within 0.2-km of Graham Lake Dam (i.e., 77% in 2016, and 17% in 2017). Assuming that the new entrance weir at Graham Lake Dam is the reason for the improved survival immediately above the dam in 2017, we anticipate that the dam related mortality in the lower 0.2-km of the Graham Lake impoundment is 16.8% (=17% - 0.2% background mortality (i.e., 1%/km adjusted for the 0.2 km reach)). We do not know specifically what causes this mortality, but we assume it is associated with the migratory delay caused by the presence of the dam, in addition to a large number of non-native fish predators that thrive in the habitat altered by the dam that result in increased predation in this area. In summary, the best available information indicates that 16.8% of smolts that attempt to outmigrate from the Union River die within 0.2 km of the Graham Lake Dam because of the existence of the Project. This mortality is incorporated into the Graham Lake Dam survival estimate (i.e., 78%) presented in Table 8.

Turbine entrainment study

Recurrent fish kills of juvenile and adult alewives, as well as eels, continue to be a major problem at the Ellsworth Project. Large numbers of dead fish have been observed with injuries consistent with pressure injuries (i.e., missing eyes) (URFCC 2018, FERC submittal 20170810-5051 and 20161017-5030). To better characterize the extent of mortality and injury associated with turbine entrainment, Black Bear conducted a Hi-Z balloon tag study in 2017 (BBHP, 2017a). Brown trout were used as a surrogate for Atlantic salmon smolts in the study as they are a closely related species that are similar in size. The results of the study indicate that mortality rates of salmonids at both the small Kaplan units (#2 and #3) and the larger propeller units (#1 and #4) are high; with 37.6% and 19.0% of trout passing through the Kaplans and propeller units dying, respectively. The downstream fishway was also studied and was shown to have a mortality rate of 3.8%. These mortality results are similar to what was observed in the 2016 smolt survival study, where 31% died through the Kaplan turbines and 4% died through the downstream fishway (BBHP, 2016b).

The results of the entrainment study also showed that the smaller faster Kaplan units (#2 and #3) were causing more injuries (including loss of equilibrium (LOE)) (29.7%) than the larger slower units (#1 and #4) (22.2%). The injury rate through the downstream fishway was documented as 3.8%. Given these passage route injury rates, as well as the proportion of fish that used the different passage routes in 2017 (BBHP, 2017a), we can estimate the total injury rate at the Ellsworth Dam. To do this, the proportion of fish that used each passage route (determined in the 2017 smolt survival study) is multiplied by the route specific injury rate (determined in the 2017 turbine entrainment study) to estimate the proportion of the run that was injured through the different passage routes (Table 9). We estimate that the total injury rate (including LOE) at the Ellsworth Dam is 17.2%. Although Black Bear did not conduct an injury assessment at the Graham Lake Dam, we can assume that the rate documented at the Ellsworth Dam downstream fishway (3.8%) would apply given that turbine passage is not an option. Combining these rates suggests that the total project injury rate is approximately 21.0%. Much of this injury is accounted for in the mortality estimate described above since most of the fish injured during passage did not survive their injuries. However, a small percentage of fish did survive their injuries for at least one hour, and presumably would have continued their migration to the estuary if they had not been recaptured as part of the study. Therefore, based on information from Black Bear's study, we estimate a sublethal injury rate of 7.4% (Table 9).

Table 9. The estimated smolt injury rate at the Ellsworth Dam based on information from Tables 4.3-4.5 of Black Bear's 2017 passage studies (BBHP, 2017a).

	Ellsworth Dam			Graham L. Dam	
	Propeller	Kaplan	Bypass	Fishway/Gates*	Total
Route specific injury (A)	22.2%	29.7%	3.8%	3.8%	
Passage Route Use (B)	34.2%	27.4%	38.5%	100.0%	
% run injured (A x B)	7.6%	8.1%	1.5%	3.8%	**21.0%**
Survival of injured fish (C)	13.0%	5.4%	1.9%	1.9%	
% run injured that survived (B x C)	4.4%	1.5%	0.7%	0.7%	**7.4%**

*Assumed based on injury rates through the downstream fishway at the Ellsworth Dam

Migratory 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. If so, then these delays are expected to reduce smolt survival (McCormick et al., 1999).

The Ellsworth Project causes significant migratory delay of Atlantic salmon smolts in the Union River. In the 2016 and 2017 studies, smolts were delayed at both the Graham Lake and Ellsworth Dams (Table 10). The median delay at these dams is significantly higher than other dams where monitoring has occurred within the GOM DPS (BBHP, 2017b, 2018, 2019; Brookfield, 2016). In 2017, 67% and 88% of salmon smolts took less than 24 hours to pass the Graham Lake Dam and Ellsworth Dam, respectively; and 61% successfully passed both dams within 48 hours. We expect that if the two dams were not there a salmon would be able to move through this reach in no more than 48 hours. The delay at the Ellsworth Project likely leads to high predation in the project headponds; but may also lead to undetected mortality later in time associated with smolts missing their physiological smolt window downstream of the Ellsworth Dam. As the Union River is relatively short, and as there are only two mainstem dams in the river, it is likely that the cumulative effects of migratory delay are less than they are on larger systems in the GOM DPS (e.g., Penobscot and Kennebec Rivers). It is possible that modifications made at the dams in between the studies in 2016 and 2017 led to a substantial reduction in migratory delay in 2017. However, this reduction could also be at least in part attributed to the much higher flow in the river in 2017 compared to 2016 (i.e. 2.5 times higher in 2017 than in 2016), which we would expect to increase the transit time of smolts through the system.

Table 10. Migratory delay measured at the Ellsworth Dam and Graham Lake Dam during the 2016 and 2017 smolt telemetry studies. Delay is measured from the time when the fish approaches within 200 meters of the dam to when it passes.

	2016		2017	
	Median (hrs)	Range (hrs)	Median (hrs)	Range (hrs)
Graham Lake Dam	79.8	2.1 – 287.4	5.6	0.1 – 118.1
Ellsworth Dam*	17.9	0.1 – 355.7	5.7	0.1 – 104.2

*Acoustically tagged fish only

Downstream Passage of Atlantic Salmon Kelts

Based on recent returns to the Union River (Figure 8), we anticipate that a small number of kelts pass downstream through the Project annually in the spring and late fall. As there are no turbines at the Graham Lake Dam, all salmon pass the dam via the fish bypass or the Tainter (i.e., bottom opening) gates. At the Ellsworth Dam, there is potential for turbine entrainment, in addition to spillway and fishway passage. We estimate that the minimum width of adult Atlantic salmon is 2.5-inches. As the spacing on the racks at the turbine intakes at the Ellsworth Dam is less than that, we would not anticipate that any kelts would become entrained in the turbines. Furthermore, as the velocities at the turbine intakes are lower than the average swim speed for adult Atlantic salmon, we do not anticipate that any kelts would become impinged on the racks. Therefore, we expect that kelts pass the project either through spillage or through the downstream fishway. In April, May, and November, when kelts are expected to outmigrate, flows in the Union River exceed Ellsworth’s hydraulic capacity (~2,500 cfs) only between 10%

and 20% of the time. Therefore, we anticipate that the majority of kelts pass the project via the downstream fish bypass, which currently passes 60 cfs of flow as spillage only occurs between 10% and 20% of the time during the kelt migration period.

Alden Research Laboratory estimates that spillway passage mortality for Atlantic salmon smolts and kelts is 3%; and that mortality through a downstream fishway is 1% (Alden Research Laboratory, 2012). The Ellsworth Dam downstream fishway utilizes a sluice along the spillway; therefore, we would anticipate that survival would more closely approximate the estimate for spillway passage. Given the available passage options at the two dams, we assume that kelt mortality at the Graham Lake Dam is no more than 1%; and that at the Ellsworth Dam it is no more than 3%. We, therefore, anticipate that existing mortality rate for kelts at the Ellsworth Project is no more than 4%.

Hydrosystem Delayed Mortality

In addition to direct mortality sustained by Atlantic salmon at the Ellsworth Project, smolts may exhibit delayed mortality in the estuary attributable to their experience at the project. 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; Haeseker et al., 2012; ISAB, 2007; Schaller & Petrosky, 2007). The concept describing this type of delayed mortality is known as the hydrosystem-related, delayed-mortality hypothesis.

Budy *et al.* (2002) examined the influence of hydropower experience on estuarine and early ocean survival rates of juvenile salmonids migrating from the Snake River to test the hypothesis that some of the mortality that occurs after downstream migrants leave a river system may be due to cumulative effects of stress and injury associated with multiple dam passages. The primary factors leading to hydrosystem stress (and subsequent delayed mortality) cited by Budy *et al.* (2002) were dam passage (turbines, spillways, bypass systems), migration conditions (e.g., flow, temperature), and collection and transport around dams, all of which could lead to increased predation, greater vulnerability to disease, and reduced fitness associated with compromised energetic and physiological condition.

More recent studies have corroborated the indirect evidence for hydrosystem delayed mortality presented by Budy *et al.* (2002) and provided data on the effects of in-river and marine environmental conditions (Schaller and Petrosky 2007, Haeseker *et al.* 2012). Based on an evaluation of historical tagging data describing spatial and temporal mortality patterns of downstream migrants, Schaller and Petrosky (2007) concluded that delayed mortality of Snake River Chinook salmon was evident and that it did not diminish with more favorable oceanic and climatic conditions. Estimates of delayed mortality reported in this study ranged from 0.75 to 0.95 (mean = 0.81) for the study years of 1991-1998 and 0.06 to 0.98 (mean = 0.64) for the period of 1975-1990. Haeseker *et al.* (2012) assessed the effects of environmental conditions experienced in freshwater and the marine environment on delayed mortality of Snake River chinook salmon and steelhead trout. This study examined seasonal and life-stage-specific survival rates of both species and analyzed the influence of environmental factors (freshwater: river flow spilled and water transit time; marine: spring upwelling, Pacific Decadal Oscillation, sea surface temperatures). Haeseker *et al.* (2012) found that both the percentage of river flow spilled and water transit time influenced in-river and estuarine/marine survival rates, whereas the Pacific Decadal Oscillation index was the most important factor influencing variation in marine and cumulative smolt-to-adult survival of both species. Also, freshwater and marine survival rates were shown to be correlated, demonstrating a relation between hydrosystem experience on estuarine and marine survival. The studies on Pacific salmon described above clearly support the delayed-mortality hypothesis proposed by Budy *et al.* (2002).

Recently, Stich *et al.* (2015a) conducted an analysis on 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 (Stich et al., 2015). They determined that estuary survival decreased as the number of dams passed during freshwater migration increased from two to nine (Figure 11). They estimated that each dam passed in the Penobscot led to a 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. These effects make smolts more susceptible to predation and disease.

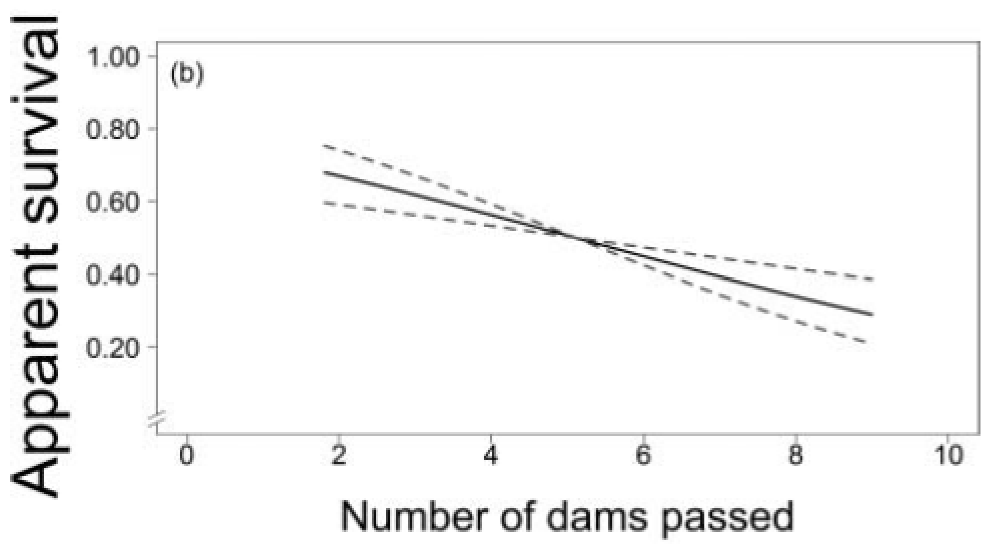

Figure 11. Apparent (or estimated) survival of Atlantic salmon smolts in the Penobscot River estuary based on the number of dams they passed during freshwater migration. The dark line is the mean survival and the dashed lines show the 95% confidence interval. The figure is excerpted from Stich *et al.* 2015.

No studies have been conducted that address the amount of hydrosystem delayed mortality that occurs at the Ellsworth Project. However, given the amount of migratory delay and sublethal injury that has been documented at the project, it is reasonable to assume that delayed mortality occurs. As described above, we estimate that the project leads to a sublethal injury rate of 7.4% under existing conditions, and that 39% of smolts are delayed by more than 48 hours during downstream migration. It is not clear to what degree these two factors contribute to hydrosystem delayed mortality at the two dams. Based on its similarity to the hydro dams on the Penobscot (in terms of passage route alternatives and the presence of turbines) we assume that the Ellsworth Dam will have the same delayed mortality rate described by Stich et al (2015) (i.e., 6%). However, as there are no turbines at Graham Lake Dam we assume that injury rates, and thus delayed mortality, may be lower. Although migratory delay at the Project is relatively high, we anticipate that the cumulative effect is limited by the fact that there are relatively few dams in the system (only two compared to nine in Stich's study in the Penobscot). Given the low injury rate at Graham Lake Dam, we anticipate that the dam will only contribute 3% to the hydrosystem delayed mortality caused by the Ellsworth Project. Therefore, we assume that 9% (i.e., 6% for the Ellsworth Dam + 3% from the Graham Lake Dam) of the smolts that survive passage at the Ellsworth Project will die in the estuary due to effects associated with passage.

To summarize, there are several sources of mortality associated with downstream passage through the Ellsworth Project, including impoundment mortality, passage mortality through two dams, and hydrosystem delayed mortality. Given the mortality rates estimated above (i.e., 42% mortality through the project (including impoundment mortality within 200 meters of the dams), and an additional 9% delayed mortality) we anticipate that if 100 smolts migrated through the action area, only 53 would survive (direct survival x delayed survival = 52.7%). This does not include background levels of mortality in the action area that would occur regardless of the presence of the dam.

Upstream Passage Effects

The Ellsworth Project does not currently provide swim-through passage for any species of diadromous fish. Rather, fish are trapped at the Ellsworth Dam, loaded into tanks on trucks, and transported to habitat above the dams. River herring that are not harvested are stocked into Graham Lake above Graham Lake Dam, whereas Atlantic salmon are driven up to the West Branch of the Union, above Graham Lake. The efficiency of the passage facility at Ellsworth has never been tested for any species of sea run fish. While it has been documented to trap shad, herring, and salmon, there is no empirical evidence regarding the proportion of fish that are able to enter the fishway and pass, nor how long they are delayed prior to being captured.

In order for endangered salmon to access habitat in the Union River under current conditions they need to be trapped and trucked above the Ellsworth Project. There are benefits to this method of passing fish, assuming that a trap is efficient and that upstream migrants are able to locate the entrance and enter the trap. However, there are also several negative effects. The primary benefit is that a fish trapped at Ellsworth can be trucked around the Graham Lake Dam, which does not have a fishway, and placed in spawning and rearing habitat in the West Branch. This potentially reduces migratory delay associated with passage inefficiencies and migration through a large impoundment. It also reduces the potential for injury or mortality during passage at the Graham Lake Dam and avoids predation during the upstream migration. However, there are several negative effects of translocation associated with this project.

Trap and truck fish passage (also known as “trap and haul”) is problematic for a number of reasons:

- As salmon are trucked to a particular location, they do not have the ability to self-select suitable habitat. At Ellsworth, salmon are transported directly to the West Branch of the River, bypassing the Middle Branch, East Branch, as well as the smaller tributaries, where suitable spawning habitat exists. This artificially limits the potential for spawning to occur throughout the watershed and may reduce spawning success if fish are not able to return to their tributary of origin.

- Passage only occurs when staff are available to operate the trap, and transport the fish. Unlike with fish lifts, you cannot automate the operation of a trap. This may substantially affect the opportunities for a fish to pass the project in a given day. For example, between 1976 and 1981 the ASRSC reported that the trap at Ellsworth was only operated for one or two days a week for two to six hours a day (MASRSC, 1982). This means that migrating salmon would have to wait downstream of the dam for up to a week in between lifts. This may result in several negative effects, including:
    - significant delay, which towards the end of the migration season may limit opportunities for spawning,
    - increased risk of predation, particularly by marine mammals such as seals that are only present below the dam,
    - increased energetic costs that may affect spawning success,
    - increased risk of a salmon leaving the river and either returning to the ocean or straying to another river.

- Studies have shown that a proportion of Atlantic salmon that are trucked will stop migrating or fallback after they are released (Askling, 2015; Sigourney et al., 2015; Spencer et al., 2011). This can be a problem if the salmon leaves the river prior to spawning, or if it drops down below a dam that lacks fish passage. Studies indicate that fallback rates vary significantly. Sigourney et al. (2015) observed a 2.4-2.6% fallback rate for trucked salmon. Spencer et al. (2011) observed an 87.5% fallback rate. Askling (2015) found a 100% of fallback rate; with 39% moving below the dam where they were trapped. As Graham Lake Dam lacks fish passage, there is no mechanism for fish that drop back that far in the river to re-ascend to spawning habitat upstream unless the fish drops further down and past Ellsworth Dam and swims into the trap again. Therefore, given the potentially high fallback rate, there is the potential for a significant number of salmon that are trucked above the dam to be trapped in areas with reduced access to spawning habitat.

Additional problems associated with trap and truck for upstream passage at this project include:

- MDMR will not allow the trap to be operated for salmon once water temperatures exceed 23˚C since handling at that temperature causes extreme stress to the fish that can lead to mortality. During the years when the most salmon were trapped at the Ellsworth Project (an average of 127 salmon per year for the period between 1974-1980), 58% were trapped in the month of July (MASRSC, 1982; MDMR, 2017). Although there is no long term temperature gage in the Union River, July temperatures in the nearby Narraguagus River (approximately 26 miles east of the Union) average 23.1˚C (10 year average based on USGS stream gage 01022500). This information indicates that Atlantic salmon do migrate in the Union River during the warmest month of the year. Between 2015 and 2018, the proportion of the run that returned to the Penobscot River between July and September ranged from 22% to 25%. The trap at the Ellsworth Project was shut down for three to ten weeks a year over the same timeframe. Therefore, given the temperature limit for safe trapping and trucking, a significant percentage of adults would be delayed for several weeks prior to having an opportunity to move upstream.

- Atlantic salmon are trapped along with thousands of river herring that are either trucked to Graham Lake or harvested for lobster bait. There is no structure in place to separate the salmon from the river herring. Rather, Black Bear personnel are on site for each lift to visually inspect the hopper to ensure that no salmon are being mishandled, stocked in the wrong location, or accidentally harvested. This is an untested method that relies entirely on detecting a salmon in a trap containing up to 5,200 alewives. Given this, it is possible that some salmon are unintentionally harvested, stocked in the wrong location, or injured.

- A different fishway hopper system is installed for river herring harvest at the trap. The harvest hopper is dry when it lifts fish. The dry hopper presents a risk for injury or mortality of Atlantic salmon captured with hundreds or thousands of river herring.

- A report by the Atlantic Sea Run Salmon Commission (MASRSC, 1982), as well as trap counts and notes provided by MDMR (MDMR, 2017), indicate that it was common for adult salmon to refuse to enter the trap at the end of the fish ladder. To capture them, MASRSC staff would block off and dewater the vertical slot fishway, and then net the salmon out of the pools. The MASRSC report further indicates that the "majority" of salmon were captured at the project in this manner. This increases the potential for injury and mortality and also suggests that the trap is ineffective at capturing salmon that ascend the ladder.

No studies have been conducted to ascertain the effectiveness of the trap entrance, but the US Atlantic salmon Assessment Committee (USASAC) assumed that the fishway as a whole was 50% effective at trapping salmon (USASAC, 1991), meaning that only one out of every two salmon returning to the Union River was trapped and available for transport upstream. Although the assessment committee report does not explain the basis for this estimate, a similar rate can be derived by comparing the stocking history of the Penobscot and Union Rivers, as well as the known smolt to adult return (SAR) rates from the Penobscot River between 1979-1988 (as shown in USASAC 1991). If we assume the same SAR rate for fish stocked in the Union as for those stocked in the Penobscot over the same timeframe, we would have anticipated an average return of 193 2SW adults per year between 1979 and 1988, rather than the average of 88 fish that were actually observed. We can therefore estimate that the fishway was only 47% (88 observed returns/192 expected returns) effective at passing Atlantic salmon during that period. This is consistent with the 50% estimate used by the USASAC (1991). Therefore, lacking an empirical study, the USASAC estimate constitutes the best available information on the effectiveness of the current Ellsworth Dam fishway.

Adult salmon that are unable to safely pass the Ellsworth Project via the existing upstream fishway will either stray to other rivers to spawn, 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 Union River, we convened an expert panel in 2010 to provide the best available information on the fate of salmon that failed to pass projects on the Penobscot River. 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, 2012). The group also indicated that projects that are closest to the ocean, may have an additional 1% mortality associated with seal predation. Using this guidance, we assume that 2% of salmon that fail to pass Ellsworth Dam will die. In addition, projects closest to the ocean were estimated to have a certain proportion drop back into the ocean. In the Union, there is no known spawning habitat downstream of the Ellsworth Dam, so we anticipate that, except for the 2% that die, all salmon that fail to pass the Ellsworth Dam will stray to neighboring rivers (e.g. Penobscot, Narraguagus).

As pre-spawn salmon are currently trucked around the Graham Lake Dam, salmon do not stray due to passage failure at that dam under existing conditions; however in the event of fallback below the dam, there is only a small amount of spawning habitat (Branch Lake Stream) available for these adults to spawn in unless they successfully pass downstream of the Ellsworth Dam and then leave the river or are re-trapped and moved back upstream. Therefore, we estimate that of the fish that attempt to pass the Ellsworth Project; 50% will pass successfully, 1% will die (i.e., 2% of the 50% that fail to pass), and 49% will stray to nearby rivers to attempt to spawn. Not all fish that stray will successfully spawn in other habitat and straying following a failed upstream passage attempt is likely to come at an energetic and physiological cost that may increase the risk of predation and decrease the likelihood of successful spawning if spawning habitat is located. Others may end up spawning in lower quality habitats than what occur in the upper Union, and therefore are less likely to produce viable offspring.

Migratory Delay

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 10^{o}C, 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 Union River (and other rivers in the GOM DPS) 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).

Numerous studies collectively report a wide range in time taken for individual adult salmon to pass upstream of various dams in the Penobscot River once detected in the vicinity of a spillway or tailrace. Passage at the Milford Project ranged between 0.1 days and 16.1 days in 2014; and in 2015 it ranged between 0.1 days and 35 days (average of 10.5 days) (BBHP, 2015, 2016a). Passage at the Lockwood Project on the Kennebec River ranged between 0.7 and 111.2 days (average of 17.0 days) (BWPH, 2017). The yearly pooled median passage time for adults at the West Enfield or Howland 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). The construction of a nature-like fishway at the Howland Dam in 2015 significantly reduced delay. In 2016, it was documented that after being detected near the entrance of the fishway 90% of radio-tagged adults passed upstream of the project within 24 hours, and that 96.7% passed within 48 hours (Maynard & Zydlewski, 2016).

It is unknown what level of delay occurs at the Ellsworth Project. Fish that are motivated to pass the Project likely are exposed to levels of 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 most resembles the Ellsworth Dam in terms of operation, configuration, and fishway type. The University of Maine conducted an assessment of passage delay at the Milford Project in 2014 and 2015 (Izzo et al., 2016). Although most 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. We expect this is an overestimate of the delay that occurs at the Ellsworth Dam as we expect attraction to be better at the Ellsworth Project given the narrower width of the river, and the fact that a higher proportion of the flow in the Union goes through the powerhouse, which is adjacent to the fishway entrance. As such, we will assume that under existing conditions at the Ellsworth Dam, 50% of the salmon that pass the project will take more than 48-hours to pass. As there is not currently a fishway at the Graham Lake Dam, and as fish are trucked to the West Branch of the Union upstream of both dams, we do not expect any delay to occur at the dam under existing conditions with trap and truck in place. However, if trap and truck was discontinued, all adults would be precluded from accessing spawning habitat upstream of the Graham Lake Dam which would have significant consequences.

4.4.2. Predation

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 Union River (MASRSC, 1982; MDIFG, 1961a). Smallmouth bass likely feed on fry and parr though little quantitative information exists regarding the extent that this occurs. Smallmouth bass are important predators of smolts in main stem 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 Ende 1993). 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.

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 main stem 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.

We have no information on the percent of any life stage of salmon lost to predation in the action area but expect that the percentage is highest for the smaller life stages. As explained above, we also expect that the Ellsworth and Graham Lake dams cause predation to be higher than it would be in the river if the dams were not there. The dams create habitats that are more suitable for fish predators and concentrate and delay salmon at the dams, which likely makes them more vulnerable to predation.

4.4.3. Water Quality

Water quality has significant implications for the functioning of designated critical habitat. The parameters of particular importance to the suitability of Atlantic salmon are water temperature, dissolved oxygen, and acidity (Table 3). According to the final EA, Black Bear collected temperature, DO, and pH data from three monitoring stations in the Graham Lake impoundment (located in the deepest areas of the northern, central, and southern sections), as well as in the Graham Lake tailrace and in the Leonard Lake impoundment. Monitoring occurred every two weeks from late April through late October 2013. Monitoring of the sites did not always occur on the same day. At each station, they collected water temperature and DO profiles at 1-meter intervals. Black Bear Hydro also measured Secchi depth, chlorophyll *a*, total phosphorus, and pH. This monitoring occurred in a single study season, was not continuous, and did not monitor the parameters during all of the critical periods for salmon. However, it does constitute the best available information regarding the status of the water quality parameters most relevant to the functioning of habitat for salmon.

Dam impoundments modify riverine thermal regimes by creating a larger volume of water to store heat, and by increasing the surface area in contact with the atmosphere (Chandesris et al., 2019). This can lead to a noticeable increase in water temperature. Chanderesis et al. (2019) monitored upstream and downstream water temperatures at 11 dams in France. They concluded that the mean downstream increase of the minimum daily temperature was 1℃, and for 85% of the sites this increase was higher than 0.5℃ (Chandesris et al., 2019). The final EA for the Ellsworth Project suggests that water quality parameters for Graham Lake and the tailrace were generally similar (Table 11). During the survey period, water temperature in Graham Lake's tailrace ranged from 67°F to 78°F (19.5℃ to 25.5℃). However, the EA concludes that when Graham Lake and the tailrace were sampled on the same days, the tailrace was approximately 1 to 2°F (i.e., 0.6℃ to 1.2℃) warmer.

Table 11. Water quality measurements taken by Black Bear during the 2013 study season.

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

DO concentrations ranged from 0.3 to 12.7 mg/L in the Graham Lake impoundment, and from 8.3 mg/L to 10.4 mg/L in the tailrace. The lowest observed DO values occurred near the bottom of the water column when the impoundment was stratified. However, during these periods a significant portion of the water column remained within a suitable range for salmon migration, spawning and rearing (Table 3). The Maine DEP stated that DO concentrations in the tailrace met or exceeded applicable Class A standards of 7 mg/L or 75 percent saturation under conditions of low flow and high water temperature.

In the Environmental Assessment, FERC analyzed the effect that turbidity, caused by the water level fluctuation in the Graham Lake impoundment, may have on the habitat in the project area. The EA indicates that Graham Lake is one of the most turbid lakes in Maine. Of the 900 lakes and impoundments monitored by the Lake Stewards of Maine, only 55 (i.e., 6.1 percent) have a shallower average Secchi depth than Graham Lake based on the Secchi depth data collected by Black Bear Hydro and the Lake Stewards (Black Bear Hydro 2014, Maine DEP 2017). The length and width of Graham Lake provide long fetches over which persistent winds can generate waves that erode soils and cause suspension of sediment in the water column and increase turbidity. Other weather-related events, such as high precipitation events and ice break-up may contribute to sediment suspension and turbidity in Graham Lake. Furthermore, lowering Graham

Lake's water surface elevation exposes additional erodible soil in the form of extensive mudflats between the water and the shoreline.

Using the Secchi depth data from 2001 to 2017 (Figure 12), FERC staff calculated the number and percentage of observations with Secchi depths less than two meters that occurred at different elevations from 98.0 to 104.2 feet msl. While turbid conditions (i.e. Secchi depths greater than or equal to 2 m) occurred at all elevations, they occurred most frequently at elevations greater than 103.0 feet msl and at elevations less than 99.0 feet msl. According to the operating curve for Graham Lake impoundment, these thresholds are exceeded during May and June (>103'), and in January, February, March, and October (<99'). This suggests that the periods of highest turbidity correspond with the spring outmigration of salmon smolts (April-June), and the latter portion of the upstream migration period for prespawn adults (May-November).

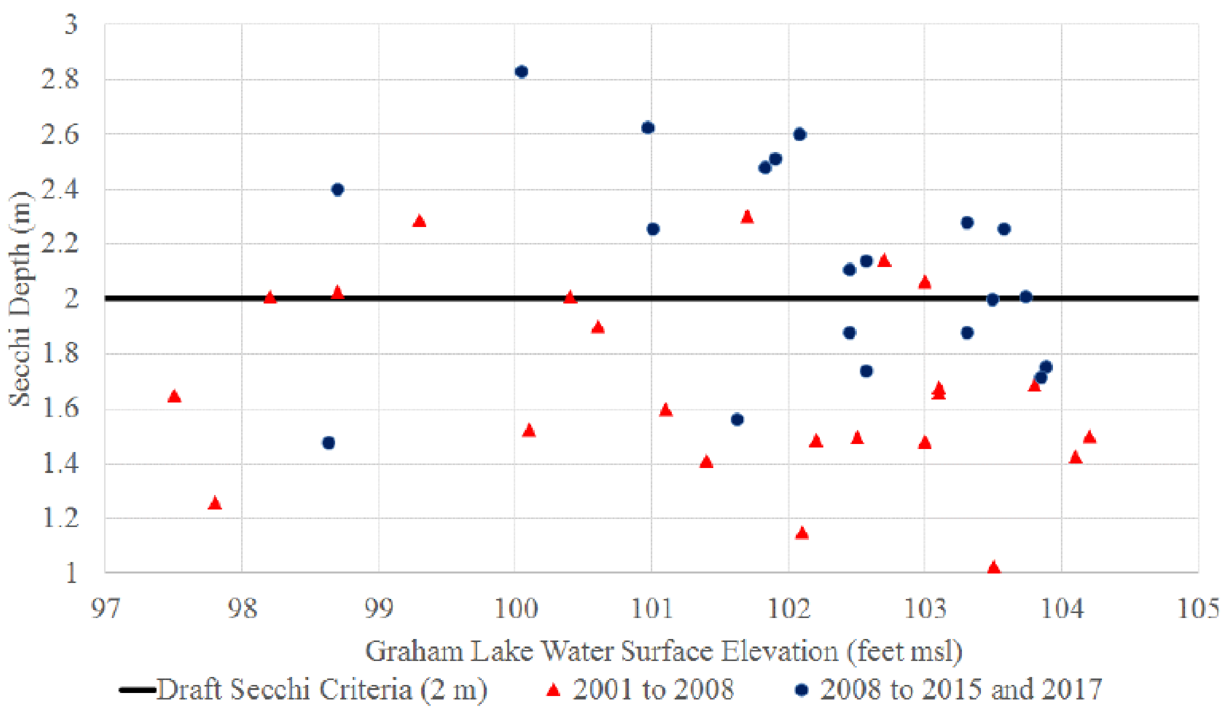

Figure 12. Secchi depth versus Graham Lake's water surface elevation. Maine DEP's draft Secchi depth criteria is shown by the black line. Staff estimated the water surface elevations from the 2001 to 2007 annual operating curves for the data shown by the red triangles. Black Bear Hydro provided the water surface elevation information for the data shown by the blue circles. This figure is excerpted from FERC's final EA.

Turbidity and suspended sediment can potentially affect all trophic levels of aquatic ecosystems. High turbidity can limit the growth and abundance of phytoplankton, periphyton, and submerged aquatic vegetation (Donohue and Garcia Molinos 2009). High suspended sediment concentrations can reduce the abundance and growth rates of zooplankton in lakes and reservoirs

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

5. Climate Change

The discussion below presents background information on global climate change and information on past and predicted future effects of global climate change throughout the range of the listed species considered here. Additionally, we present the available information on predicted effects of climate change on listed species and critical habitat in the action area over the lifespan of the proposed project. Climate change is relevant to the Status of the Species, Environmental Baseline and Cumulative Effects sections of this Opinion; rather than include partial discussion in several sections of this Opinion, we are synthesizing this information into one discussion, below.

5.1. Background Information on Global climate change

In its Fifth Assessment Report (AR5) from 2014, the Intergovernmental Panel on Climate Change (IPCC) stated that the globally averaged combined land and ocean surface temperature data has shown a warming of 0.85°C (likely range: 0.65° to 1.06°C) over the period of 1880-2012. Similarly, the total increase between the average of the 1850-1900 period and the 2003-2012 period is 0.78°C (likely range: 0.72° to 0.85°C). On a global scale, ocean warming has been largest near the surface, with the upper 75 meters of the world's oceans having warmed by 0.11°C (likely range: 0.09° to 0.13°C) per decade over the period of 1971-2010 (IPCC 2014). In regards to resultant sea level rise, it is very likely that the mean rate of global averaged sea level rise was 1.7 millimeters/year (likely range: 1.5 to 1.9 millimeters/year) between 1901 and 2010, 2.0 millimeters/year (likely range: 1.7 to 2.3 millimeters/year) between 1971 and 2010, and 3.2 millimeters/year (likely range: 2.8 to 3.6 millimeters/year) between 1993 and 2010.

Climate model projections exhibit a wide range of plausible scenarios for both temperature and precipitation over the next several decades. The global mean surface temperature change for the period 2016-2035 relative to 1986-2005 will likely be in the range of 0.3° to 0.7°C (medium confidence). This assessment is based on multiple lines of evidence and assumes there will be no major volcanic eruptions or secular changes in total solar irradiance. Relative to natural internal variability, near-term increases in seasonal mean and annual mean temperatures are expected to be larger in the tropics and subtropics than in mid- and high latitudes (high confidence). This temperature increase will very likely be associated with more extreme precipitation and faster evaporation of water, leading to greater frequency of both very wet and very dry conditions. Climate warming has also resulted in increased river discharge and glacial and sea-ice melting (Greene *et al.* 2008). The strongest ocean warming is projected for the surface in tropical and Northern Hemisphere subtropical regions. At greater depths, the warming will be most pronounced in the Southern Ocean (high confidence). Best estimates of ocean warming in the top 100 meters are about 0.6° to 2.0°C, and about 0.3° to 0.6°C at a depth of about 1,000 meters by the end of the 21st century (IPCC 2014).

Under Representative Concentration Pathway (RCP) 8.5, the projected change in global mean surface air temperature and global mean sea level rise for the mid- and late 21st century relative to the reference period of 1986-2005 is as follows. Global average surface temperatures are likely to be 2.0°C higher (likely range: 1.4° to 2.6°C) from 2046-2065 and 3.7°C higher (likely range: 2.6° to 4.8°C) from 2081-2100. Global mean sea levels are likely to be 0.30 meters higher (likely range: 0.22 to 0.38 meters) from 2046-2065 and 0.63 meters higher (likely range: 0.45 to 0.82 meters) from 2081-2100, with a rate of sea level rise during 2081-2100 of 8 to 16 millimeters/year (medium confidence).

The past three decades have witnessed major changes in ocean circulation patterns in the Arctic, and these were accompanied by climate associated changes as well (Greene *et al.* 2008). Shifts in atmospheric conditions have altered Arctic Ocean circulation patterns and the export of freshwater to the North Atlantic (IPCC 2007, Greene *et al.* 2008). With respect specifically to the North Atlantic Oscillation (NAO), changes in salinity and temperature are thought to be the result of changes in the Earth's atmosphere caused by anthropogenic forces (IPCC 2007). The NAO impacts climate variability throughout the Northern Hemisphere (IPCC 2007). Data from the 1960s through the 2000s showed that the NAO index increased from minimum values in the 1960s to strongly positive index values in the 1990s and somewhat declined since (IPCC 2007). This warming extends over 1,000 meters deep and is deeper than anywhere in the world's oceans and is particularly evident under the Gulf Stream/North Atlantic Current system (IPCC 2007). On a global scale, large discharges of freshwater into the North Atlantic subarctic seas can lead to intense stratification of the upper water column and a disruption of North Atlantic Deepwater (NADW) formation (IPCC 2007; Greene *et al.* 2008). There is evidence that the NADW has already freshened significantly (IPCC 2007). This in turn can lead to a slowing down of the global ocean thermohaline (large-scale circulation in the ocean that transforms low-density upper ocean waters to higher density intermediate and deep waters and returns those waters back to the upper ocean), which can have climatic ramifications for the entire world (Greene *et al.* 2008).

There is a high confidence, based on substantial new evidence, that observed changes in marine systems are associated with rising water temperatures, as well as related changes in ice cover, salinity, oxygen levels, and circulation. Ocean acidification resulting from massive amounts of carbon dioxide and pollutants released into the air can have major adverse impacts on the calcium balance in the oceans. Changes to the marine ecosystem due to climate change include shifts in ranges and changes in algal, plankton, and fish abundance (IPCC 2007). These trends have been most apparent over the past few decades, although this may also be due to increased research. Information on future impacts of climate change in the action area is discussed below.

While predictions are available regarding potential effects of climate change globally, it is more difficult to assess the potential effects of climate change over the next few decades on coastal and marine resources on smaller geographic scales, such as the action area, especially as climate variability is a dominant factor in shaping coastal and marine systems. The effects of future change will vary greatly in diverse coastal regions for the U.S. Additional information on potential effects of climate change specific to the action area is discussed below. Warming is very likely to continue in the U.S. over the next 50 years regardless of reduction in greenhouse gases, due to emissions that have already occurred (NAST 2000). It is very likely that the magnitude and frequency of ecosystem changes will continue to increase in the next 50 years, and it is possible that they will accelerate. Climate change can cause or exacerbate direct stress on ecosystems through high temperatures, a reduction in water availability, and altered frequency of extreme events and severe storms. Water temperatures in streams and rivers are likely to increase as the climate warms and are very likely to have both direct and indirect effects on aquatic ecosystems. Changes in temperature will be most evident during low flow periods when they are of greatest concern (NAST 2000). In some marine and freshwater systems, shifts in geographic ranges and changes in algal, plankton, and fish abundance are associated with high confidence with rising water temperatures, as well as related changes in ice cover, salinity, oxygen levels and circulation (IPCC 2007).

Expected consequences of climate change for river systems could be a decrease in the amount of dissolved oxygen in surface waters and an increase in the concentration of nutrients and toxic chemicals due to reduced flushing rate (Murdoch *et al.* 2000). Because many rivers are already under a great deal of stress due to excessive water withdrawal or land development, and this stress may be exacerbated by changes in climate, anticipating and planning adaptive strategies may be critical (Hulme 2005). A warmer-wetter climate could ameliorate poor water quality conditions in places where human-caused concentrations of nutrients and pollutants currently degrade water quality (Murdoch *et al.* 2000). Increases in water temperature and changes in seasonal patterns of runoff will very likely disturb fish habitat and affect recreational uses of lakes, streams, and wetlands. Surface water resources along the U.S. Atlantic coast are intensively managed with dams and channels and almost all are affected by human activities; in some systems water quality is either below recommended levels or nearly so. A global analysis of the potential effects of climate change on river basins indicates that due to changes in discharge and water stress, the area of large river basins in need of reactive or proactive management interventions in response to climate change will be much higher for basins impacted by dams than for basins with free-flowing rivers (Palmer *et al.* 2008). Human-induced disturbances also influence coastal and marine systems, often reducing the ability of the systems to adapt so that systems that might ordinarily be capable of responding to variability and change are less able to do so. Because stresses on water quality are associated with many activities, the impacts of the existing stresses are likely to be exacerbated by climate change. Within 50 years, river basins that are impacted by dams or by extensive development will experience greater changes in discharge and water stress than unimpacted, free-flowing rivers (Palmer *et al.* 2008).

While debated, researchers anticipate: 1) the frequency and intensity of droughts and floods will change across the nation; 2) a warming of about 0.2°C per decade; and 3) a rise in sea level (NAST 2000). Sea level is expected to continue rising; during the 20th century global sea level has increased 15 to 20 centimeters. It is also important to note that ocean temperature in the U.S. Northeast Shelf and surrounding Northwest Atlantic waters have warmed faster than the global average over the last decade (Pershing *et al.* 2015). New projections for the U.S. Northeast Shelf and Northwest Atlantic Ocean suggest that this region will warm two to three times faster than the global average and thus existing projections from the IPCC may be too conservative (Saba *et al.* 2015).

5.2. Anticipated Effects to Atlantic Salmon and Critical Habitat

Atlantic salmon may be especially vulnerable to the effects 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 effects 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, predator risks, and/or thermal stress (Friedland 1998). Since the highest rate of 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 spatial relationships 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).

Humans may also seek to adapt to climate change by manipulating water sources, for example in response to increased irrigation needs, which may further reduce stream flow and biodiversity (Bates *et al.* 2008). Water extraction is a high level threat to Atlantic salmon, as adequate water quantity and quality are critical for all life stages of Atlantic salmon (NMFS and USFWS 2005). Climate change will also affect precipitation, with northern areas predicted to become wetter and southern areas predicted to become drier in the future (Karl *et al.* 2009). Droughts may further exacerbate poor water quality and impede or prevent migration of Atlantic salmon (Riley *et al.* 2009).

We anticipate 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 (<23º 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.

5.2.1. Anticipated Effects to Atlantic Salmon and Critical Habitat in the Action Area

Information on how climate change will impact the action area is extremely limited. According to Fernandez *et al.* (2015), the Intergovernmental Panel on Climate Change (IPCC) models predict that Maine’s annual temperature will increase another 3.0–5.0 °F (1.7–2.8 °C) by 2050. The IPCC models predict that precipitation will continue to increase across the Northeast by 5–10% by 2050, although the distribution of this increase is likely to vary across the climate zones (Fernandez *et al.* 2015); model predictions show greater increases in precipitation in interior Maine. Total accumulated snow is predicted to decline in Maine especially along the coast where total winter snow loss could exceed 40% relative to recent climate (Fernandez *et al.* 2015). Since 2004, sea surface temperatures in the Gulf of Maine have accelerated to 0.41 °F (0.23 °C) per year; a rate that is faster than 99% of the world’s oceans (Fernandez *et al.* 2015).

According to the most recent National Climate Assessment (Melillo *et al.* 2014), a global sea level is projected to rise an additional 0.5 to 2.0 feet (0.2 to 0.6 meters) or more by 2050. Rising sea levels would likely shift the salt wedge in the Union River and other rivers in the GOM DPS. As there is significant uncertainty in the rate and timing of change as well as the effect of any changes that may be experienced in the action area due to climate change, it is difficult to predict the impact of these changes on Atlantic salmon.

In the action area, it is possible that changing seasonal temperature regimes could result in changes in the timing of seasonal migrations for the GOM DPS of Atlantic salmon in Maine. There could be shifts in the timing of spawning; presumably, if water temperatures stay warm further in the fall, and water temperature is a primary spawning cue, spawning migrations could occur earlier in the year and spawning events could occur later. However, because salmon spawning is not triggered solely by water temperature, but also by day length (which would not be affected by climate change) and river flow (which could be affected by climate change), it is not possible to predict how any change in water temperature or river flow alone will affect the seasonal movements of salmon throughout the action area.

Atlantic salmon are cold water fish and have a thermal tolerance zone where activity and growth is optimal (Decola 1970). Temperature can be a stimulant for salmon migration, spawning, and feeding (Elson, 1969). Temperature can also significantly influence egg incubation success or failure, food requirements and digestive rates, growth and development rates, vulnerability to disease and predation, and may be responsible for direct mortality (Garside 1973, Spence *et al.* 1996, Peterson *et al.* 1977, Whalen *et al.* 1999). When temperatures exceeded 23°C, adult Atlantic salmon can cease upstream movements. Salmon mortalities were associated with daily average temperatures of 26°C to 27°C.

As described above, over the long term, global climate change may affect Atlantic salmon and critical habitat by affecting the location of the salt wedge, distribution of prey, water flows, temperature and quality. However, there is significant uncertainty, due to a lack of scientific data, on the degree to which these effects may be experienced over the term of the proposed action. While we can make some predictions on the likely effects of climate change on this species, without modeling and additional scientific data, these predictions remain speculative. Additionally, these predictions do not take into account the adaptive capacity of this species, which may allow them to deal with change better than predicted.

6. Effects of the Action

This section of a biological opinion assesses the effects of the proposed action on threatened or endangered species or critical habitat. 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 effects 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 effects on the species and their habitat within the context of the species status now and projected over the course of the action.

FERC is proposing to issue a new license for the Ellsworth Project for a term of 30 to 50 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 2.4. For purposes of this Opinion, we are assuming that FERC will issue a 50-year license.

Based on the improvement in survival expected from the proposed passage measures at the Ellsworth Dam, as well as a commitment to adaptively manage passage at the Graham Lake Dam to achieve a performance standard, it is reasonable to assume that Black Bear can verify that the downstream passage performance standards have been met for Atlantic salmon within five to nine years of FERC's issuance of a new license. This is consistent with the timeframe that was needed to achieve downstream performance standards at Black Bear's projects on the Penobscot River. As explained below, based on similar highly effective fishways in the GOM DPS, it is reasonable to assume that Black Bear can verify that the upstream passage performance standard has been met within three years of the new fishways being built (i.e., within 18 years of license issuance). Therefore, the following section analyzes the effects of the action during an interim period when Black Bear is modifying, constructing, and evaluating fishways, as well as the remainder of the license term during which the project is operating in such a manner that the fish passage performance standards are being achieved. We also analyze the effects of proposed studies on listed Atlantic salmon and their critical habitat.

The historical and ongoing effects of the Ellsworth Project under the previous license are considered in the Environmental Baseline (section 4.4.1). These effects include those that are associated with the presence of the dams in the river. With the exception of improvements addressed in this section resulting from adherence to the requirements of the new license, we largely anticipate that these effects will continue into the future with the issuance of a new license for the project. As FERC may decide to not issue a new license, and has the authority to order the surrender and decommissioning of the dams (see FERC's 1995 decommissioning and licensing policy statement; 60 FR 339 1995), we consider that the effects of the continued existence of the two project dams are consequences of the action subject to consultation under section 7 of the ESA.

6.1. Species Presence

Interim Phase

As described in section 4.1, there are few salmon naturally produced or stocked in the Union River. In the last decade, there were only two years (2014 and 2019) when more than one adult salmon was documented in the river. In those years, two Atlantic salmon were transported into the West Branch of the Union from the fish trap at the Ellsworth Dam. Stocking effort in the Union River has been minimal since the 1990s, and was reduced to almost zero in 2017. A small amount of stocking (generally less than 1,000 fry annually) are reportedly stocked by school groups into the West Branch of the Union annually by the Fish Friends program. Given current freshwater and marine survival rates, we do not anticipate that this stocking effort is sufficient to result in returning salmon. Therefore, under current passage and stocking conditions, salmon presence is likely limited to salmon straying from the nearby Penobscot and Narraguagus Rivers. Based on information from the last decade, in the near-term we do not anticipate that more than two prespawn salmon will be passed at the Ellsworth Project in any given year. Correspondingly, we would not anticipate more than one spawning event in the Union River annually during this interim time period. We estimate that a spawning event could produce approximately 108 salmon smolts (Julie Nieland, NEFSC, personal communication, January 27, 2017) in the Union River. We expect that this low level of salmon presence in the river will persist at least until the downstream performance standard has been achieved (by year nine of the license).

Achievement of Performance Standard Phase

A significant increase in salmon returns to the Union River is expected to require improved up and downstream passage survival and either an increase in stocking to “jumpstart” the population and/or an increase in strays and marine survival. The only aspect of these scenarios that is within the scope of the proposed action under consideration here is passage success and survival rates of salmon due to causes attributable to the Project. While we cannot state with any certainty when more salmon will occur in the action area, NMFS, U.S. FWS and Maine DMR are actively engaged in programs to recover Atlantic salmon, including in the Downeast SHRU. We expect that as recovery actions are addressed, including improvements at the Project, the salmon populations will respond and we will see increases in returns to the Union River.

Aspects of the proposed action (i.e. fishway improvements) will improve survival and passage effectiveness to the point that the number of salmon in the river is expected to increase. With higher upstream passage rates, we anticipate that more straying salmon will be passed into the river. Additionally, with substantially higher downstream survival, more smolts will survive to the estuary, which will lead to more adult Atlantic salmon homing back to the Union River. When this occurs, the Union River may become a priority for stocking, which would further increase the abundance of juvenile and adult salmon in the system. Therefore, in the latter portion of the license term (beginning after the downstream standard is met by year nine) we expect more salmon will be present in the Union River.

6.2. Hydroelectric Operations

6.2.1. Riverine Processes

In section 4.4.1.1, we describe how the presence of the Ellsworth Project has affected the natural hydrologic regime of the Union River historically. The operation of the Ellsworth Project in a store-and-release mode reduces spring runoff flows, which leads to less severe flood events, and augments 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 main stem. The extent to which these streamflow modifications in the Union River watershed impact salmon habitat (including migratory corridors during applicable seasons) is unknown. However, increased embeddedness of spawning and invertebrate colonization substrates, diminished 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.

The Graham Lake impoundment substantially affects the habitat within the action area by slowing down migration, creating habitat for non-native fish species, and by negatively affecting water quality (e.g., increasing water temperature and turbidity, while reducing dissolved oxygen). As described in section 4.4.1.1, we expect that when there are salmon in the system, significant smolt mortality could occur in the Graham Lake impoundment immediately (within 200 meters) upstream of the dam. This mortality is likely caused by a combination of factors, including predation by non-native fish species that thrive in the environment created by the impoundment of the river, and high levels of migratory delay associated with passage inefficiencies at the dam that prevent the smolts from moving past the dam quickly. As this mortality is closely associated with the effectiveness of the downstream fishway, we will assess it in more detail in our discussion of fish passage effects below (section 6.2.2.1).

In addition to mortality in the lower impoundment, there is potentially a high level of dam-related mortality that occurs in the upper impoundment under certain conditions. However, the best available information indicates that the mortality rate through the impoundment in 2016 was consistent with the mortality rate documented by Black Bear in the mainstem of the Penobscot River, and with what was observed in the three kilometer unimpounded reach monitored by Black Bear in the Union River during the 2016 and 2017 smolt survival studies. Although the available information is limited temporally (survival in the impoundment was only monitored for one year), and does not use a sufficiently long reference reach, it constitutes the best available information regarding the mortality rate in the project impoundments. Therefore, based on this, we conclude that the dam only contributes to mortality of smolts occurring in the lower impoundment (i.e. the first 200 meters of the impoundment upstream of the dam).

6.2.2. Fish Passage

6.2.2.1. Downstream Fish Passage

Under the proposed action, the Ellsworth Project will continue to affect outmigrating salmon by: 1) injuring and killing smolts and kelts passing downstream through the project facilities; 2) delaying outmigration; and, 3) increasing stress levels, which, in the case of salmon smolts, can lead to a subsequent decrease in saltwater tolerance. Section 4.4.1 describes the past effects of the project on outmigrating salmon. Based on the results of the 2017 smolt survival study (BBHP, 2017a), we anticipate that the current smolt mortality rate at the Ellsworth Project is 42% (not including delayed mortality), and that the sublethal injury rate is 7.4% (Section 4.4.1.2).

The proposed action includes improvements (described in section 2.4) to downstream passage at the Ellsworth Dam that are expected to: 1) increase the proportion of fish that pass the project via the downstream fishway, and 2) improve the safety of that passage route. The proposed action also includes improvements to the downstream fishway at the Graham Lake Dam that will make the temporary fishway entrance constructed in 2017 permanent, and ensure a minimum of three feet of water depth within the fishway through the fish passage season. These improvements will occur within two years of the license being issued. The action also includes a cumulative passage standard (not including hydrosystem delayed mortality) of 90% for Atlantic salmon smolts and kelts (i.e., the license will require that no more than 10% of smolts and kelts that pass through both dams are killed). Black Bear has proposed to evaluate smolt passage for three years to verify that they have achieved the standard. If the passage standard is not met within this timeframe, then additional measures will be implemented and evaluated for another three years. Therefore, it is anticipated that the performance standard could be achieved and validated between five and nine years after license issuance (Figure 13). Although the survival could be sufficiently high to achieve the standard in year two of the license (i.e., once the measures have been implemented), we will not consider it met until it has been verified through studies. Regardless, we expect that project mortality and injury rates will be reduced after the fishway modifications are made, whether the standard has been verified through studies or not.

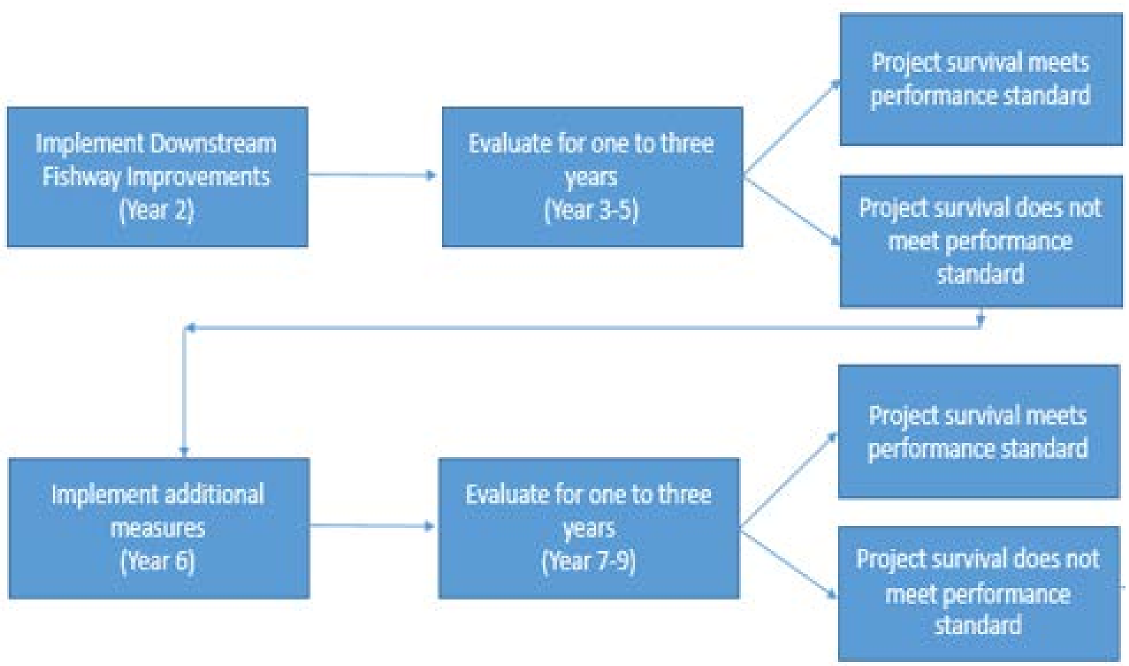

Figure 13. The adaptive management framework associated with smolt survival at the Ellsworth Project.

We have conducted an analysis to estimate survival at the Ellsworth Dam after the proposed improvements have been implemented. Using information from the 2016 and 2017 field studies at Ellsworth, as well as information on the effectiveness of guidance booms and racks at other projects in Maine; based on these sources, we have estimated the proposed measures will increase survival at Ellsworth Dam to at least 95.7% (Attachment 1). If the total project (including Graham Lake Dam) performance standard (i.e., 90%) for smolt survival is not met after the proposed measures have been implemented, then Black Bear will implement additional measures at the Ellsworth Dam that will be developed in consultation with the agencies. As indicated in the FEA, additional measures at the Ellsworth Dam might include turbine shutdowns and/or the installation of additional panels on the guidance boom. These measures would further reduce the number of fish that are entrained in the turbines and would increase the efficiency of the downstream fishway; both of which would contribute to increased survival.

Given the injury rates documented in Black Bear's turbine entrainment study and the proportion of fish that used the different passage routes in 2017, we estimate that the total injury rate (including loss of equilibrium) at the Ellsworth Project is 21.0% (Table 9). Much of this injury is accounted for in the mortality estimate since most of the fish did not survive their injuries. However, based on the study results, we estimate that approximately 7.4% of smolts will be injured but survive to continue their migration to the estuary. These fish will either succumb to their injuries in the estuary, be predated upon due to their reduced fitness, or continue their migration unaffected; at this time we do not have sufficient information to determine the proportion of injured fish that would fall into any of these three categories. The proposed structural modifications, as well as the proposal to shut down unit #1 during the smolt migration period, will significantly reduce the number of fish that will be injured at the project compared to current operating conditions. We conclude that these measures will reduce the overall injury rate to 11.7%[4], and will reduce the sublethal injury rate to 5.1%. Therefore, we expect that after implementation and verification of the downstream measures (i.e., by year nine of the license) the overall smolt injury rate at the Ellsworth Project will be no higher than 11.7%, and the sublethal injury rate will not exceed 5.1%, a 31% reduction from the existing condition. As noted above, not all smolts that experience sublethal injury will die, however, as we cannot determine the impact that these sublethal injuries will have on future survival and fitness, for the purposes of this analysis we assume that these smolts die or have significantly reduced fitness.

[4] We modified the estimate by assuming: 1) all the fish that used Unit #1 in 2017 would go through the downstream fishway, 2) that there is an increase in bypass efficiency of 35% (a rate observed on the Kennebec River) due to the installation of the guidance boom, and 3) that the injury rate associated with the fish bypasses at both dams is reduced to zero due to fishway improvements.

The best available information indicates that the proposed measure at Graham Lake Dam will not improve survival above what was documented in the 2017 survival study (77.9%; direct passage survival and headpond survival combined). The proposal to modify the fishway to allow for three feet of water depth regardless of the pond elevation will allow for adequate fishway flow throughout the fish passage season. However, in the months when Atlantic salmon smolts are migrating to the ocean (April-June), flow is generally high and is sufficient for passage regardless of the elevation of the entrance. Therefore, this modification will not improve smolt survival above what was observed in 2017.

The majority of the smolt mortality at the Graham Lake Dam occurs immediately upstream of the dam, rather than as a direct result of passage itself. The mortality in the headpond was 77.0% in 2016 and 17.6% in 2017 (BBHP, 2016b, 2017a). A large proportion of smolts are delayed upstream of project, and it is probable that this delay leads to high rates of predation from non-native fish species in the headpond (e.g., largemouth and smallmouth bass). We anticipate that methods that will improve attraction to the fishway will reduce delay, and lead to lower exposure to predation. Measures for increasing fishway attraction might include the use of a guidance boom, increasing fish passage flow, or creating multiple passage routes.

As indicated, not all mortality at Graham Lake Dam was associated with headpond mortality. A significant portion of smolts were killed while going through the downstream fishway in both 2016 (39%) and 2017 (7.6%) (BBHP, 2016b, 2017a). Alden Research Laboratory estimates that a well-designed downstream fishway should kill no more than 1% of outmigrating Atlantic salmon smolts (Alden Research Laboratory, 2012). Therefore, measures that significantly improve the safety of the fishway (e.g. deepen plunge pools, sluice fish into the river) could lead to a measureable improvement in dam survival, particularly given that there are no turbines at the dam. Fish passage technology is available to improve both the attraction to, and the safety of, the existing structure. Given Black Bear's proposal to adaptively manage survival at the Project, and given that there are measures available that are expected to improve the effectiveness of the fishway, we anticipate that smolt survival at Graham Lake Dam will increase. Without specific measures, we cannot estimate what extent survival will improve, but given the anticipated survival at the Ellsworth Dam (i.e., 95.7%), we expect that the survival at Graham Lake Dam will need to be at least 94% for the combined 90% performance standard to be met. It is reasonable to expect that this standard can be achieved given the lack of turbines at the dam and the known technologies noted above that would be expected to increase survival of salmon passing downstream of the dam.

Given the above information, we anticipate that during the first two years of the license, smolt mortality associated with downstream passage will not exceed the cumulative survival observed in the 2017 smolt survival study (i.e. 77.9% survival at Graham Lake Dam x 74.0% survival at Ellsworth Dam = 57.6% survival or 42.4% mortality) (BBHP, 2017a). With an anticipated 9% hydrosystem delayed mortality rate, we expect that during this period approximately 53% of outmigrating smolts will survive (Table 12). This estimate includes the mortality that occurs within 200 meters upstream of each dam, and was corrected for background mortality. Therefore, we anticipate that 47% of the smolts attempting to outmigrate from above the Graham Lake Dam will die due to causes attributable to the Ellsworth Project.

As indicated, we do not believe that the proposal to make the Alden-type weir at Graham Lake Dam permanent will improve downstream survival of salmon smolts; therefore, we assume that the survival documented in 2017 (i.e., 77.9%) will persist until additional measures are implemented. However, we expect that the proposed measures at the Ellsworth Dam will lead to an increase in dam (i.e. 74.0% to 95.7%) and cumulative passage survival (57.6% to 74.5%), by the third year of the license. In addition to the 9% hydrosystem delayed mortality, we estimate total project mortality to decrease to approximately 32.2% by year three of the license (Table 12). Based on the results of studies, Black Bear will work with the agencies to develop additional measures that will be implemented at Graham Lake Dam and Ellsworth Dam in order to further reduce direct mortality to the point that no more than 10% of salmon smolts will be killed due to the operation of the Project. These improvements will also lead to a reduction in sublethal injury and migratory delay, which will reduce the estimated hydrosystem delayed mortality to 6% from 9%. Although no specific measures have been proposed at Graham Lake Dam, there are several that could be reasonably anticipated to increase smolt survival. Therefore, we anticipate that Black Bear will have achieved the performance standard within nine years of license issuance. At that time, we expect that no more than 15.4% of Atlantic salmon smolts outmigrating from the Union River will die due to causes attributable to project operations, inclusive of hydrosystem delayed mortality.

We expect that the mortality rate of salmon kelts will continue at the levels described in the Environmental Baseline (section 4.4.1). Lacking project specific information, we have estimated that the project leads to a cumulative mortality of 4% of outmigrating salmon kelts. The installation of the guidance boom should reduce migratory delay at the Ellsworth Dam, but we do not expect it to reduce direct mortality of kelts, as they are already precluded from swimming through the turbines due to the narrow spacing on the existing intake racks.

Although we expect poor survival rates to persist at the project during the early years of the license, very few salmon will be killed prior to the performance standard being achieved because of the very small number of salmon that are expected to occur in the river during this period. As stated previously, there is limited stocking or natural production occurring in the Union River at this time. Therefore, we expect very few salmon to be exposed to passage effects early in the license. That said, with the proposed improvements to upstream and downstream passage at the project, our expectation is that salmon abundance will increase. After year nine of the license, we expect smolt mortality not to exceed 15.4% (including hydrosystem delayed mortality; Table 12) and kelt mortality not to exceed 4%.

Migratory Delay

In section 4.4.1.2., we describe the ongoing migratory delay currently caused by the dams (Table 10). Improvements to the structures led to a significant reduction in migratory delay, with the median cumulative delay going from 97.7 hours in 2016, to 11.3 hours after modifications were made at both dams in 2017. As indicated previously, migratory delay can lead to smolts missing their physiological smolt window and result in increased exposure to predation. The 2017 study provides the best available information for delay at the dam. Therefore, we expect that the median cumulative migratory delay for smolts passing downstream over the Project dams during the interim period (i.e., prior to the implementation and evaluation of fishway improvements) will be 11.3 hours. In 2017, 67% and 88% of salmon smolts took less than 24 hours to pass the Graham Lake Dam and Ellsworth Dam, respectively; and 61% successfully passed both dams within 48 hours.

We do not know specifically what amount of delay in a given river 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 48-hour delay (cumulative at the two dams) is not expected to be long enough to cause a smolt to miss the smolt migration window.

NMFS Interim Guidance on the ESA Term “Harass” (PD 02-110-19; December 21, 2016[5] 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.

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

Here, we carry out that four-step assessment. We have established that all outmigrating smolts will encounter the two dams and that the dams will result in a disruption of their downstream migrations (step 1) and that while the mean period of delay will only be 11.3 hours, 39% of smolts will be delayed for more than 48 hours (step 2). We have established the expected response of the exposed smolts (step 3): individual smolts delayed more than 48 hours 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, 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 48 hours on their downstream migration are likely to be adversely affected and that effect amounts to harassment. Therefore, prior to the implementation of improved fish passage and verification of the performance standards (within nine years of license issuance), we anticipate that up to 39% of salmon smolts that pass the project will be exposed to significant delay (i.e., take more than 48 hours to pass both dams), which we consider to meet the definition of harassment.

NMFS considers "harm" in the definition of "take" as "an act which actually kills or injures fish or wildlife. Such an act may include significant habitat modification or degradation where it actually kills or injures fish or wildlife by significantly impairing essential behavioral patterns, including breeding, spawning, rearing, migrating, feeding or sheltering" (50 CFR §222.102). We have determined that delay of greater than 48 hours (24 hours per dam) would significantly disrupt the behaviors of individual smolts. Migratory delay caused by dams can potentially lead to salmon smolts missing the physiological smolt window (i.e., the period when an individual smolt's condition is optimal for making the freshwater to saltwater transition), which can lead to mortality. Additionally, a smolt may be delayed for a long enough period that the chance of being predated in the estuary increases due to the higher concentration of predators that congregate as the water warms. The mortality associated with migratory delay would be considered as a component of hydrosystem delayed mortality, which is addressed below.

The proposal to install a guidance boom and increase passage flow at the Ellsworth Dam should reduce migratory delay. The reduction in delay associated with the construction of the temporary Alden-weir at Graham Lake Dam in 2017 was significant, but Black Bear has not proposed anything that would further reduce delay at the dam. However, they have proposed to adaptively manage effective passage at the dam, and we anticipate that any new measures developed for that purpose would also reduce delay. Given what has been documented at Black Bear's Projects in the lower Penobscot (BBHP, 2019), we anticipate that effective downstream passage will allow the majority of salmon smolts to pass an individual dam within 24 hours. Black Bear monitored residence time (i.e., the amount of time a smolt takes to pass a dam once it has come within 200 meters) above four dams over three years (2016-2018), and determined that 92.5%-100% of the salmon smolts passed each project within 24 hours during that three year period (Table 5.0-1 of BBHP 2019). Given the peaking operation of this project, as well as the current high level of delay, it is reasonable to assume that the result of the proposed action will be closer to the low end of the range documented on the Penobscot between 2016 and 2019. Therefore, we assume that no more than 7.5% (i.e., 1-92.5%) of Atlantic salmon smolts will be significantly delayed (> 24 hours) at either dam after the fishway improvements have been implemented and evaluated (by year nine of the license). This constitutes a 38% increase in the proportion of smolts that pass within 24 hours at the Graham Lake Dam, and a 5% increase at the Ellsworth Dam. We cannot state specifically how this relates to the proportion of fish that take less than 48 hours to pass both dams, as a fish that passes Graham Lake Dam in more than 24 hours could successfully pass the Ellsworth Dam in less than 24 hours. However, if we average the dam-specific improvement rates (38% and 5%), we can conservatively estimate that the proposed improvements will lead to a 22% improvement in cumulative delay at the Project. As such, by year 9 of the license we expect that 75% (61%*1.22) of smolts will pass the project within 48 hours. Therefore, after the implementation of improved fish passage and verification of the performance standards (by year 9 of the license), we anticipate that up to 25% of salmon smolts that pass the project will be exposed to significant delay (i.e., take more than 48 hours to pass both dams), which we consider to meet the definition of harassment.

Hydrosystem Delayed Mortality

As explained in section 4.4.1.2, some of the smolt mortality that occurs in the estuary downstream of the Ellsworth Project is attributable to the delayed effects of dam passage. Stich et al. (2015) determined that this mortality equates to 6% per dam in the Penobscot River. Given that the Graham Lake Dam does not have turbines, we estimate that the total hydrosystem delayed mortality associated with the Ellsworth Project is currently 9% (i.e., 6% at the Ellsworth Dam + 3% at the Graham Lake Dam). The factors that cause this mortality are believed to be associated with 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. Nevertheless, as we expect a 22% increase in the proportion of fish that take less than 48 hours to pass the Project (both Graham Lake Dam and Ellsworth Dam), and a 31% reduction in sublethal injury (5.1% compared to 7.4%), we expect that there will be a reduction in hydrosystem delayed mortality. Given our lack of understanding regarding precisely how these factors contribute to delayed mortality, we will conservatively assume that the proposal will lead to a 31% reduction in the effect (i.e., a reduction equivalent to the reduction in sublethal injury). Therefore, we anticipate that after the fishway improvements have been implemented and evaluated, hydrosystem delayed mortality will be reduced to approximately 6% (31% of 9%). Therefore, by year nine of the license we anticipate that no more than 6% of smolts will die as a result of hydrosystem delayed mortality in the Union River.

Table 12. Summary of downstream passage effects on Atlantic salmon smolts at the Ellsworth Project.

	Interim Years 1-2	Proposed Measures Years 3-9	Performance Standard Years 10-Exp.
Mortality (Survival)*			
Graham Lake Dam	22.1% (77.9%)	22.1% (77.9%)	6.0% (94.0%)**
Ellsworth Dam	26.0% (74.0%)	4.3% (95.7%)	4.3% (95.7%)
Delayed Mortality	9% (91%)	9% (91%)	6% (94%)
Total Project	47.0% (53.0%)	32.2% (67.8%)	15.4% (84.6%)
Sublethal Injury (% of run)			
Graham Lake Dam	0.7%	0.7%	0.7%
Ellsworth Dam	6.7%	4.4%	4.4%
Total Project Injury	7.4%	5.1%	5.1%
Delay (% pass in more than 48 hrs)			
Total Project	39%	39%	25%

* In addition to passage survival, estimates include headpond mortality within 200 meters of the dam.
**Survival needed to achieve the cumulative standard of 90% given the calculated survival at the Ellsworth Dam.

6.2.2.2. Upstream Fish Passage

The Ellsworth Project is comprised of two dams that both pose a barrier to sea-run fish migration in the Union River. The Ellsworth Dam has a fish trap that is primarily used to capture river herring for harvest and stocking in Graham Lake. If an Atlantic salmon is trapped at the Ellsworth Dam, it is placed into a tank and transported to the West Branch of the Union River upstream of the Graham Lake impoundment. The Graham Lake Dam does not currently have a fishway. The efficiency of the trap and truck fishway at the Ellsworth Dam has never been assessed for any species. The effectiveness of the facility is a combination of two different factors: the effectiveness of the vertical slot fishway, and the effectiveness of the trap and transport operation at passing fish. Vertical slot fishways can be effective for passing Atlantic salmon. Based upon radio telemetry studies conducted from 1989-1992, the pooled upstream passage rates for adult Atlantic salmon at the vertical slot fishway at the West Enfield Project on the Penobscot River is approximately 90% (Shepard, 1995). However, the effectiveness of a trap and transport facility is influenced by many factors (described in section 4.4.1) that are project specific and difficult to predict. In particular, there is information to suggest that salmon that successfully use the vertical slot fishway at the Ellsworth Dam may refuse to enter the fish trap (MASRSC, 1982). In fact, the Maine Atlantic Sea Run Salmon Commission (1982) reported that the “majority” of the salmon refused to enter the trap, and that they had to be netted out of the fishway itself. The possibility that the majority of salmon will not enter the trap at the Ellsworth Dam suggests that the overall passage efficiency is relatively low, despite the potential for high passage through the vertical slot fishway. Although a field study has not been conducted, the US Atlantic Salmon Assessment Committee estimated that the fishway (vertical slot and trap and truck) is 50% effective at passing Atlantic salmon (USASAC, 1991). This is consistent with our analysis that compares stocking effort and the number of returns to the Union River with the smolt to adult return (SAR) rate observed on the Penobscot between 1979 and 1988. In that analysis, we determined that only 47% of the expected number of returns were observed at the Ellsworth trap based on the number of smolts stocked in the Union River and the average SAR rate that was observed on the Penobscot during that timeframe (~ 0.5%).

The proposed action includes the construction of swim-through fishways at both dams by year 15 of the new license, as well as a commitment to achieve a project passage standard of 90% (i.e. ~95% per dam) by year 18 of the license (meaning that 90% of all upstream migrants entering the Union River will successfully pass upstream of both dams). FERC did not propose any specific measures for achieving the passage standard if the new fishways are not as effective as intended. However, studies will be conducted after fishway construction, which will inform the development of any modifications that will be needed to achieve the standard. Given the passage rates for Atlantic salmon seen at other projects in the DPS (e.g., Milford 98% in 2015), Lockwood (89% in 2017)), it is reasonable to assume that the new fishways constructed at the Ellsworth and Graham Lake Dams will be highly effective and achieve this standard within a short period of time following construction. Although the fishways will be constructed in year 15 of the license, we expect it may take up to three years to refine and test the operation through adult salmon efficiency studies. This is a reasonable amount of time given what has occurred at other projects within the GOM DPS.

Adult salmon that are unable to safely pass the Ellsworth Project via the existing upstream fishway will either spawn in other nearby rivers, 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 Union River, we convened an expert panel in 2010 to provide the best available information on the fate of salmon that failed to pass projects on the Penobscot River. 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. As described in our 2012 Biological Opinion for Black Bear's Hydro Projects in the lower Penobscot River, 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 (FERC Accession #: 20120831-5201; Appendix B). The group also indicated that projects that are closest to the ocean, may have an additional 1% mortality associated with seal predation. We anticipate that the Ellsworth Dam would fall into this category, but that Graham Lake Dam would not. In addition, projects closest to the ocean were estimated to have a certain proportion drop back into the ocean. In the Union, there is no known spawning habitat downstream of the Ellsworth Dam. Therefore, we anticipate that except for the salmon that could die (i.e. 2% of the fish that fail to pass), all salmon that fail to pass the Ellsworth Dam will stray to neighboring rivers and attempt to spawn. This will be the case for the duration of the project license.

In the first 15 years of the license, there will be no salmon attempting to pass Graham Lake Dam, as all salmon will be trucked from the Ellsworth Dam to the West Branch. However, the proposed action includes the construction of a swim-through fishway at Graham Lake by year 15 of the license. Following construction of this fishway, we expect that Atlantic salmon will no longer be trapped and trucked, and will swim through the fishway at the Ellsworth Dam and be available for upstream passage at the new Graham Lake dam fishway. Given the conclusions of the expert panel, following construction of the fishway, we anticipate that 1% of the fish that fail to pass the new fishway will die and that the rest will either pass successfully, or spawn in habitat downstream of the Graham Lake Dam. There are an estimated 320 accessible spawning habitat units available in Branch Lake Stream and another 8 units available in the mainstem Union River below Graham Lake Dam.

As indicated in section 6.1, the number of adult salmon actually exposed to these passage rates will be low until natural reproduction and/or stocking increases in the Union River. Therefore, we do not expect any adult salmon to die due to upstream passage inefficiencies during the first 15 years of the license. We cannot predict the number of returning salmon to the river after passage conditions have improved (year 15 to license expiration). However, with the anticipated passage rate of 95% per dam, we would not expect the mortality rate to exceed 0.10% (2% x 5%=0.10%) at the Ellsworth Dam, or 0.05% (1% x 5%=0.05%) at the Graham Lake Dam. Given the expected returns and the low mortality rate, we would not expect more than one adult salmon to die to passage inefficiencies. We anticipate that the majority of salmon that fail to pass will survive and will stray to habitat downstream of Graham Lake Dam (equivalent to 4.90% of the total run at the Ellsworth Dam and 4.95% of the total run at the Graham Lake Dam), or to one of the nearby rivers (e.g. Narraguagus, Penobscot) where they would have the opportunity to spawn. We anticipate that these salmon will be harassed as they will be forced to spawn in potentially unsuitable habitat or, in the worst case scenario, return to the ocean without spawning.

Migratory Delay

As indicated in section 4.4.1, 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). As detailed in section 4.4.1, migratory delay has 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). For these reasons, we consider delay greater than 96 hours (48 hours per dam) to meet the definition of harassment.

The fishways at Ellsworth and Graham Lake will be designed, constructed, and operated specifically to pass Atlantic salmon in a safe, timely, and effective manner. Black Bear has proposed to conduct a study to evaluate the effectiveness of the existing fishway entrance prior to constructing a new swim-through fishway in that location. Although standards for that assessment have not yet been established, we assume that if the existing entrance does not attract adults in a relatively short amount of time (i.e., such that average delay is well under 48 hours), that it will be relocated or significantly modified. Therefore, we believe that once the new fishway is installed, the number of adults delayed for more than 48 hours will be low. We expect that the configuration and operation of the two dams should allow for adequate attraction to the fishway entrance. At the Ellsworth Dam, there is minimal spill during the adult migration period. The flow duration curves for the months of June through October indicate the project would spill water less than 5% of the time during the adult migration period (Black Bear FLA 2015). Therefore, more than 95% of the time all of the river flow is passed through the powerhouse, which is proximal to the fishway entrance. Although the river is approximately 60 meters wide below the dam, all of the flow is passed through the 20-meter section on the west side of the river that contains the powerhouse and the fishway. Similarly, at Graham Lake Dam the entire river flows through a 30-meter wide channel immediately downstream of the dam. The new fishway will be constructed within that channel. For comparison, the river below the Milford Dam is approximately 380 meters wide, and flow can occur across the entire width of the structure during the migration period. This leads to false attraction and delay as adults congregate downstream of the spillway hundreds of feet away from the fishway. The conditions at Graham Lake and Ellsworth reduce the potential for delay compared to fishways on other river systems.

In addition to the configuration of the Ellsworth Project dams, the proposal to provide volitional passage at the project for Atlantic salmon reduces the potential for delay at the project. As detailed in section 4.4.1.2, migratory delay is a negative effect of trap and truck facilities. Although fish can be moved quickly to spawning habitat once they are captured, the trap at Ellsworth only captures fish when an operator is onsite (7 am to 6 pm), and does not operate to capture salmon when water temperatures exceed 23°C, which can occur for weeks at a time during the summer months. Between 2015 and 2018, the proportion of the salmon run that returned to the Penobscot River between July and September ranged from 22% to 25%. The trap at the Ellsworth Project was not operating to pass salmon for three to ten weeks a year over the same timeframe. Thus, given the temperature limit for safe trapping and trucking, a significant percentage of adults could be delayed for several weeks prior to having an opportunity to move upstream. In addition, we anticipate that a large proportion (up to 100%) of the fish that are trapped and trucked fall back in the river after release, which potentially leads to even more delay. Therefore, we anticipate that migratory delay will be reduced when volitional passage for salmon is reestablished in year 15 of the license.

As indicated, we lack specific information regarding the amount of dam-related delay that would reduce a salmon's energy reserves in a way that would affect its fitness. However, we believe that 48 hours is a conservative estimate that is protective of the species and is consistent with the amount of time that we would expect a salmon to swim through an unimpounded reach of river. Additional project-specific information will be needed to further refine this threshold. The establishment of volitional passage, the design of the fishways, and the concentration of flow in the vicinity of the new fishways suggests that prespawn adults will be able to locate the entrances at the Ellsworth Project in less time than what occurs at the Milford Project (average of 10.5 days). In section 4.4.1.2, we estimated that the Ellsworth Dam would pass 50% of motivated spawners within 96 hours under baseline conditions. Given the proposed evaluation and modification of the fishway, we anticipate that after the project has achieved the 90% passage standard (year 15 to 18 of the new license), we would expect that no more than 25% of adults will be cumulatively delayed for more than 96 hours (48 hours per dam); therefore, harassment associated with upstream migratory delay to be reduced to no more than 25% of adults.

Here, we carry out the four-step assessment for determining harassment detailed in section 6.2.2.1. We have established that all prespawn adult salmon will encounter the two dams and that the dams 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 18 of the license); whereas 25% will be delayed by more than 96 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 per dam (96 hours cumulatively) 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 96 hours (48 hours per dam) at the Ellsworth Project during their upstream migration are likely to be adversely affected and that effect meets the definition of harassment. Therefore, prior to the implementation of improved fish passage and verification of the performance standards (within 18 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 96 hours to pass both dams), which we consider to meet the definition of harassment. After the attainment of the performance standard (year 18 to license expiration) we expect that the amount of delay will be reduced and that 25% of adults will take more than 96 hours to pass the Project (cumulative at both dams).

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 96 hours would significantly disrupt the behaviors of individual adults. Although 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), we do not anticipate that to occur at this project. The distance to abundant spawning habitat in the West Branch of the Union River (~35 kilometers from the Ellsworth Dam) is relatively short (approximately 20% the distance that salmon must travel on the Kennebec or Penobscot), so delayed fish will be less likely to fully deplete their energy reserves during migration. Additionally, abundant spawning habitat has recently become available in Branch Lake Stream, which flows into the Ellsworth Dam impoundment 2-km upstream of the dam, and only 3-km upstream of the estuary. This tributary provides thermal refuge, and contains relatively abundant spawning and rearing habitat, as well as numerous resting pools for Atlantic salmon (Table 6). This habitat would be available to fish that successfully pass Ellsworth, but are either low on energy due to delay at Ellsworth dam, or are significantly delayed at the Graham Lake Dam. Given the relatively short length of the river and the proximity to spawning habitat, we do not consider delay of adults during their upstream migration to meet the definition of "harm".

Trapping and Handling

As explained above, until the new fishway is constructed, any Atlantic salmon adults that enter the Ellsworth fishway will be captured, held in a tank, and transported upstream above the Graham Lake Dam. Trapping, handling and trucking fish causes them stress. The primary contributing factors to stress and death from handling are differences in water temperatures (between the river and wherever the fish are held), dissolved oxygen conditions, the amount of time that fish are held out of the water, and physical trauma. Stress on Atlantic salmon increases rapidly from handling if the water temperature is too warm or dissolved oxygen is below saturation. Fish that are transferred to holding tanks can experience trauma if care is not taken in the transfer process, and fish can experience stress and injury from overcrowding in traps that are not emptied on a regular basis. Debris buildup at traps can also kill or injure fish if the traps are not monitored and cleared on a regular basis.

All migrating adult Atlantic salmon in the Union River will be affected by the Project during the first 15 years of the license as they will be trapped, handled, and trucked upriver of Graham Lake on the West Branch of the Union. The effect that the trapping and trucking of fish has on passage effectiveness and migratory delay is addressed above. However, here we consider the additional effects of handling and associated marking/monitoring (e.g., biological sampling, fin clip/punch, scale sample) and trucking on migrating Atlantic salmon. Black Bear is responsible for the handling and transport of fish, but MDMR is contacted whenever a salmon is captured. MDMR maintains a database of adult Atlantic salmon mortalities attributable to trapping and trucking from the Veazie fish trap. Between 1978 and 2011, the median mortality rate for adult Atlantic salmon trapped at the Veazie Dam on the Penobscot River was 0.07%. Given the small number of salmon being trapped at the Ellsworth Dam under baseline conditions (no more than two per year), we do not anticipate that this mortality rate equates to any fish being killed due to effects of trapping and trucking over the period when these activities will occur. However, removing salmon from the water and handling them to transport them to tanks and to take biological samples can lead to stress, that may manifest itself in fall back behavior after release, or in minor injury associated with being transported in tanks in the back of trucks. We do not anticipate any additional injury or stress associated with marking and/or biological sampling that will take place in association with this handling.

Here, we carry out the four-step assessment for determining harassment detailed in section 6.2.2.1. We have established that during the first 15 years of the license, prespawn adult salmon will encounter the trap at the Ellsworth dam and will be exposed to the effects of trapping, handling, and trucking, which constitutes a disruption of their upstream migrations (step 1). We expect that 100% of these fish will be subject to the effects of trapping, handling, and trucking as they migrate to spawning habitat upstream of the dams (step 2). We have established the expected response of the exposed adults (step 3). As discussed in section 4.4.1.2, salmon that are handled and translocated could fall back in the river or hold in place for some amount of time prior to continuing their migration. This can lead to migratory delay, increased energy costs, and an increased potential for predation. Minor injuries (such as scale loss) may expose fish to increased rates of infection, and could make the fish less fit for migration and spawning. 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 100% of prespawn adults that are captured at the Ellsworth dam are likely to be adversely affected and that effect amounts to harassment. For the reasons described above (i.e., the relatively short distance to spawning, rearing, and resting habitat), we do not anticipate that the effect of trapping, handling, and trucking leads to “harm” of the individual fish (i.e., we do not anticipate that this disruption of behavior will lead to mortality). Any affected fish will have ample time to recover from the passage experience prior to migrating the short distance to habitat in the West Branch to spawn.

We anticipate that the construction of swim-through fishways at Ellsworth and Graham Lake Dams will eliminate the need for any handling and trucking of salmon and, therefore, will eliminate any harassment associated with the operation of a trap and truck passage facility.

6.3. Effects of Aquatic Monitoring and Evaluation

Black Bear has proposed to conduct upstream and downstream passage studies to assess the effectiveness of the proposed fish passage improvement measures. These studies are necessary to monitor the effect of the proposed action, and would not occur but for the proposed action. We anticipate that the effects of handling and tagging will lead to minor injury of every study fish, but that they will recover after a short period and will be able to continue their migration. This conclusion is based on the results of numerous similar studies within the GOM DPS of Atlantic salmon. Therefore, we do not believe that these effects will lead to a significant disruption of behavior.

In order to determine the effectiveness of the downstream fish passage facilities and gather information necessary to make improvements, Black Bear will conduct downstream survival studies for Atlantic salmon smolts. Black Bear has proposed to evaluate passage effectiveness for one to three years after the initial modifications are made. If the performance standard is not met, Black Bear will implement additional measures and then conduct another one to three years of evaluation. These studies will commence two years after the license is issued, and will be repeated annually until the standard is achieved (up to six years). We anticipate that a smolt survival study will need to occur every ten years after the standard is achieved to monitor the actual amount of incidental take, and to verify that the project is operating as expected. This means that an additional four study years may be needed, depending on the license duration. Black Bear did not propose to conduct kelt survival studies.

The downstream smolt survival studies will involve obtaining Atlantic salmon smolts (from the Green Lake National Fish Hatchery, or some other source), surgically implanting radio and/or acoustic transmitter tags, and then releasing study fish upriver of the Project. 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. It is expected that up to 300 smolts will be tagged per year for up to 10 years of study, for a total of 3,000 smolts.

In addition to smolt studies to assess downstream effectiveness, Black Bear will conduct studies with adults to assess the effectiveness of the upstream fishways and to gather information needed to make improvements. Black Bear has proposed to coordinate with resource agencies to stock uniquely marked Atlantic salmon smolts upstream of Ellsworth Dam to serve as a source of imprinted adult fish (target of 40 marked returning adults annually) for studying upstream passage once downstream passage improvements have been implemented and downstream passage testing is completed. The upstream passage studies will be conducted in two phases. The initial study will determine if the existing entrance at the Ellsworth fish trap is sufficient to attract 95% of motivated prespawn salmon with minimal delay. If the entrance is sufficient, then it will be used for the swim-through fishway that will be constructed by year 15 of the license. If not, a new fishway location will be need to be identified. The second phase of evaluation will assess the efficiency of the new swim-through fishways at Ellsworth and Graham Lake Dams once they are constructed. Black Bear has proposed one to three years of evaluation for each phase. Therefore, we anticipate that there will be two to six years of upstream passage studies for Atlantic salmon over the term of the license. Upstream passage efficiency studies will be conducted at the Ellsworth Project following the stocking of a sufficient number of salmon smolts to return 40 or more adults for each study year. Therefore, it is expected that Black Bear will tag up to 240 fish (40 per year over six years) for these studies.

Tagging

Techniques such as PIT tagging, coded wire tagging, fin-clipping, and the use of radio or acoustic transmitters are commonly used techniques with Atlantic salmon. All sampling, handling, and tagging procedures have an inherent potential to stress, injure, or even kill the marked fish. Telemetry using radio and/or acoustic tags will be the primary technique for the proposed downstream studies. Although radio tags are sufficient for studies in freshwater, they will not function in the estuarine habitat downstream of the Ellsworth Dam because of incompatibility with salinity.

The method proposed for the downstream passage studies is to surgically implant tags within the body cavities of the smolts. These tags do not interfere with feeding or movement. However, the tagging procedure requires 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 & Hubert, 1985; Mellas & Haynes, 1985).

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 & Hoyt, 1982; Matthews & 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 study will be handled 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 100% of the fish that are handled and tagged will be injured.

A proportion of the smolts are anticipated to be killed due to handling and tagging. There is some variability in the reported level of mortality associated with tagging juvenile salmonids. We did not document any 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 died. Over the same timeframe, we 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.* (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 study.

All adult Atlantic salmon used in the passage studies will be injured due to handling and tagging. However, long term effects of handling and tagging on adult salmon appear to be negligible. Bridger and Booth (Bridger & Booth, 2003) indicate that implanting tags gastrically does not affect the swimming ability, migratory orientation, and buoyancy of test fish. Due to handling and tag insertion, it is possible that a small proportion of study fish may die due to delayed effects. In a study assessing tagging mortality in hatchery reared yearling Chinook salmon, Hockersmith *et al.* (2000) determined that 2% (28 out of 1,156) died after having radio tags gastrically implanted. Given the size differential between a yearling Chinook and an adult Atlantic salmon, it is expected that this would represent a conservative estimate of tagging mortality in the adult salmon being used in the passage studies at the Ellsworth Project. Given the small number of Atlantic salmon being tagged (no more than 240 adults) and that adult salmon are less likely than yearling Chinook salmon to be significantly injured by tag implantation, it is not expected that any adult Atlantic salmon will be killed as part of the upstream passage studies. Injuries are expected to be minimized by having trained professionals conduct the procedures using established protocols.

Summary of Effects

The issuance of a new license to Black Bear to operate the Ellsworth Project will prolong all of the effects associated with dams in the action area, as described in the environmental baseline (section 4.4) and the effects of the action (section 6). These effects include upstream and downstream passage delay and mortality, as well as hydrosystem delayed mortality. The implementation of fish passage improvements will improve the baseline condition of the action area, but passage inefficiencies will continue to adversely affect Atlantic salmon within the action area.

As described previously, with the exception of the salmon used for studies, we anticipate that few salmon will occur in the Union River until either stocking or natural production increases. It is highly unlikely that either will occur until the passage inefficiencies and mortality at the project have been significantly reduced. Until this occurs, we expect that no more than two salmon will be passed upstream at the Ellsworth Dam annually, and that in most years no salmon will be passed. It is possible that in some years salmon will spawn in the Union and produce a small number of smolts. We anticipate that during this interim period (prior to performance standards being achieved) there will be no more than 108 smolts outmigrating in the Union River annually (not including smolts used in survival studies). These smolts will be exposed to mortality ranging from 15 to 47% depending on whether the downstream passage modifications have been made yet or not (Table 12). We expect that the survival rate will improve immediately after the proposed measures have been implemented, and that by year nine of the license, will have met the 90% survival standard. Outmigrating kelts will be exposed to mortality as well, but as they are less subject to predation in the dam headponds, and are excluded from passing through the turbines by the existing trashracks at the Ellsworth Dam, we anticipate it will be substantially less. We expect that no more than 4% of the outmigrating kelts will be killed due to effects of the Ellsworth Project. We anticipate that this mortality will be reduced by the proposed measures as they will improve the safety of the fish bypass.

The monitoring studies will lead to the injury and handling of up to 3,000 smolts, and up to 240 adult salmon. We expect that 2% of the smolts (no more than 60 individuals) used in studies could be killed due to the effects of tagging. We do not anticipate that any adult salmon will die as a result of tagging and handling.

6.4. Effects to Atlantic Salmon Critical Habitat

In this analysis, we consider the consequences of the action on critical habitat in the action area (see Section 4.1 Environmental Baseline). For each PBF that may be affected by the action, we determine whether any effects 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 support the conservation needs of Atlantic salmon s in the action area. Part of this analysis is consideration of the conservation value of the habitat and whether the action will have effects on the ability of Atlantic salmon to use the feature(s), temporarily or permanently, and consideration of the effect of the action on the action area’s ability to develop the feature over time.

As explained above, all of the spawning and rearing and migratory PBFs are present in the action area. All of the PBFs will be affected by the proposed action, except for M6. PBF M6 refers to the need for water chemistry that supports seawater adaptation of smolts. Specifically, this PBF addresses the need for low acidity water as smolts that are exposed to water that is too acidic (low pH) can lose their tolerance for salt water (USOFR, 2009a), which would affect their ability to successfully transition to saltwater. We do not anticipate that the proposed action will affect the pH of water in the action area; therefore, the project will have no effect on this feature and we will not consider PBF M6 further. Below, we analyze the potential effects of the proposed action on the remaining PBFs.

PBF SR1

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.

The MIDIFG survey identified numerous resting pools of high (i.e. excellent or good) quality downstream of the Graham Lake Dam, as well as in some of the tributaries (e.g. East Branch, Middle Branch, West Branch, Tannery Brook) that flow into the Graham Lake impoundment (MDIFG, 1961a). It is reasonable to assume that the Leonard and Graham Lake impoundments currently inundate additional pools that provide cold water refuge and cover in the summer.

The suitability of the pools in the action area is affected in two ways. First, the conversion of riverine habitat to lacustrine habitat results in the outflow at Graham Lake Dam having higher temperatures and lower oxygen levels than what would occur in the river absent the dams (i.e., if the impoundment was not there). The results of the study that Black Bear conducted in 2013 indicate that temperatures in Graham Lake can approach 29 °C at the surface, and that although cooler temperatures exist deeper in the impoundment due to stratification, those cold water areas may have dissolved oxygen levels below the tolerance of adult Atlantic salmon (<4.5 mg/L) during the hottest times of the year.

Although many of the pools in the action area will remain suitable for salmon resting, others may be dewatered depending on whether the Graham Lake impoundment is being operated in store or release mode. The flooding of the habitat in the impoundment slows down flow, which leads to warmer water temperatures with lower dissolved oxygen levels and decreases the value of the pool for holding of adults. Additionally, when storing water in Graham Lake there is less water flowing in the river downstream of the dam. This leads to some amount of dewatering of the habitat along the margins of the river which reduces available habitat. Conversely, when outflow is greater than inflow, the habitat upstream of the dam is dewatered, while habitat downstream of the dam is at risk of being inundated or flushed out. However, the way the dam operates in the summer months may maintain the suitability of pools downstream of the dam for a longer duration than what would be expected if the river were unimpounded. That is because the water stored in the impoundment during the high flow period (April-May) is gradually released during the warmer, drier summer months. This means that the pools remain inundated at the time of year when salmon would be seeking cool, well oxygenated pools.

Although the proposed action includes a reduction in the water level fluctuation (i.e. from 10.8 feet to 4.5 feet) allowed in the Graham Lake impoundment, Black Bear will still operate the project to store and release water for the purposes of power generation. The Ellsworth Dam impoundment will continue to fluctuate by up to 1-foot. The continued existence of the two dams and fluctuation of the impoundments will continue to adversely affect the functioning of SR1 by drying out resting pools in the action area, which reduces the availability and suitability of habitat available for resting adult salmon in the action area. Therefore, we anticipate that the proposed action will adversely affect the functioning of PBF SR1 and the ability of these features to support adult salmon in the action area.

PBF SR2 and SR3

Freshwater 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 (SR2), as well as to support emergence, territorial development, and feeding activities of Atlantic salmon fry (SR3).

These two PBFs address the need for suitable spawning habitat (October 1 through December 14), as well as embryo development and fry emergence (October 1 to April 14). Although much of the spawning habitat in the Union River is located in the West Branch upstream of the action area, there is some that occurs in the action area. MDIFG (1961) indicates that there is a relatively large amount of spawning habitat in Branch Lake Stream (320 habitat units) and Tannery Brook (175 habitat units); with lesser amounts in the Middle Branch of the Union (36 habitat units), and the mainstem below Graham Lake Dam (8 habitat units) (Table 6). As described previously, we anticipate that these estimates are conservative as the survey only identified “ideal” spawning habitat. The amount of rearing habitat in the action area is only 2% of habitat identified in MDIFG’s 1961 survey of the Union River; whereas the amount of spawning habitat is less than 0.5% of what was documented (MDIFG, 1961a).

PBFs SR 2 and SR 3 require habitat that contains clean substrate, as well as cool well-oxygenated water. The flooding of the Graham Lake impoundment adversely affects both of these parameters. As described previously, the Graham Lake Dam impounds approximately 75 kilometers of river and stream habitat. The continued impoundment of the river will lead to increased sedimentation, as well as higher water temperatures, and lower oxygen levels (see section 4.4.3) than would occur if the dams were not present. We also expect that a small amount of habitat in the lower portion of the major tributaries of the Graham Lake impoundment (e.g. Tannery, West Branch, East Branch, Middle Branch) is adversely affected by the fluctuation of water levels due to the operation of the Project. In addition to reducing water quality, the continued existence of the dam and maintenance of the associated impoundment increases the abundance of non-native fish (e.g. smallmouth bass, largemouth bass) that eat juvenile salmon. The proposed action will reduce the fluctuation of the pond level over existing conditions but the continued existence of the dam and artificial manipulation of water levels caused by project operations will result in effects to substrate, temperature, and dissolved oxygen (i.e., effects to PBFs SR2 and SR3) that would not occur but for the project.

In addition to the tributary habitat, MDIFG (1961) identifies a small amount of spawning habitat within the lower Union River. Although the specific location was not identified, we can assume that it occurs immediately downstream of the Graham Lake Dam, based on the results of spatial modelling that indicates there is rearing habitat in that location (Wright et al., 2008). This habitat is affected by the operation of the Graham Lake Dam. As the project controls the volume of water released to the river, it affects the natural hydrologic regime in the habitat below the dam. According to the operating curve for the Graham Lake impoundment, Black Bear is storing water in the impoundment during the months of October and November, when spawning salmon are anticipated to use this habitat; but is releasing water during embryo and fry development between the months of January and March (Figure 5 of FERC's Final EA). This means that less water is released into the habitat than would naturally occur during spawning (potentially limiting the amount of space available for redd construction), whereas more flow is released than would occur naturally during embryo and fry development (potentially washing out redds). This flow alteration leads to a reduction in the functioning of the SR2 and SR3 by affecting velocity, depth, and pool abundance within the reach. Therefore, the operation of the project adversely affects the small amount of spawning habitat downstream of the Graham Lake Dam.

PBF SR2 and SR3 refer to the need for "clean, permeable gravel and cobble substrate." As described in section 4.4.3, the turbidity within and downstream of Graham Lake is excessive and results from the existence of the dam and its operations. Turbidity can have an adverse effect on the functioning of salmon habitat as it deposits fine material on to the gravel and cobble that is needed for spawning and rearing. FERC staff indicate that although high turbidity levels occur at all pond levels, they are more common when levels are either above 103 feet or below 99 feet. Therefore, the proposal to reduce the fluctuation of Graham Lake to 4.5 feet should significantly reduce, but not eliminate, this effect; however, there is still higher turbidity in this reach than would occur absent the dam.

We anticipate that the proposed action will adversely affect PBF SR 2 and SR3 for the duration of the new license due to the continued modification of the habitat within the Graham Lake impoundment and its tributaries, as well as effects associated with the regulation of flow on habitat downstream of the dam.

PBF SR4-SR7

Freshwater rearing sites with the space (SR4), habitat diversity (SR5), cool water (SR6), and diverse food resources (SR7) necessary to support growth and survival of Atlantic salmon parr.

As indicated previously, there is abundant rearing habitat within the Union River and the action area. MDIFG (1961) indicated that there was a relatively large amount of nursery habitat in Branch Lake Stream (768 habitat units) and Tannery Brook (442 habitat units); with lesser amounts in the Middle Branch of the Union (294 habitat units), and the mainstem below Graham Lake Dam (184 habitat units) (Table 6). We anticipate that these estimates are conservative as the survey only identified "ideal" rearing habitat. A small amount of habitat was surveyed in the mainstem of the lower Union, which is likely the reach of river directly below the Graham Lake Dam. The predictive model developed by Wright et al. (2008) indicated that there were approximately 950 units of rearing habitat within this reach.

In general, SR 4-SR 7 are affected similarly to SR 1-3 by the fluctuations of the Graham Lake Dam impoundment. The alteration of the natural hydrologic regime leads to higher or lower flows than what would be expected if the Graham Lake Dam was operated as a run-of-river dam or if the dam was not there at all. These changes in flow directly affect the width, depth and velocity of the rearing habitat downstream of the dam. This can limit the space and habitat diversity available for rearing in the river channel when water is being stored in the impoundment. However, in some instances, the project's ability to control the flow in the Union may benefit the functioning of the habitat downstream of the dam. For instance, in low flow periods, the passing of a minimum flow allows for the continued functioning of the habitat, which otherwise might not be suitable for rearing under low flow conditions. In these instances, however, the temperature of the water flowing over the Graham Lake Dam may exceed the temperature for juvenile salmon due, in part, to the stratification that occurs in Graham Lake.

Information provided in Black Bear's 2013 study of dissolved oxygen and temperature shows that on one extremely warm day, the surface water immediately above the dam approached 29℃, while the water 12 meters down was approximately 17℃. Despite the cool temperature deeper in the water column, the surface water that passed the Graham Lake Dam into the rearing habitat was approximately 26℃, which is above the thermal tolerance of the species (Table 3). We do not have temperature data from habitat upstream of the impoundment from 2013 that can be compared directly to Black Bear's 2013 study; but MDMR has maintained a temperature logger in the West Branch (~13-km upstream of the upper extent of the Graham Lake impoundment) that has monitored temperature hourly over the last few years[6]. The average July temperature for the 2016, 2017, and 2018 monitoring periods is 22.8℃, 22.2℃, and 23.5℃, respectively. The average temperature recorded in the Graham Lake tailrace in 2013 was 26℃. Although this is not a direct comparison, it suggests that the Graham Lake impoundment may be warming the river by as much as 4℃ in some years. Increasing the temperature adversely affects the functioning of SR 4-7, which are dependent on cool water temperatures during the warm summer months. Therefore, the proposed action leads to effects that are neither insignificant nor discountable and constitute an adverse effect to designated critical habitat for Atlantic salmon.

[6] Ecosheds. Stream Temperature Database. Data Viewer. http://ecosheds.org/

We anticipate that the maintenance of a large artificial lake, as well as the modification of flow, temperature, and dissolved oxygen downstream of the impoundment, will affect the available food resources (e.g. mayflies, stoneflies, chironomids, caddisflies) in the Union River. Black Bear sampled the benthic macroinvertebrate community in the Union River downstream of Graham Lake during the summer of 2014 and 2015 to assess stream health. FERC staff indicate in their EA that the monitoring results demonstrated that the benthic macroinvertebrate community downstream of the Graham Lake Dam was abundant but composed of only a few species. The community was dominated by filter feeding caddisflies, which are intermediate between species that are sensitive to environmental conditions and those that are tolerant of a wide variety of conditions. Few mayflies and no stoneflies were collected in either year. As a result, the macroinvertebrate community did not attain Maine's Class B aquatic life standards, which state that discharges to Class B waters may not cause adverse impacts to aquatic life, such that the receiving waters must be of sufficient quality to support all aquatic species indigenous to the receiving water without detrimental changes in the resident biological community. Macroinvertebrates were not sampled in the Graham Lake impoundment, but we anticipate that a similar affect occurs there. The results of the sampling indicates that the operation of the Graham Lake impoundment adversely affects PBF SR 7 by reducing the diversity, and potentially the availability, of food resources for juvenile Atlantic salmon within the action area.

PBF M1

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

The condition of PBF M1 in the action are degraded due to the presence of the Ellsworth Project; these negative effects would be eliminated if the dams were not present. The proposed action is to trap and truck Atlantic salmon for release 30 kilometers upstream of the Ellsworth Dam for the first 15 years of the license. This will result in a lack of access to the spawning habitat present within the action area as it will be bypassed by the trucking operation. Although salmon will be transported to habitat in the West Branch, the habitat downstream of the release point will not be utilized unless they fall back in the river after release. As the Project will continue to be a physical barrier that prevents access to spawning grounds in the action area, it will adversely affect the functioning of M1. The proposed action includes the construction of a swim-through fishway at both of the dams by year 15. After fishway construction, Black Bear will evaluate the effectiveness of the fishways and adaptively manage its operation until at least 90% (cumulative) of prespawn salmon can effectively pass the Project. This proposed measure will substantially increase accessibility to the spawning habitat in the action area, however, access will continue to be blocked for 10% of the salmon that approach the project. Due to the proposed action, the action area will not be "free from physical and biological barriers that delay or prevent access of adult salmon seeking spawning grounds" and, therefore, the project will continue to adversely affect PBF M1 throughout the term of the new license.

PBF M2

Freshwater and estuary migration sites with pool, lake, and in-stream 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.

Both PBFs SR1 and M2 refer to the need for holding and resting areas that prespawn salmon can use during their upstream migration. SR1 refers specifically to pools "near freshwater spawning sites," whereas M2 speaks to the need for holding areas throughout the migratory corridor. Regardless, the effect of the proposed action on these types of habitat is similar. Pools and in-stream habitats within the action area are modified largely due to the presence of the Graham Lake impoundment and the regulation of flow through the Graham Lake Dam. Water quantity and quality in the action area is affected by the store and release operation at the dam. When water is being stored in the impoundment, the amount of water being released downstream is limited and pools and other in-stream habitats are at risk of being dewatered. Similarly, when the Graham Lake impoundment is being drawn down, there are large areas around the shoreline that are dewatered entirely. This regulation of flow significantly affects the ability of that habitat to function as holding areas for salmon.

Although the regulation of flow adversely affects the functioning of this PBF above and below the dams, the maintenance of two artificial lakes (Leonard and Graham) may have a beneficial effect to the functioning of the habitat, as well. Black Bear has documented that the Graham Lake impoundment stratifies in the summer months. Therefore, although the surface water is exceedingly warm, the temperatures lower in the water column are significantly cooler. For instance, Black Bear's study report indicates that the surface water temperature in the lower impoundment approached 29℃ in July 2013, but that the temperature closer to the bottom was 17℃, which is well within the thermal tolerance for salmon. This effect could provide a valuable holding area for salmon at a time of year when the mainstem Union River is otherwise above the thermal tolerance for Atlantic salmon. The impoundment also likely retains woody debris that could potentially be used as cover.

Although some effects of the dam on PBF M2 may be beneficial (i.e., providing improved habitat conditions in limited areas compared to the habitat conditions that would be present absent the dams), overall the dams and their operation adversely affect the ability of the habitat in the action area to function as resting and holding habitat for adult Atlantic salmon.

PBF M3

Migration sites with abundant, diverse native fish communities to serve as a protective buffer against predation

The fishway at Ellsworth is currently operated to trap and transport the State of Maine's target escapement for river herring upstream into the Graham Lake impoundment. The goal of the escapement is to provide an annual run of 2.3 million fish; with the fish in excess of the escapement goal being harvested as bait for the lobster industry (URFCC, 2015). The target is based on the production capacity of the currently accessible alewife habitat in the Union River watershed. This target has changed numerous times; most recently in 2015 when it was increased from 150,000 to 315,000. At current trapping effort, Black Bear has been able to achieve the escapement goal, although they have yet to capture the full 2.3 million fish that the habitat has the capacity to produce. Black Bear has indicated that with the existing facility and trapping effort they can trap and transport 26,000 river herring a day. With a 42-day season on average, this equates to 1.1 million herring, which is well short of the 2.3 million target. This indicates that although it may be possible that the trap is capable of passing the full run, there would likely be significant migratory delay. The increase in the escapement goal in 2015 was not expected to change the return numbers until 2019 given the four-year life cycle of the species. However, in that year the Ellsworth trap captured only 394,000 river herring; well below the population target of 2.3 million. Therefore, the ability of the trapping facility to handle the anticipated returns is unknown. Additionally, it is unknown how the state's management of the species will change over the license term. Modifications to the trap, such as an increase in the size of the hopper, may be necessary to achieve future population targets.

Fish Kills

The Downeast Salmon Federation (DSF) has documented injury and mortality of fish (alewife and American eel) at the Ellsworth dam annually between 2014 and 2017. They have filed their observation data with FERC, including information on the timing of observations, injury type, species observed, and estimates of the number of dead fish (URFCC 2018, FERC submittals 20170810-5051 and 20161017-5030). The information provided by DSF from the 2017 fish passage season (URFCC, 2018) indicates that thousands of adults were observed dead downstream of the Ellsworth Dam in June of 2017, and that "10,000 or more" dead juveniles were documented in August. Notwithstanding Black Bear's efforts to reduce the scope and scale of entrainment related injury and mortality, fish kill events continue to occur seasonally. The injured and dead fish show marks consistent with turbine entrainment (e.g. decapitation, lacerations, missing eyes, scale loss). The proportion of outmigrating adult and juvenile river herring being affected remains unknown, as no study has occurred to address this question. The size difference between salmon, eels, and river herring makes a direct comparison between the results of the 2015-2017 downstream survival studies problematic. However, given the abundance of dead fish observed and the mortality rates in the other species studied, we assume that the proportion of alosines being killed through turbine passage is substantial.

Although the extent of these events has yet to be adequately quantified, it is apparent that the project is killing a large number of both adult and juvenile fish. We expect that the project will continue to adversely affect this PBF by reducing the abundance and diversity of native fish species until the downstream passage issues at this project are resolved for all diadromous fish. The proposal to install a guidance boom should reduce turbine mortality of adult and, to some degree, juvenile river herring. The increased flow through the downstream fishway should also increase attraction to the downstream fishway, which is the safest passage route at the dam. Black Bear will evaluate passage conditions for these species after the proposed measures have been implemented with the goal of achieving 90% upstream passage and downstream survival. We anticipate that the proposed modifications will significantly improve conditions for river herring over current conditions, but that some inefficiencies will remain. We anticipate that during the term of the new license, the proposed action will continue to have a detectable effect on the diverse native fish communities' ability to serve as a protective buffer against salmon predation. Therefore, we anticipate that the proposed action will continue to adversely affect PBF M3 throughout the term of the new license.

PBF M4

Migration sites free from physical and biological barriers that delay or prevent emigration of smolts to the marine environment.

The features of M4 in the action area have limited function due to the presence of the Ellsworth Project; these effects would be eliminated if the dams were not present. Since Black Bear will be required to operate and maintain downstream fishways for Atlantic salmon smolts 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 proposed improvements will not make the fishways 100% effective at passing downstream migrating smolts, we do anticipate that they will significantly improve passage survival at the project. However, even with the proposed passage improvements, the Ellsworth Project will continue to act as a physical barrier that delays, injures, and kills outmigrating Atlantic salmon smolts (as described in sections 4.4.1 and 6.2.2.1). The downstream fishway will not eliminate these adverse effects of the project on the features of M4 in the action area and, therefore, we conclude that FERC's issuance of a new license will continue to adversely affect the PBFs of M4 in the action area.

PBF M5

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

As we have indicated, Black Bear operates the Graham Lake Dam to store water in its impoundment during the month of May, when we anticipate the majority of the smolt outmigration occurs. This means that there is less water being released from the impoundment than there is flowing in. This could conceptually lead to an increase in temperature and to smolts slowing their migration speed through the impoundment. However, there is generally sufficient flow in the river in the month of May to allow for smolt migration. The proposed minimum flow for the smolt migration period is 250 cfs, but the mean flow in the month of May is substantially higher (i.e. 1,200 cfs; Black Bear's FLA 2015). Given the standard operation of the dam, we do not anticipate rapidly fluctuating water levels that would lead to stranding of migrating Atlantic salmon or dewatering of habitat downstream the project.

During spring months, high flows and low water temperatures into the action area should be protective of the features of M5. Black Bear did not monitor water temperatures in the action area in the month of May during their 2013 study. However, they did record the mean daily temperatures during the 2016 and 2017 smolt survival studies (BBHP, 2016b, 2017a). During those studies, the daily mean temperature ranged between 11.6℃ and 20.6℃ in 2016; and between 11.3℃ and 18.0℃ in 2017. For comparison, in 2017 the MDMR data logger in the West Branch recorded a mean hourly temperature of 13.8℃ (Range: 9.1-18.8℃) over the same period (May 16 to June 3) (Ecosheds Stream Temperature Database). This is not a direct comparison as Black Bear documented the mean daily temperature, whereas the MDMR data logger records temperature hourly. It is clear, however, that in 2017 there was significant overlap between the temperature range Black Bear documented in the action area, and the range documented upstream of the Graham Lake impoundment over the same time period. It is possible that the impoundment may slow down the flow sufficiently to cause it to warm, but it appears that this may not be a significant effect given the large amount of water moving through the river at that time of year. Therefore, we conclude that the proposed action's effect on PBF M5 would be so small that effects could not be meaningfully measured, evaluated, or detected and as such are insignificant.

Summary of Effects of Proposed Activities on Atlantic Salmon Critical Habitat

Effects to PBF M5 will be so small that they are not able to be meaningfully measured, detected or evaluated and are therefore, insignificant. We have determined that the proposed action will have long-term adverse effects on PBF SR 1-7 and M 1-4. In the Integration and Synthesis (section 8), we analyze whether the adverse effects will appreciably diminish the value of the critical habitat designated within the Downeast Coastal SHRU. We then consider whether the action is likely to destroy or adversely modify the critical habitat designated for the Gulf of Maine DPS.

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 effects 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 Union 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. It is likely that Atlantic salmon have been accidentally harvested at the Ellsworth fishtrap during the alewife harvest. 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 Union River.

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, stormwater 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 effects analysis outline above, we considered the effects of FERC's proposed licensing of the Ellsworth Project. We expect that licensing the project will result in continued adverse effects to Atlantic salmon associated with the continued presence of the two structures in the river, when compared to a free-flowing river condition that would exist if there were no dams.

However, we expect implementation of the proposed, recommended, and mandatory license terms will reduce effects to Atlantic salmon compared to current operational and structural conditions. While we expect an overall improvement compared to current conditions, the project will continue to result in significant adverse effects to individual Atlantic salmon and many of the features of designated critical habitat. The project will continue to affect upstream and downstream passage of Atlantic salmon, result in the injury and death of individuals, and have a negative impact on salmon habitat. In the discussion below, we consider whether the effects of the proposed action reasonably 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 is likely to 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."

Summary of Upstream Passage Effects

Atlantic salmon use the upstream fishway at the Ellsworth Project. However, even when operated pursuant to the new license, the project will not be 100% effective at passing all Atlantic salmon that are motivated to access habitat upriver. We have concluded that the fishway (trap and truck) at the Ellsworth Dam will be 50% effective during the interim period (first 15 years of the license before the new upstream fishway is operational). We anticipate that it will increase to 90% (Ellsworth and Graham Lake, cumulatively) once the new fishways have been constructed and evaluated to ensure compliance with the passage standard (by year 18). Adult salmon that are not passed at the Ellsworth and Graham Lake dams will either spawn in downstream areas, stray to other rivers, return to the ocean without spawning, or die in the river. These salmon are significantly affected by the stress, injury and mortality associated with locating and successfully passing the fishways; effects to these individuals can include harassment, harm, or mortality. As explained in the effects of the action section of this Opinion, we estimate mortality rates for Atlantic salmon that fail to pass the Ellsworth and Graham Lake Dams are 2% and 0%, respectively, during the first 15 years of the license; and 2% (0.1% of the total number of fish approaching the project) and 1% (0.05% of the total number of fish approaching the project), respectively, from when the standard is achieved (between year 16 and 18) to license expiration.

We have concluded that the project will lead to migratory delay in motivated prespawn adults. Migratory delay reduces the energy reserves of migrating salmon, and may reduce the probability that they will have sufficient energy to spawn successfully, and/or migrate back out to the ocean where they can commence feeding again and retain the potential to become a repeat spawner. Delay can result in a spectrum of effects, from a minor increase in energy expenditure that has an insignificant impact on spawning success or general physiological condition, to significant disruptions in migratory behavior that come at an energetic costs that reduces spawning success and/or reduces the potential for surviving the migration back to the ocean following spawning or reducing the potential for surviving to return as a repeat spawner. In the worst case, the energetic costs of delay have such a significant impact on condition that the adult fails to spawn and/or dies on its way to the spawning grounds. We have estimated that during the interim period, 50% of the salmon that successfully navigate the Ellsworth fishway will take longer than 96 hours to do so, which we consider long enough to be a significant disruption of migration. With the construction of highly effective fishways at both the Graham Lake and Ellsworth Dams, we expect that no more than 25% of the salmon attempting to pass upstream of the Ellsworth Project will take longer than 96 hours. As explained above, we consider delay greater than 48 hours per dam (96 hours, cumulative) to be harassment as it is a significant disruption of migration. Although we anticipate that 25% of adults will be harassed due to migratory delay, we expect that there are some features of the Union River that minimize the effect of this take on individuals; that is, these features reduce the potential for this delay to result in a reduction in spawning success. As the Union is significantly smaller than the larger rivers to the west (e.g., Kennebec and Penobscot), upstream migrating adults do not have very far to migrate to access spawning habitat, thus reducing the overall energy needs for upstream migrants.

Summary of Downstream Passage Effects

Atlantic salmon smolts outmigrate to the estuary in the spring after rearing in freshwater streams. As described previously, over the life of the project license, we consider that the project will operate under three conditions: the existing condition (year 1-2), the condition that exists after the proposed measures have been constructed (year 3-9; collectively, the interim phase), and the condition once performance standards are met (year 10 to license expiration) (Table 13). The increase in survival between year two and year three is attributable to the increase in survival we expect from the installation of downstream improvements at the Ellsworth Dam (i.e. guidance boom, racks, increased downstream passage flow, modified downstream fishway). Although we expect a significant improvement in survival at the Ellsworth Dam, we do not expect that the proposal for the Graham Lake Dam (i.e. making the temporary Alden-type weir permanent) will result in an increase in survival. Additional measures will be developed for the dam based on the results of the survival studies that will be conducted starting in year three. As indicated in the proposed action, Black Bear and FERC have committed to the achievement of a 90% survival standard. We expect that, given the proposal for adaptive management, Black Bear will be able to achieve that standard within nine years of license issuance (i.e. within six years of the installation of fish passage improvements).

Dams can result in unnatural delays and sublethal injuries to outmigrating smolts that can lead to increased predation and reduced fitness in the freshwater to saltwater transition. Stich et al. (2015) completed a study that looked at this effect on Atlantic salmon in the Penobscot River. They determined that smolts that passed more dams in freshwater died at a higher rate in the estuary than fish that passed fewer (or no) dams. They estimated approximately 6% smolt mortality in the estuary for each dam passed during the freshwater migration; this is termed "hydrosystem delayed mortality." Although this effect has not been studied in the Union River, we assume a similar proportion of smolts will be subject to delayed mortality in the estuary due to their passage experience at the Ellsworth Project. However, we estimate that delayed mortality will be lower in the Union River (compared to the Penobscot) because the Graham Lake Dam does not have turbines and therefore has lower injury rates. Therefore, we anticipate that up to 9% (6% for Ellsworth Dam + 3% for Graham Lake Dam) of salmon smolts that migrate downstream of the Ellsworth Project prior to year nine of the license (the point at which we expect compliance with the 90% standard) will die in the estuary because of that passage experience. We anticipate that the proposed improvements will reduce this mortality, as it will be reducing the effect of both of the identified causative factors (migratory delay and injury). Lacking specific information on how these factors relate to delayed mortality, we conservatively estimate that the action will reduce hydrosystem delayed mortality in the Union River to 6% (i.e., a reduction of 31% from the estimated 9% occurring under baseline conditions). We anticipate that this level of mortality will continue to occur from at least year ten to expiration of the new license.

Atlantic salmon kelts outmigrate in the fall after spawning, or in the spring after overwintering in freshwater. They are exposed to the same challenges associated with dam passage as smolts but, due to their greater length, are more likely to be struck by a turbine blade if they pass through the turbines (Alden Research Laboratory, 2012). However, as indicated in section 6.2.2, both the existing and proposed racks at Ellsworth Dam will exclude kelts from becoming entrained in the turbines. Therefore, we do not anticipate that the proposed action will lead to higher passage survival for kelts. We anticipate that 99% and 97% of the kelts passing Graham Lake Dam and the Ellsworth Dam, respectively, will survive passage. This equates to a cumulative project kelt survival of 96%. Although we do not anticipate a change in survival, the proposed action will reduce migratory delay by increasing guidance to the downstream fishway at both dams, thereby increasing the speed at which kelts pass downstream of the project. We do not have information regarding migratory delay of kelts in the Union River. Kelts are known to outmigrate during periods of high flow in the spring and fall, and have been documented passing via spill and sluices at the dams on the Penobscot River (Shepard, 1989). Given the configuration and flow allocation at the Graham Lake and Ellsworth Dams, we anticipate that kelts will quickly find and pass the downstream fishways, or spillways/gates if flow is particularly high. We do not anticipate any delayed mortality of kelts associated with dam passage, as we do not anticipate that turbine entrainment, which could lead to higher rates of migratory delay and injury, would occur. Additionally, we anticipate that minor injury (such as scale loss and loss of equilibrium) from passage through the downstream fishways would have less of an impact on adult salmon than on smolts, and that predation would be less of a risk for larger fish. As such, we do not anticipate any adverse effects to downstream migrating kelts other than the 4% mortality.

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 effects of the proposed action on the likelihood of the species' 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 HUs 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 Downeast Coastal SHRU over the 30-50 year life of the new project license. As addressed in the effects of the action section of the Opinion, we expect that as passage improves in the river it may become a higher priority for stocking. The hatchery program, sponsored by the U.S. Fish and Wildlife Service, 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.

8.1.1. Survival Analysis

The first step in conducting the jeopardy analysis is to assess the effects 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 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 effects to individual salmon that were identified in the “Effects of the Action” section of this Opinion will affect the Union River population of Atlantic salmon, how the effects to the Union River population will affect the Downeast Coastal SHRU, and then finally, how the effects to the Downeast Coastal 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 Downeast Coastal SHRU is necessary for attainment of the delisting criteria and recovery of the GOM DPS.

When considering how a proposed action is likely to affect the survival of a species, we consider effects to reproduction, numbers and distribution. The number of returning adult Atlantic salmon to the Downeast Coastal SHRU is a measure of both the reproduction and numbers of the species. We consider the ability of pre-spawn Atlantic salmon to access high quality spawning and rearing habitat in the six major Downeast Rivers (i.e., Dennys, East Machias, Machias, Pleasant, Narraguagus, and Union) as a measure of distribution.

Below, we analyze whether the proposed action (FERC issuance of a new license consistent with the “Staff Alternative with Mandatory Conditions”) will reduce the reproduction, numbers, or distribution of the Atlantic salmon in the action area and the Downeast Coastal SHRU to a point that appreciably reduces the species likelihood of survival in the wild.

Interim Phase

In section 6.1, we describe the period prior to the verification of the downstream performance standard being achieved (by year nine of the license) as being the interim phase where we expect very few salmon to occur in the action area (based on an assumption of a continuation of current stocking practices occurring over this period). A basic model can predict the effect that the proposed changes will have on the number of returning Atlantic salmon to the Union River during this phase given the lack of stocking in combination with poor marine and freshwater survival. As indicated above, during this phase we expect that no more than two Atlantic salmon will successfully pass the Ellsworth Project per year. These fish would likely be straying to the Union River from the adjacent Penobscot and Narraguagus Rivers. Based on information from NOAA’s Northeast Fisheries Science Center[7], we expect approximately 108 smolts to be produced from a single spawning event, which is the most we expect if only two salmon are passed upstream. Using the 10-year average smolt to adult return rate for hatchery fish on the Penobscot River (0.2%; USASAC 2019), we can use the expected number of smolts produced in the watershed to estimate the number of adults that would be expected to return to the river. If all 108 smolts successfully transitioned to the marine environment, we would expect 0.22 adults to return to the Union River to spawn. Adding the mortality rates for smolts that have been attributed to the Ellsworth Project, including hydrosystem delayed mortality, reduces the estimated number of returns to 0.11 adults. Therefore, while the downstream mortality attributable to project operations results in a hypothetical reduction in the number of adult returns, in years where there are only two spawning adults, it is extremely unlikely that those adults would produce any returning adults, regardless of the effects of the Ellsworth Project. While we do not expect it to occur over this interim period, in a hypothetical scenario where stocking was increased or conditions changed such that there was a more robust number of adult returns, the effect of the Ellsworth Project would become more apparent and the reduction in numbers would be clear. For example, for every 20 adult returns, we would expect the production of 1,080 smolts and with no dam related mortality, we would expect approximately 2 adults to return (calculated 2.16) which would be reduced to 1 when accounting for project related mortality, inclusive of hydrosystem delay mortality.

Performance Standard Phase (Year 10 – License Expiration)

[7] J. Nieland, NOAA’s Northeast Fisheries Science Center, Preliminary data, January 27, 2017.

In section 6.1, we describe the phase after the downstream performance standard has been achieved (year 10 to license expiration) as the timeframe when we would expect the number of salmon in the Union River to begin to increase. As described in the recovery plan (USFWS & NMFS, 2019), phase two of recovery is focused on "abating imminent threats", such as those posed by hydro projects, to allow for the persistence of the species in the GOM DPS. Once the threats have been adequately reduced, we will transition to phase three of recovery, which focuses on "increasing the abundance, distribution, and productivity of naturally reared Atlantic salmon." This is consistent with action F2.0 of the recovery plan, which indicates that we should "implement stocking programs for vacant habitat targeted at preventing extinction of locally adapted stocks and increasing their abundance and distribution" (USFWS & NMFS, 2019). As we are still in phase two of recovery, the priority in the Union River is to abate the imminent threats in the system, namely the threats posed by the Ellsworth Project.

Our expectation is that stocking of juvenile Atlantic salmon would occur in the Union River once the significant passage inefficiencies at the project have been resolved (i.e., once the fishways are operating in compliance with the performance standards). Although we cannot predict precisely when a change in stocking practice would occur, what lifestages would be stocked, or the extent of the stocking effort; we anticipate that stocking of early life stages and/or smolts would begin around year 15 of the new license (i.e., after the upstream fishways have been constructed), and would occur at levels similar to what has occurred historically (i.e., similar to that of the 1990s). We expect that stocking combined with the proposed fishway improvements will allow for a run in the Union River that would improve abundance, reproduction, and distribution of the species within the Downeast Coastal SHRU. To illustrate this point, we have used a simple model to estimate the number of expected returns under three passage/survival scenarios assuming smolt stocking were to return to levels seen back in the 1990s (~20,000 per year; Baum 1997). The scenarios are: 1) no dam effects, 2) effects of the Ellsworth Project operating under the terms of the existing license, and 3) Project effects with the implementation of the proposed action (i.e., operation of the project under the terms anticipated for the proposed license). Under scenario 1, we assume the existing smolt to adult return rate (0.2%), and 0% mortality associated with the direct and indirect effects of dam passage, including hydrosystem delayed mortality. Under this scenario, we would anticipate that having 20,000 smolts migrating out to sea would result in a return of 40 adults to the Union River. Under scenario 2, we assume the existing upstream passage and downstream survival rates (50%/53%) and the same 0.2% marine return rate. Under this scenario, we would expect that only 10 adults would return to the Union River. Under scenario 3, we assume that the Project is in compliance with upstream and downstream passage/survival standards (90% cumulative), has a reduced hydrosystem delayed mortality rate of 6%, and no change in the 0.2% smolt to adult return rate (i.e., no change in marine survival). Under this scenario we would expect a return of approximately 30 adult salmon passing the Ellsworth Project each year. This model suggests that the proposed action will lead to a 25% reduction from what would be expected if the river was undammed (30 fish versus 40 fish); but leads to a three-fold increase from what would be expected if the project continued to operate under the terms of its existing license (10 fish versus 30 fish).

Under existing conditions and stocking effort (no significant stocking), the Union River contributes minimally to the production of Atlantic salmon in the Downeast SHRU. Over the last decade, the number of prespawn Atlantic salmon returning to all rivers in the Downeast Coastal SHRU ranged between 53 and 305 annually; with an average return of 112 individuals (derived from data in USASAC 2019). The Union River has contributed no more than two salmon per year (averaging less than one) throughout this timeframe. Therefore, we anticipate that although effects to salmon will continue to occur at the Ellsworth Project, the consequences of the reduction in reproduction and numbers resulting from the loss of individual salmon in the Union River during the interim period (i.e., years 1-9 of the license) will be negligible; that is, they will be so small that they will not be detectable at the level of the Downeast SHRU or the DPS as a whole.

Our analysis indicates that operation of the project consistent with the proposed new license (i.e., inclusive of the proposed fish passage measures achieving the performance standards) would lead to a three-fold increase in returns over what we would expect under existing conditions (assuming the extent of the stocking is equivalent). The analysis also shows that the proposed action would lead to 25% fewer adults returning to the Union than what would occur if the dams did not exist. With more production and stocking occurring in the River, numerically more salmon will be affected by the passage inefficiencies at the project. Therefore, even with the significantly improved passage over current conditions, the project will reduce the number and reproduction of prespawn salmon in the Union River, the Downeast Coastal SHRU, and thus the GOM DPS, compared to the numbers and reproduction that could occur absent the proposed action (i.e., if the projects were not licensed and the dams were removed). However, we expect that the construction of fishways and adherence to performance standards will allow for an increase to the abundance and reproduction of Atlantic salmon in the action area that will result in an increase in spawning adults and allow for restoration of a population of wild Atlantic salmon in the Union River.

Compared to current conditions, the proposed action will broaden the distribution of the species in the Union River, as operating the fishways in compliance with the performance standards will restore access to upstream habitats. This will result in restoration of access to approximately a quarter of the critical habitat in the Downeast Coastal SHRU. Given the anticipated efficiency of the fishways when operated in compliance with the performance standards, we expect habitat in the Union River will be nearly as accessible as a result of the proposed action as it would be if the dams were no longer present. Given these improvements in access, we anticipate that the proposed action will lead to a significant increase the distribution of Atlantic salmon in the Downeast SHRU. Presently, 28,500 units (95% of the habitat recovery criteria) are currently considered fully accessible in the Downeast Coastal SHRU. The proposed fish passage measures and performance standards will make a large amount of previously inaccessible habitat accessible by year 15-18 of the license. The project currently blocks access to 13,337 habitat units. Therefore, restoring access to the watershed will increase the amount of accessible habitat in the Downeast SHRU by approximately 50%. We expect that this habitat will be utilized by salmon during the term of the new license, as the implementation of safe, timely, and effective fish passage will make it much more likely that a stocking program will be re-initiated in the Union River. Additionally, we expect that Atlantic salmon straying from the Narraguagus and Penobscot Rivers will be able to access suitable spawning habitat in the Union under these conditions.

In summary, the proposed action is anticipated to result in an increase in the numbers, reproduction, and distribution of Atlantic salmon in the action area, the Union River, the Downeast Coastal SHRU and the DPS as a whole, compared to current conditions. When compared to a future scenario without the proposed action (i.e., no license is issued and the dams are removed), the proposed action would reduce the potential numbers and reproductive potential (through a reduction in numbers) of Atlantic salmon in the Union River but would have a negligible impact on distribution. Based on the analysis provided above, the loss of Atlantic salmon smolts, kelts, and prespawn adults resulting from the operation of the Ellsworth 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:

- The action is expected to result in an increase in numbers and reproductive output of Atlantic salmon in the Union River, which would result in an increase in the population trend of Atlantic salmon in the Union River, which will positively impact the population trend of the Downeast Coastal SHRU and the DPS as a whole;
- The loss of individual Atlantic salmon due to the Project is not expected to impact the genetic heterogeneity of the Downeast Coastal SHRU or the species as a whole because there is no locally adapted stock of Atlantic salmon in the Union River; and
- The Project will result in an increase in distribution of Atlantic salmon in the Union River and restoration of access to a significant portion of habitat in the Downeast Coastal SHRU.

8.1.2. Recovery Analysis

The second step in conducting the jeopardy analysis is to assess the effects of the proposed action 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 (USFWS and NMFS 1998). As with the survival analysis, there are three criteria that are evaluated under the recovery analysis: reproduction, abundance and distribution.

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. As explained above, we have determined that the proposed action will not appreciably reduce the likelihood that Atlantic salmon will survive in the wild. Here, we consider the potential for the action to reduce the likelihood of 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 Downeast Coastal 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 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. We have created a conceptual model to indicate how marine and freshwater survival rates would need to change in order to recover Atlantic salmon (NMFS 2010). In Figure 14, the dot represents current marine and freshwater survival rates, whereas the curved 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 above the curved line, the population is growing, and, thus, trending towards recovery (lambda greater than one). The straight 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 path to achieving a self-sustaining population that is trending towards recovery.

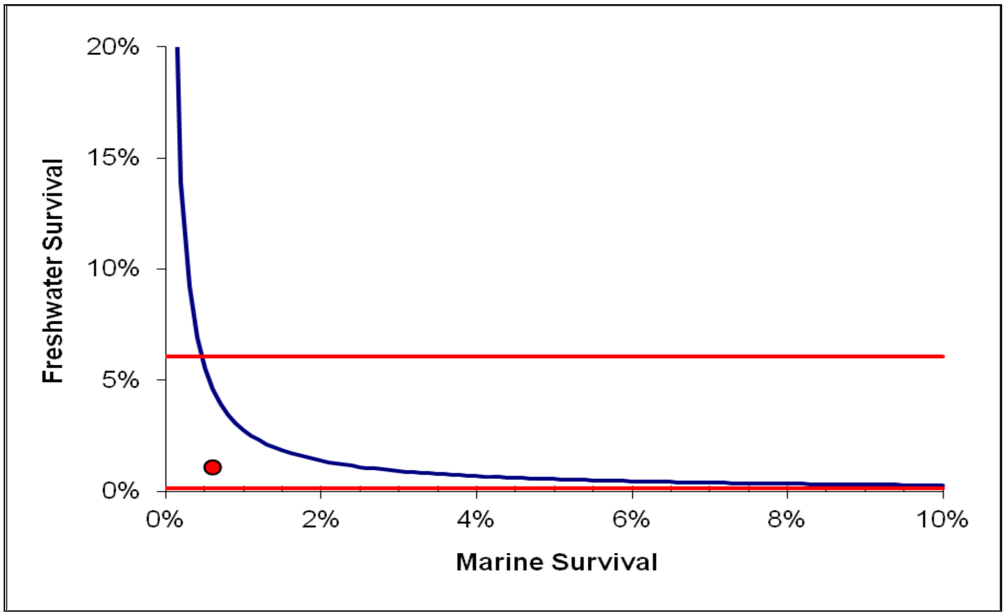

Figure 14. NMFS (2010) conceptual model depicting marine and freshwater survival relative to recovery of the GOM DPS of Atlantic salmon (Note: The dot represents current conditions, the curved line represents recovery, and the straight lines are the historic maximum and minimum freshwater survival).

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 Union River which reduces the number of smolts and adults surviving to reproduce in the Union River and in the Downeast Coastal SHRU. We anticipate that these effects will be reduced with the construction of safe, timely, and effective upstream and downstream fishways at the project but mortality rates of smolts and adults will be higher than they would be if the dams were removed. As indicated above, given the assumed survival and passage rates and the expected marine survival rate, we expect that the proposed action will lead to a three-fold increase in returns when compared to the existing survival rates at the project. However, the action will still lead to 25% fewer returns than if there were no dams in the system. Therefore, we anticipate that, should marine survival rates increase, this newly accessible habitat could support a large number of spawning salmon that would lead to an increase in production and abundance of Atlantic salmon in the Downeast SHRU. Therefore, assuming a sufficient increase in marine survival, we expect that the commencement of stocking and the improvements in upstream and downstream passage will allow the Union River to support a viable, self-sustaining population of Atlantic salmon that will be capable of having a positive growth rate. These are the two conditions necessary for the Union River to contribute to the recovery of the Downeast SHRU and the Gulf of Maine DPS. We anticipate that the proposed action will lead to an increase the distribution of Atlantic salmon in the Downeast SHRU. Presently, approximately 28,500 units (95% of the habitat recovery criteria) are currently fully accessible in the Downeast Coastal SHRU. The proposed fish passage measures and performance standards will open up a large amount of previously inaccessible habitat. The Project currently blocks 13,337 units, which equates to an approximately 50% increase in available habitat compared to current conditions.

Although the Ellsworth Project will continue to adversely affect juvenile and adult Atlantic salmon in the Union River, it will not affect salmon outside of the Union River, that is, salmon in the rest of the habitat within the Downeast Coastal SHRU. The SHRU is comprised of six rivers (i.e., Dennys, East Machias, Machias, Pleasant, Narraguagus, and the Union), and all of them, support small runs of Atlantic salmon. While the proposed action will adversely affect Atlantic salmon in the Union River, it does not affect the salmon in any of the other five rivers. Therefore, the potential for the proposed action to appreciably diminish recovery of the SHRU and DPS is limited. However, the Union River contains approximately a quarter of the modelled rearing habitat within critical habitat in the Downeast Coastal SHRU. Therefore, the restoration of access to the habitat in the river is important in order to achieve the recovery goals. The proposal to improve upstream and downstream passage at the Ellsworth Project would restore access to the Union for the first time in over a century. Restoration of effective passage will allow salmon straying from neighboring rivers to access the abundant habitat upstream of the project. Additionally, the attainment of high passage and survival rates could lead to the initiation of a stocking program that could jumpstart the salmon run, and increase the probability that a sustainable run will develop in the Union River. Restoring access to a quarter of the critical habitat in the Downeast SHRU greatly increases the distribution of Atlantic salmon, and creates the conditions necessary for improved abundance and reproduction.

The proposed action does not require the construction of downstream passage improvements until two years after the license issuance, and does not require the implementation of swim though passage until year 15 of the license. The timing of downstream fishway improvements means that there would be high mortality of juvenile salmon in the initial two-year phase of the new license if any salmon were in the action area. Given the lack of salmon stocking or natural production in the river, we do not anticipate many salmon to be killed until the population begins to increase. We expect the survival rate to improve immediately after the construction of the fish passage enhancements. Swim-through upstream passage will not be implemented until year 15. A total lack of passage during this interim period might hinder the restoration of a salmon run in the Union if salmon were present. However, the lack of salmon production or stocking in the River, in addition to the presence of an interim trap and truck facility, significantly limits the effect that the lack of swim-through passage will have on the recovery of the species.

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 effects to the environment that would prevent Atlantic salmon from completing their entire life cycle, including reproduction, sustenance, and shelter. The above analysis predicts that the proposed project will lead to an improvement in the numbers, reproduction and distribution of Atlantic salmon. Despite the threats faced by individual Atlantic salmon inside and outside of the action area, the proposed action will not increase the vulnerability of individual Atlantic salmon to these additional threats and exposure to ongoing threats will not increase susceptibility to effects related to the proposed action.

Although the proposed action will increase survival and passage rates for Atlantic salmon in the action area compared to current conditions, the continued existence of the two dams and the operation of the Ellsworth Project will result in a reduction in the number of Atlantic salmon in the Union River compared to the number that could occur if there was no dam related mortality. While Atlantic salmon mortality caused by the Ellsworth Project will continue to reduce the numbers and reproduction of Atlantic salmon in the Union River, we expect that the passage targets and proposed passage improvements will allow for a self-sustaining run, assuming a sufficient increase in marine survival. Thus, the proposed action is likely to result in an improvement in the status and trend of Atlantic salmon in the Union River, as well as an improvement in connectivity and distribution, and will provide conditions that allow for the potential for recovery of Atlantic salmon in the Union River. Therefore, because the proposed action will increase the likelihood that Atlantic salmon in the Union River can recover, it will not reduce the likelihood that the Downeast Coastal SHRU or the species as a whole can recover. Therefore, the proposed action will not appreciably reduce the likelihood that the GOM DPS can be brought to the point at which they are no longer listed as endangered.

Summary of effects to the survival and recovery of Atlantic salmon

In this section, we summarize the effects 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 appreciably reduce the likelihood of survival 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).

Compared to current conditions, the proposed action is expected to result in an increase in numbers, reproduction, and distribution of Atlantic salmon in the action area. This should result in an increasing population trend for Atlantic salmon in the Union River, which would improve the potential for survival and recovery of the Downeast Coastal SHRU and the DPS. Even compared to a hypothetical future scenario with no dams in the action area, the reduction in numbers and distribution of Atlantic salmon in the action area is not likely to appreciably reduce the ability of the Union River to support a self-sustaining run of Atlantic salmon of sufficient size, reproductive potential, and distribution. While we are not able to predict with precision how climate change will impact Atlantic salmon in the action area, or how the species will adapt to climate change-related environmental impacts, no additional project effects related to climate change to Atlantic salmon in the action area are anticipated over the life of the proposed action (i.e., through the license period of the project). We have considered the effects of the proposed action in light of cumulative effects explained above, and have concluded that even in light of the ongoing impacts of these activities and conditions including climate change; the conclusions reached above do not change. Based on the analysis presented herein, the proposed action is not likely to appreciably reduce the survival and recovery of the species.

8.2. Adverse Modification Analysis

We consider the impacts of the proposed action on critical habitat designated in the Downeast Coastal SHRU, and whether the proposed action and its' consequences are likely to result in the destruction or adverse modification of critical habitat designated for the Gulf of Maine DPS of Atlantic salmon. On February 11, 2016, NMFS and USFWS published a revised regulatory definition of "destruction or adverse modification" (81 FR 7214). Destruction or adverse modification "means a direct or indirect alteration that appreciably diminishes the value of critical habitat for the conservation of a listed species. Such alterations may include, but are not limited to, those that alter the physical or biological features essential to the conservation of a species or that preclude or significantly delay development of such features." As described in the preamble to the proposed rule for the revised definition (79 FR 27060, May 12, 2014), the "destruction or adverse modification" definition focuses on how Federal actions affect the quantity and quality of the physical or biological features in the designated critical habitat for a listed species and, especially in the case of unoccupied habitat, on any impacts to the critical habitat itself. Specifically, the Services will generally conclude that a Federal action is likely to "destroy or adversely modify" designated critical habitat if the action results in an alteration of the quantity or quality of the physical or biological features of designated critical habitat, or that precludes or significantly delays the capacity of that habitat to develop those features over time, and if the effect of the alteration is to appreciably diminish the value of critical habitat for the conservation of the species.

According to the 2019 Atlantic salmon recovery plan (USFWS and NMFS 2019), recovery of Atlantic salmon will require at least 30,000 units of accessible and suitable spawning and rearing habitat in each SHRU including the Downeast Coastal SHRU. Presently, approximately 28,500 units (95% of the recovery criteria) are currently considered fully accessible in the Downeast Coastal SHRU. Habitat upstream 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. The Union River contains 14,341 modelled habitat units, of which 97% (i.e., 13,337 units) are above the Ellsworth Dam. As such, we expect an additional 13,337 habitat units will become accessible within the SHRU once upstream and downstream performance standards are achieved and verified at the Ellsworth Project. Therefore, the goal of achieving 30,000 units of accessible and suitable spawning and rearing habitat in the Downeast Coastal SHRU is expected to occur over the next 18 years.

As explained in Section 6.4, we have determined that the action is likely to adversely affect PBFs SR 1-7 and M 1-4. 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 for the conservation of the Gulf of Maine DPS of Atlantic salmon. This analysis takes into account the geographic and temporal scope of the proposed action, recognizing that "functionality" of critical habitat necessarily means that it support the conservation of the species and progress toward recovery both now and in the future. 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.

We consider the impacts to the physical and biological features of spawning and rearing habitat (SR 1-7) and migratory habitat (M1, M2, M3 and M4) in the project area within the context of the conservation value of critical habitat in the Downeast Coastal SHRU and the GOM DPS as a whole. In doing so, we must consider whether any reduction in quality of the critical habitat within the action area appreciably diminishes the value of critical habitat for the conservation of the species.

We identified that the effects to the spawning and rearing PBFs are primarily associated with the maintenance of the Graham Lake impoundment, and the water level fluctuations associated with dam operation. These effects likely render the mapped spawning and rearing habitat in the tailrace of the dam non-functional. However, the amount of habitat units in that reach (i.e., 8 units of spawning habitat; 184 units of rearing habitat) is relatively small when compared to the amount of habitat available in the tributaries to the lower Union River, and to the habitat that is present in the West and East Branches of the river upstream of the action area. The amount of rearing habitat affected is only 2% of what MDIFG identified in their 1961 survey; whereas the amount of spawning habitat is less than 0.5% of what was documented (MDIFG, 1961a). Given the relatively small loss of habitat when compared to the amount present within the Union River, we do not consider that the proposed action will significantly affect the production potential of the spawning and rearing habitat within the Downeast Coastal SHRU.

We anticipate that the effects of the action will allow for the functioning of migration habitat in the action area, although not immediately. Safe and effective downstream passage for Atlantic salmon will not be implemented and verified until five to nine years after the issuance of the license. Similarly, upstream passage will not be constructed and evaluated until year 18 of the license. This constitutes a substantial delay when you consider the current condition of the species. However, there is abundant habitat currently available in the other Downeast Rivers, most of it vacant or under-utilized by salmon. Although we believe that the habitat in the Union will be necessary in order to achieve recovery goals over the long term, its conservation value is low in the short term as very few salmon occur in the river. Given the amount of underutilized habitat in the Downeast rivers that currently host salmon runs, we do not anticipate a time in the next 18 years where the impediments to passage in the Union River will be the limiting factor in the recovery of Atlantic salmon to the Downeast Coastal SHRU. The other five rivers in the Downeast SHRU have abundant accessible habitat, host locally adapted salmon stocks, and have benefited from a concerted decades-old restoration effort. Conversely, the Union River salmon run was extirpated more than a century ago, and the threats posed by the Ellsworth Project have significantly limited the value of any potential restoration efforts or a substantial stocking program. Once the effects of the project have been minimized adequately, we anticipate that restoration of the Union River will become a priority in the Downeast Coastal SHRU. However, it will take time to adequately implement improvements at the Project and to verify their effectiveness. Given these factors, we do not anticipate that the project timeline will substantially affect the timing of the recovery of Atlantic salmon in the Downeast Coastal SHRU.

Therefore, as we anticipate that the effects of the proposed action will not appreciably diminish the value of critical habitat for the conservation of the Downeast Coastal SHRU, 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 effects of the action, 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. The action is also not likely to adversely affect shortnose sturgeon or any DPS of Atlantic sturgeon.

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."*[8] For use on an interim basis, 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").

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 Black Bear 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 Black Bear 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 effects 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 nine years of monitoring and adaptive management to achieve the downstream smolt performance standard of 90% (approximately 95% per dam). 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 a low as 58% (42% mortality) during the first part of this adaptive management period. As described in the effects of the action section (Section 6), we anticipate that survival will increase over the course of the

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

license. This ITS exempts the following amount of annual take for smolts in the action area (Table 13).

Table 13. Anticipated smolt mortality (rounded to the nearest %) at the Ellsworth Project (Ellsworth and Graham Lake Dams, cumulative) during the term of the new license.

Condition	Timing	Passage Mortality	HDM*	Total**
Existing	Year 1-2	42%	9%	47%
Downstream Measures	Year 3-9	26%	9%	32%
Performance Standard	Year 10-Exp	10%	6%	15%

*Hydrosystem Delayed Mortality
** Total Mortality= 100% - ((100% - Passage Mortality) x (100% - Hydrosystem Delayed Mortality))

In addition to mortality, we anticipate that the proposed action will lead to the sublethal injury of 7.4% of smolts prior to the fishway improvements in year two of the license. After the implementation and verification of passage improvements (by year nine of the license), we anticipate that sublethal injury will be reduced to 5.1% due to fewer fish passing via the turbines.

In addition to the direct effect of dam passage, it is anticipated that some proportion of smolts that survive passage at Ellsworth could die in the estuary due to migratory delay and sublethal effects of dam passage. Stich et al. (2015) estimated this hydrosystem delayed mortality to be approximately 6% for each dam passed during the freshwater migration. Although a similar study has not been conducted on the Union River, the mortality rate can be assumed to be similar. However, we estimate that delayed mortality from passage at Graham Lake Dam is lower due to the lack of turbine passage. Therefore, we anticipate that delayed mortality under current conditions is 9% (6% for the Ellsworth Dam + 3% for the Graham Lake Dam). Migratory delay and sublethal injury are rationally connected to hydrosystem delayed mortality as they are believed to be the causative factors contributing to this effect. We believe that the proposed action will reduce both of these factors, and therefore we anticipate that there will be a reduction in delayed mortality. As indicated in section 6.2.2.1, we anticipate that hydrosystem mortality will be reduced to 6% after the implementation and verification of downstream passage improvements (by year nine of the license).

Hydrosystem delayed mortality is difficult to monitor using traditional telemetry methods. In circumstances where we cannot effectively monitor take, we use a proxy to estimate its extent. The proxy must be rationally connected to the taking and provide an obvious threshold of exempted take which, if exceeded, provides a basis for reinitiating consultation. For this proposed action, the known migratory delay (>24 hour residence time per dam) and sublethal injury rate at the Project provides a proxy for estimating the amount of incidental take associated with hydrosystem delayed mortality. We will consider take associated with hydrosystem delayed mortality (i.e., 9% (year 1 to 9) and 6% (year 10 to expiration)) to have been exceeded if smolts monitored during the proposed downstream passage studies exceed what we expect for migratory delay (i.e., 33% and 12% for Graham Lake Dam and Ellsworth Dam, respectively (year 1 to 9) and 92.5% per dam (year 10 to expiration)) or sublethal injury rates (i.e., 7.4% (year 1 to 9) and 5.1% (year 10 to expiration)).

Kelts

The best available information indicates that 96% of kelts survive passage at the Ellsworth Project under existing and proposed conditions. Therefore, this ITS exempts the death or injury of up to 4% of kelts migrating in the action area annually.

Pre-Spawned Adults

It could take up to 18 years to verify that the upstream adult salmon performance standard of 90% (approximately 95% per dam) has been achieved. This is based on the proposal to construct the fishways in the 15th year of the license, and to verify that the standard has been achieved in a one to three year study. The best available information indicates the existing upstream fishway at the project has a minimum efficiency of 50%. Therefore, up to 50% of pre-spawn Atlantic salmon in the action area could be impacted during the first 15 years of the license. An expert panel convened by NMFS determined that a small proportion of fish that fail to pass a given hydro project will die, and that the rest will stray. We have estimated that 2% of the fish that fail to pass the Ellsworth Dam, and 1% of the fish that fail to pass the Graham Lake Dam, will die. Given the increase in passage efficiency expected with fishway construction, we expect that the proportion of the run that dies or strays will be significantly reduced (Table 14). Fish that fail to pass the fishway, but do not die (49% of the run (year 1-15), and 4.90% (year 15 to expiration)), are harassed, and potentially harmed, due to the energetic costs of delay, and by forcing a change in their natural reproductive behavior; either by spawning in potentially less suitable habitat downstream or in other rivers, or by dropping back into the ocean without spawning.

Migratory delay can lead to adverse energetic effects that reduce the likelihood that salmon will successfully spawn and outmigrate to the estuary. We therefore conclude that salmon that take more than 96 hours (48 hours per dam) to pass the project will be harassed. We anticipate that 50% of salmon will be delayed by more than 96 hours prior to the construction of the new fishways, and 25% will be delayed by more than 96 hours after fishway construction.

Table 14. The anticipated fate of pre-spawn Atlantic salmon that attempt to pass upstream of the Ellsworth Project. As all salmon will be trucked around Graham Lake Dam until year 15 of the license we do not expect that any will attempt to pass the project, and thus none are anticipated to stray or die from the attempt.

	Ellsworth Dam		Graham Lake Dam	
	Years 1-15	Year 16 to exp.	Years 1-15	Year 16 to exp.
Pass Successfully	50.00%	95.00%*	NA	95.00%
% Die	1.00%	0.10%	NA	0.05%
Spawn in habitat downstream	0.00%	0.00%	NA	4.95%
Stray to another river	49.00%	4.90%	NA	0.00%

*The proposed project passage standard is 90%, which equates to approximately 95% per dam.

Given the expected small number of returning prespawn adult salmon in the first 15 years of the license, we do not believe that the mortality rate described above equates to any fish being killed due to upstream passage inefficiencies. Stocking may occur after the standard has been achieved, but given the higher passage efficiency we expect that very few will die. Therefore, we anticipate that no more than one prespawn adult will be killed over the duration of the license term.

Every prespawn salmon that is trapped at the project during the first 15 years of the license will be subjected to trapping, handling, and trucking. We anticipate that effects from these activities lead to minor stress and injury (due to potential scale loss and fin clipping), but that they will not be harassed as we do not expect that migration will be significantly disrupted. As indicated above, we expect that very few salmon (no more than 2 per year) will pass the project during the first 15 years of the license.

Fish Passage Monitoring

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 3,000 smolts. Of these, up to 2% are expected to die due to handling and tagging.

To study the effects of dam passage on upstream adults, up to 240 adults will be surgically implanted with radio tags during the studies. Up to 2% of the study fish are expected to die due to handling and tagging.

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 July 2019 Final Environmental Assessment (FEA) for Hydropower License for the Ellsworth 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 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 the amount and extent of take exempted in the ITS of this Opinion.
2. FERC must ensure, through enforceable conditions of the Project license, 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.

10.2.1. Terms and Conditions

In order to be exempt from the prohibitions of section 9 of the ESA, FERC and Black Bear 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 Black Bear to do the following:

1. Prepare in consultation with us a plan to measure the survival performance standard for downstream migrating Atlantic salmon smolts and kelts at the Ellsworth Project. The need for studies will be confirmed in annual consultation with NMFS.
    a. Require Black Bear to measure the survival of downstream migrating Atlantic salmon smolts and kelts at the Ellsworth Project using a scientifically acceptable methodology.
        i. Measure the survival of downstream migrating smolts approaching within 200 meters of the dams downstream to the point where delayed effects of passage can be quantified.
        ii. Measure the survival of downstream migrating kelts approaching within 200 meters of the dams downstream to the point where delayed effects of passage

can be quantified. To make the best use of fish, this study should coincide with the three-year upstream passage study (Term and Condition #3).

iii. A Cormack-Jolly-Seber (CJS) model, or other acceptable approach, must be used to determine if the survival estimate and associated error bounds are within the scope of published telemetry work for salmon in the region.

iv. Black Bear must consult with us concerning the application of appropriate statistical methodology and must provide an electronic copy of model(s) and data to us.

v. In consultation with NMFS, Black Bear must design and conduct a one to three year study to compare smolt mortality through the Graham Lake impoundment with a reference reach that is unimpacted by the project, and is of sufficient length to adequately measure background mortality in the Union River. To make the best use of study fish, this study should coincide with the smolt survival studies conducted after the implementation of downstream fish passage improvements at the Ellsworth and Graham Lake Dams.

vi. Conduct a smolt injury assessment as part of the smolt survival studies. This can be done either as a field study, or as a desktop analysis using passage route selection information and the known injury rate of each of the possible passage routes at the Ellsworth Project.

b. All tags released in the system must 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 standard achieved if, based upon an average of three years, 90% (cumulative survival through both dams) of smolts and kelts survive downstream passage at the Ellsworth Project. If, after the first or second year of each three-year evaluation, it is determined that it is statistically impossible or improbable that the standard can be met, the study will cease and additional measures will be installed as soon as possible.

2. Require that Black Bear develop and implement an adaptive management strategy to address downstream passage inefficiencies at the Graham Lake Dam.
    a. Studies conducted to verify adherence to the performance standard at Graham Lake Dam must occur after measures have been implemented to increase survival both within the headpond (within 200 meters of the dam) and through the fishway itself.
    b. Concurrent with the first year of smolt survival studies, conduct a one-year study to investigate the potential causes of Atlantic salmon smolt mortality within 200 meters of the Graham Lake dam.
    c. An adaptive management plan must be developed in consultation with NMFS that includes a proposal to identify and ameliorate the potential sources of mortality in the Graham Lake Dam headpond. The plan must include a description of any studies that will be conducted, as well as how they will inform the development of specific passage measures.

        i. The plan must include specific structural or operational measures that will be implemented prior to the study that will improve passage survival through the Graham Lake Dam fishway itself (e.g., sluice or chute). The study required in T&C 2b should include a component that evaluates the effectiveness of this measure.
   d. The adaptive management plan must be completed no later than one year after license issuance.

3. Prepare in consultation with NMFS a plan to evaluate the adequacy of the existing fishway entrance location at the Ellsworth Dam, and to measure the passage performance standard at the new fishways for upstream migrating pre-spawned Atlantic salmon at both the Ellsworth and Graham Lake Dams. The need for studies will be confirmed in annual consultation with NMFS.
   a. Require Black Bear to measure the passage efficiency 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 determine if the survival estimate and associated error bounds are within the scope of published telemetry work for salmon in the region.
        ii. Black Bear must consult with us concerning the application of appropriate statistical methodology and must provide an electronic copy of model(s) and data to us.
        iii. As a component of their upstream passage studies, Black Bear must monitor the effect of migratory delay caused by fish passage inefficiencies at the Ellsworth and Graham Lake Dams. Among other factors, the study must address the energetic costs associated with delay.
   b. All tags released in the system must 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 two-years, 90% (cumulative passage through both dams) of pre-spawned adult Atlantic salmon approaching the project successfully pass upstream the project.
   d. Require Black Bear to develop a plan, in consultation with the agencies, to stock uniquely marked Atlantic salmon smolts (or other appropriate lifestage) upstream of the Ellsworth Project. These fish will serve as a source of imprinted adult fish (i.e., fish homing to areas upstream of Ellsworth Dam) for up to six years of upstream effectiveness testing. Stocking will occur on a timeline developed with NMFS, USFWS, and MDMR. This plan must be provided to NMFS at least two years before smolt stocking is anticipated so that appropriate planning can take place.

To implement reasonable and prudent measure #2, FERC must require Black Bear 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 NMFS weekly during the fish passage season.
2. Notify NMFS of any changes in operation including maintenance activities and debris management at the project during the term of the new license.
3. Remove any debris that could affect the ability of fish to pass either the downstream or upstream fish passages immediately upon inspection.
4. Consult with NMFS annually concerning the replacement of flashboards.
5. Prepare an Operations and Maintenance plan for the upstream and downstream fishways in consultation with resource agencies. The Operations and Maintenance plan must 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.
6. Submit as-built drawings to NMFS for the current configuration of the upstream and downstream fishways.
7. Require that Black Bear seek comments from NMFS on any new fish passage design plans at the 30%, 60%, and 90% design phase.
8. Allow NMFS staff to inspect the upstream and downstream fishways at reasonable times, including but not limited to annual engineering inspection.
9. During years when the trap and truck operations are in place for upstream migrating Atlantic salmon, FERC must ensure that the following conditions are met to minimize the potential for injury and mortality of adult Atlantic salmon, reduce delay, and monitor the actual amount of take:
    a. The fishway must be operational each year from May 1 until November 15 and operated daily from 7:00 am – 6:00 pm, or 1 hour before sunset in the spring/fall
    b. Tending Frequency:
        a. May 1 – July 15: Minimum of at least three times per day (9:00 am, 1:00 pm, and 6:00 pm, or 1 hour before sunset)
        b. July 15 – November 15: Minimum or twice per day (~10:00 am & 1 hour before sunset)
    c. Black Bear staff must be on site during river herring harvest and stocking operations in May/June.
    d. All persons operating the trapping facility must be familiar with Maine DMR's trapping protocols, and aquaculture suspect identification protocol, and must participate in Maine DMR's training on the proper handling of Atlantic salmon.
    e. Prior to using the alewife harvest hopper, the hopper shall be inspected by Maine DMR.
    f. Prior to lifting any alewife from the fishway for the purpose of harvesting, the trap will be partially lifted such that it remains in three feet of water and evaluated for the presence of adult Atlantic salmon. Any Atlantic salmon found will be netted and removed following established protocols.

g. Atlantic salmon samples and data (in a format compatible with the Maine DMR database) collected by Black Bear shall be cataloged and provided to Maine DMR, with a copy of all data being submitted to NMFS.
h. Black Bear must adhere to Maine DMR's salmon handling protocol as described in Maine Department of Marine Resources Suspected Aquaculture Origin Atlantic Salmon Identification and Notification Protocol and DMR trap (AQSP) and Fish Handling Protocol.
i. If a visual inspection of fish (step 1of AQSP) indicates restoration fish, then
    i. Collect biological data per the adult handling protocol
    ii. Collect scale samples from every adult Atlantic salmon (step 3 of AQSP).
    iii. Apply an adipose punch if an adipose fin exists; otherwise, apply an upper caudal fin punch. Insert other tag (e.g., floy, PIT), as appropriate.
    iv. Transport the Atlantic salmon to the release site above Graham Lake.
j. If visual inspection of the adult Atlantic salmon (Step 1 of AQSP) suggests aquaculture escapee, then hold the salmon in a suitable tank with appropriate dissolved oxygen levels and call Maine DMR for further instructions, which could include: (Collect scale sample, mount on slide, send picture of scale to MDMR staff and await further instructions)
    i. If no response from Maine DMR, then collect scale, apply punch (retain tissue for genetic analysis), floy-tag, and release fish to the tailwater (see step 4 of AQSP)
k. If Maine DMR suspects the Atlantic salmon is an aquaculture escapee (step 6 of AQSP), then hold fish for Maine DMR. If Maine DMR believes the scale pattern is inconclusive Maine DMR will advise that the Atlantic salmon be transported to upstream release site.

10. Contact NMFS within 24 hours of any interactions with Atlantic salmon, including non-lethal and lethal takes (Dan Tierney: by email (Dan.Tierney@noaa.gov) or phone (207) 866-3755 and to: incidental.take@noaa.gov. By December 31 of each year, an annual report summarizing this information must be provided to NMFS to document the take level from all sources and all life stages.
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.

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 Black Bear will be required to measure and monitor the success of the proposed performance standards. Term and Conditions #1 and #3 require that Black Bear measure their adherence to the passage standards in a way that is statistically sound and appropriate. Term and Condition # 3 describes measures that must be taken at Graham Lake Dam to identify passage measures that can be implemented to meet Black Bear's commitment to achieve a passage standard. 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 Black Bear are necessary and appropriate 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. These terms and conditions also describe the protocol Black Bear must follow to adequately minimize effects to individual salmon that are captured at the trap. During years when the trap and truck operations are in place for upstream migrating Atlantic salmon, FERC and Black Bear must minimize the potential for injury and mortality of adult Atlantic salmon, reduce delay, and monitor the actual amount of take. 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.

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 Union River. This could involve the removal of other barriers to fish migration in the watershed, or the construction of fishways. Compensatory funds could also be deposited in an in-lieu fee (ILF) program, such as the Atlantic Salmon

Restoration and Conservation Program (ASRCP), sponsored by the Maine Department of Marine Resources (https://www.maine.gov/dmr/science-research/searun/programs/ilffacts.html). FERC and the licensee should work closely with the state and federal fisheries agencies to identify suitable projects that 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, 30 to 50 year license for the Ellsworth 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 Black Bear not carry out the non-discretionary RPMs or associated Terms and Conditions contained within this Opinion.

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Attachment 1: Estimation of smolt survival at the Ellsworth Dam after proposed fishway improvements have been implemented.

Expected Increase Based upon Full Depth Racks at Orono Dam		
Orono 2010 Partial Depth - Bypass Efficiency	44/104	42%
Orono Total efficiency Full Depth[1]	97/176	55%
Orono 2014 Full Depth - Bypass Efficiency	27/45	60%
Orono 2015 Full Depth - Bypass Efficiency	29/64	45%
Orono 2016 Full Depth - Bypass Efficiency	41/67	61%
Change in Efficiency (55%-42%)		13%

Lockwood Rigid Fish Guidance Boom Efficie	Bypass Fish/Total Canal Fish	Bypass Eff.
2007 With No Boom	8/45	17.78%
2013 w Boom	33/64	51.56%
2014 w Boom	10/19	52.63%
2015 w Boom	29/54	53.70%
Total	72/137	52.55%
Difference		34.78%

		Unit 1	Unit 2	Unit 3	Unit 4	Bypass	Spillway[2,3]	Bypass Eficiency	Survival
2016	route choice	0	23	16	0	25	0		
	route survival	81.00%	69.20%	69.20%	100.00%	96.00%	96.2%		
2017	route choice	32	24	16	0	8	37		
	route survival	81.00%	62.40%	62.40%	100.00%	96.20%	96.2%		

Overall	route choice	32	47	32	0	33	37	22.92%	
	route survival	81.00%	65.73%	65.80%	100.00%	96.05%	96.20%		80.20%
		Unit1[3]	Unit 2	Unit 3	Unit 4	Bypass	Spillway		Survival
Full Depth Racks[2,4] 100%Bypass Survival	Expected Route Choice	32	41	28	0	43	37	36.03%	
	Expected Survival	81.00%	65.73%	65.80%	100.00%	100.00%	96.20%		82.88%

		Unit1	Unit 2	Unit 3	Unit 4	Bypass	Spillway		Survival
Full Depth Racks plus Fish Screen[5,6]	Expected Route Choice	13	17	12	0	102	37	70.81%	
	Expected Survival	81.00%	65.73%	65.80%	100.00%	100.00%	96.20%		92.40%
						Increased Attraction Flow		2%	94.40%

With Unit 1 Shut Down for 15 days

		Unit1[3]	Unit 2	Unit 3	Unit 4	Bypass[8]	Spillway[8]		Survival
Full Depth Racks[2,4] 100%Bypass Survival	Expected Route Choice	0	41	28	0	59	53		
	Expected Survival	81.00%	65.73%	65.80%	100.00%	100.00%	96.20%		85.90%
		Unit1	Unit 2	Unit 3	Unit 4	Bypass	Spillway		Survival
Full Depth Racks plus Fish Screen[5,6]	Expected Route Choice	0	17	12	0	109	43		
	Expected Survival	81.00%	65.73%	65.80%	100.00%	100.00%	96.20%		93.67%
								2%	95.67%

1. The Orono station went through a complete rehab prior to 2014 which included an additional powerhouse, a modified downstream fish passage, full depth

instead of partial depth racks, and a portion of the racks angled

2. This value estimates a change in route selection of fish attracted to the intake bays related to installation of full depth 1-inch racks. Fish attracted to the spillway were not considered.

3. Since there is no proposal to make the Unit 1 racks full depth, we have assumed no change.

4. Assumed trashrack spacing does not influence attraction to the Spillway

5. This rough calculation is for salmon smolts based on field testing of survival. Juvenile alosines are much smaller fish, thus having less probability of blade strike and theortically higher survival.

6. The probability that the powerhouse is not operating at full capacity is higher during downstream alosid passage than for smolt passage, thus it is likely that more fish will use the bypass

7. The attraction flow over the outer weir is going to be increased from 20 cfs to 120 cfs. A conservative assumption of 2% increased survival has been made for this improvement. Note that the walls to the weir will also be tapered similar to the Alden Weir at Graham lake which made about a 60% increase in survival.

8. Assumes 0 Fish through Unit 1 and divides those fish equally amongst spillway and Bypass.