NATIONAL MARINE FISHERIES SERVICE
ENDANGERED SPECIES ACT
BIOLOGICAL OPINION

Agency: Federal Energy Regulatory Commission (FERC)

Activity Considered: Proposed amendment of the license for the Brunswick (FERC No. 2284) and Lewiston Falls (FERC No. 2302) Hydro Projects

GARFO-2020-02015

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

Date Issued: December 28, 2021

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1. Introduction and Background

This is 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 approval of applications to amend the operating license for the Brunswick and Lewiston Falls Projects to incorporate provisions described in a proposed species protection plan (SPP). The amended licenses would be in effect until the conclusion of the next relicensing process, which is currently anticipated to occur by February 28, 2029, for the Brunswick Project, and by August 31, 2026, for the Lewiston Falls Project. The Brunswick and Lewiston Falls Projects are existing hydroelectric projects located on the Androscoggin River, Maine. The Brunswick Dam is located at the head of tide and is the first dam on the River. The Lewiston Falls Project is the fourth dam on the River, upstream of Brunswick and two additional dams (the Pejepscot and Worumbo Projects). We note here that we are considering two independent federal actions (i.e., amendment of two licenses issued under the Federal Power Act for two independent hydropower projects) in this one Opinion.

In a letter dated June 13, 2019, FERC designated Brookfield White Pine Hydro, LLC (BWPH or Licensee) as their non-federal representative to conduct informal ESA consultation with us. In a December 31, 2019, letter to FERC, BWPH requested that FERC amend the licenses for the Brunswick and Lewiston Falls Projects to incorporate the provisions of a SPP for Atlantic salmon, Atlantic sturgeon, and shortnose sturgeon. On June 26, 2020, FERC submitted a Biological Assessment to us along with a request for formal consultation on the effects of project operations pursuant to the proposed license amendments. In a letter to FERC on July 30, 2020, we requested clarification on the proposed action, as well as additional information regarding the operation of the existing upstream fishway at the Brunswick Project. BWPH filed the requested information with FERC on April 12, 2021. On April 29, 2021, FERC once again requested formal consultation with us. Because the license amendments would only be in effect until the current Brunswick and Lewiston Falls licenses expire, this Opinion only considers the effects of the projects on listed species for that period. Issuance of any new license for the period beyond the expiration of the existing licenses is a separate federal action that will require new section 7 consultations. Therefore, the take exemption included in the Incidental Take Statement included with this Opinion is only in effect for the period in which the facilities would be operated in accordance with the SPP; that is, any take exemption included with this Opinion is effective only for the period of time considered in this Opinion and does not extend beyond the current licenses. It is our expectation that upon receipt of this Opinion, FERC will issue a license amendment for each project, which incorporates the measures contained in the SPP as well as any terms and conditions from the Incidental Take Statement.

This Opinion is based on information provided in FERC's June 26, 2020, Biological Assessment and SPP, as well as BWHP's fishway operation and maintenance plan (filed with FERC on April 12, 2021). A complete administrative record of this consultation will be maintained at our Maine Field Office in Orono, Maine. Formal consultation was initiated on April 29, 2021.

1.1 Consultation History

- **June 13, 2019 –** FERC designated FPL Energy to act as its non-federal representative in conducting informal consultation under section 7 of the ESA regarding federally listed species at the Brunswick and Lewiston Falls Projects.
- **March 6, 2019; March 29, 2019; April 24, 2019; June 6, 2019; August 30, 2019 (site visit); September 27, 2019** – Meetings were held by BWPH with the state and federal agencies to discuss the Brunswick and Lewiston Falls SPP.
- **December 31, 2019** – BWPH submitted a draft Biological Assessment and Species Protection Plan to FERC.
- **June 26, 2020** – FERC adopted BWPH's BA and SPP and requested formal ESA consultation with us.
- **July 30, 2020** – NMFS responded to FERC's request for formal consultation indicating that additional information was needed regarding the operation and maintenance of the existing vertical slot fishway and trap at the Brunswick Project.
- **August 11, 2020** – FERC ordered BWHP to work with the fisheries agencies to revise their fishway operations and maintenance plan and then file it so that it can be incorporated into the BA and SPP.
- **December 3, 2020** – Brookfield met with NMFS, USFWS, MDMR, and MDIFW regarding the revisions to the Passage Operations and Maintenance Plan.
- **April 12, 2021 --** BWHP filed a revised fishway O&M plan for the Brunswick Project with FERC.
- **April 29, 2021** – FERC incorporated the revised fishway O&M plan into their consultation request, adopted the BA and SPP, and submitted a letter to us requesting the initiation of formal consultation.
- **May 24, 2021** – NMFS submitted a letter to FERC indicating that all of the information required to initiate a formal consultation for the project had been received.

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 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 so, we must identify a reasonable and prudent alternative(s) (RPA) to the action as proposed 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 Brunswick and Lewiston Falls Projects were constructed prior to the listing of any endangered species under our jurisdiction and are currently licensed by FERC to operate until February 28, 2029 and August 31, 2026, respectively. While the ESA provides broad authority to protect threatened and endangered species in the U.S., we must consider the action at hand in the context of this section 7 consultation. In this matter, the action triggering the section 7 consultation is the proposed amendment of two existing FERC licenses to incorporate specific measures to protect ESA-listed species. The proposed action is not the issuance of a new license by FERC to operate the hydropower projects at these dams, as they are already licensed to operate. It is, therefore, necessary to draw a distinction in our analysis between certain ongoing effects of the projects that are part of the environmental baseline versus effects of the proposed actions. For instance, some effects of the dams are associated with the lawful existence of the physical structures in the river. As FERC does not have discretionary authority to decommission or remove a dam outside of a relicensing proceeding (60 FR 339 1995), some effects (e.g., the effects of the physical presence of the dam including the existing impoundment, sediment loading, water quality)[1] must be considered as part of the environmental baseline. Therefore, only the effects associated with the proposed amendment to alter aspects of the projects and their operations to protect Atlantic salmon (e.g. passage effectiveness, passage survival, migratory delay) and the implementation of studies (e.g. handling, tagging), which are consequences of the operation of the facility consistent with the terms of the proposed license amendment, are effects of the proposed action.

The critical habitat analysis determines whether the proposed action will destroy or adversely modify designated critical habitat for ESA-listed species by examining any change in the

[1] In the context of relicensing, where FERC does have discretionary authority to deny a license, or decommission, or remove a dam, some or all of these effects would be considered effects of the proposed action.

conservation value of the physical and biological features of that critical habitat. As defined by NMFS and USFWS, destruction or adverse modification "means a direct or indirect alteration that appreciably diminishes the value of critical habitat 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).

2. PROJECT DESCRIPTION AND PROPOSED ACTION

As noted above, this consultation is considering the effects of two independent federal actions. FERC is proposing to amend the licenses for the Brunswick and Lewiston Falls hydropower projects, pursuant to authorities under the Federal Power Act, to incorporate provisions of a species protection plan.

2.1 BRUNSWICK

The Brunswick Project is located at river mile 6 at the head of tide, and is the first dam on the mainstem of the Androscoggin River. The dam and powerhouse span the Androscoggin River immediately above the U.S. Route 201 Bridge connecting Topsham and Brunswick, at a site known as Brunswick Falls. The Brunswick Project includes a 300-acre reservoir, a 605-foot long and 40-foot high concrete gravity dam, a gate section containing two Taintor gates and an emergency spillway, and a powerhouse and intake. The Project also has a vertical slot fishway, a 21-foot high fish barrier wall between the dam and Shad Island, and a three foot high by 20-foot long concrete fish barrier weir across Granney Hole Stream in Topsham.

The concrete gravity dam consists of two ogee overflow spillway sections separated by a pier and barrier wall. The right spillway section, about 128-foot-long, is topped with wooden flashboards that are 2.6 feet high. The left section does not have flashboards. The intake structure and powerhouse are integral with the dam and located adjacent to the Brunswick shoreline. The powerhouse contains three vertical propeller turbine generators. Unit 1 has a hydraulic capacity of 4,400 cubic feet per second (cfs), and units 2 and 3 have a hydraulic capacity of 1,200 cfs. The trashracks in front of the turbines have 3.5-inch rack spacing.

The Brunswick Project normally operates as run of river. Due to the on/off nature of the units and the small pond available, the pond fluctuates to allow the units to operate efficiently; however, the pond is too small to store water for any significant amount of peaking. Thus, the station is considered run of river. Impoundment drawdowns are generally limited to less than two feet below the top of the spillway.

Downstream of the dam's spillway, the riverbed consists of broad ledges interspersed with one large pool and a few smaller pools. Immediately to the south of the spillway is a concrete retaining wall that separates the tailwater area from the spillway ledge area. Along the downstream end of the spillway area is a naturally occurring rock ledge that acts as a natural barrier to fish. In the 1980s, concrete caps were added to portions of the ledge to create a more effective barrier to fish access. The ledge is approximately 520 feet long, 15 feet wide, and six feet high (at high tide). This substantial barrier serves to prevent fish from being drawn up into the ledges near the spillway portion of the dam during periods of large spill.

Upstream fish passage at Brunswick is provided via a vertical slot fishway and associated trap, sort, and truck facility that were installed in 1983. The fishway is 570 feet long and consists of 42 individual pools, with a one-foot drop between each. The trapping facility, located at the upstream end of the fishway, provides biologists the opportunity to collect data on migratory and resident fish species that use the fishway. As fish swim to the top of the fishway, fixed grating guides them past a viewing window and into a 500-gallon capacity fish hoist (trap). The hoist elevates the fish to overhead sorting tanks where staff sort and pass fish upstream. Atlantic salmon pass upstream above the 40-foot dam after biological data are collected. The fishway is currently operated between May 1 and November 15. During the period of fishway operation, an attraction flow of 100 cfs is provided.

The Brunswick fishway facility is maintained by the licensee; however, since its construction, Maine Department of Marine Resources (MDMR) personnel have operated the fishway each season under prior agreement. Although the fishway was designed and constructed to be a volitional fishway that could be operated 24-hours a day; it is currently operated as a trapping facility due to the State of Maine's concerns regarding the potential spread of invasive species, particularly white catfish. This reduced operation affects the effectiveness of the fishway as fish can only pass when it is being staffed. BWPH's Fishway Operations and Maintenance (O&M) Plan (filed with on April 12, 2021) indicates that during the river herring and shad season (prior to August 1) all fish are lifted to the sorting facility and all invasive species are returned to the tailrace. Following the river herring and shad season, for the timely passage of Atlantic salmon, the fishway may be operated volitionally (such as when river temperatures exceed 23°C) but only if it can be confirmed that an invasive species is also not in the upper flume in the vicinity of the upstream gate. Should an invasive species be present, that fish will be dip netted from the upper flume and returned to the tailrace prior to opening the upstream gate and allowing the Atlantic salmon to pass. If water temperatures make it unsafe to handle Atlantic salmon, they are allowed to volitionally swim through the fishway without being handled.

The Brunswick fishway is shutdown annually for maintenance and repair in the month of August. As indicated in the Fishway O&M plan, annual maintenance requiring the shutdown of upstream fishways is conducted during the first two weeks of August, and the fishway is not shut down for any longer than it takes to make the necessary repairs.

Downstream passage is provided at the Brunswick Project via a surface sluice and associated 18-inch pipe that discharges fish into the project tailrace. The existing sluice gate and pipe were installed in 1983. The sluice is located along the face of the powerhouse between units one and two.

2.1.1 Proposed Action

Upstream Fish Passage

The Brunswick Project has a vertical slot fishway that provides upstream passage for Atlantic salmon, as well as other anadromous and resident species. Shortnose and Atlantic sturgeon are not passed at the project, but are returned to the river downstream (see sturgeon handling plan). Under the terms of this SPP, as well as the Brunswick O&M plan, the vertical slot fishway will be operated as follows:

1. The Licensee will continue to operate the existing vertical slot fishway for upstream passage for the period May 1 through November 15, as river conditions allow[2]. The Licensee and MDMR will continue to cooperate on the operation of the fishway for use by Atlantic salmon, as well as river herring and American shad.
2. The fishway will be operated to trap and sort all fish species, including Atlantic salmon. All Atlantic salmon will be released to Brunswick impoundment to continue their upstream migration.
3. The Licensee will undertake measures necessary to keep the fishway in good operating condition. If the fishway malfunctions or becomes inoperable during the critical fish passage operation months, the Licensee will repair the fishway and restore it to normal operation as soon as can be safely and reasonably done.
4. The Licensee and/or MDMR will maintain records of all fish moved via the fishway, including detailed records of Atlantic salmon moved via the fish lift, including an assessment of size, age, and condition.
5. During periods of fishway operation when the public observation room is open and manned, trained Licensee staff will observe the fishway/trap for Atlantic salmon and will trap and release Atlantic salmon to the impoundment.

As indicated above, consistent with an agreement between the licensee and the State of Maine, the fishway and trapping facility are only operated when it is being monitored for invasive species. To facilitate monitoring for invasive species and Atlantic salmon, BWPH is proposing to install a direct feed remote video monitoring system in 2021 in addition to automating the upstream fishway gate. The camera will be positioned so that observers can view all fish passing the upper flume viewing window. The gate will be operated by onsite staff when they are present, but will also be capable of being operated remotely if no staff are onsite. The camera feed will be checked for invasive species prior to opening the gate to pass a salmon and a riser will be placed in the floor of the flume in front of the window to prevent blind spots.

BWPH and MDMR will operate the fishway on the following schedule:

- May 1 to June 15: MDMR or BWHP staff will monitor the fishway seven days per week daily from 07:00 to 19:00. BWHP seasonal staff and operational staff will provide supplemental coverage as needed.

- June 16 to July 31: MDMR or BWHP staff will monitor the fishway seven days per week daily from 09:00 to 19:00. BWPH seasonal staff and operational staff will provide supplemental coverage as needed.

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[2] Although BWPH proposed to open the fishway beginning on April 15 in their SPP and draft BA, they incorporated an opening date of May 1 in the O&M plan, which was developed in consultation with state and federal fishery agencies after the filing of the SPP and BA. During that consultation, BWPH confirmed with the fishery agencies that salmon are not known to enter the river prior to May 1 (Kelly Maloney, BWPH, personal communication, May 21, 2021).

- August 1 to November 15: BWPH seasonal staff and operational staff will be on site several hours a day to conduct daily checks and cleaning, but may not be onsite from 09:00 to 19:00 every day. The video feed will be monitored, as described above, from 09:00 to 19:00 by fish passage technicians stationed at the Lockwood facility on the nearby Kennebec River during the times that seasonal or operational staff are not onsite and actively monitoring the Brunswick fishway.

MDMR and BWPH staff will trap and sort all fish species, including Atlantic salmon. MDMR will truck alewife from the Brunswick trapping facility and will collect biological information and samples of Atlantic salmon (length, scales, genetic punch and condition) when river temperatures are below 23℃[3]. When river temperatures exceed 23℃ all Atlantic salmon will be passed directly to the headpond without handling. Length and condition will be recorded from observations made from the viewing window. BWPH staff will not handle Atlantic salmon, but will take pictures, estimate length of the fish, and then allow them to pass into the headpond. All Atlantic salmon, American shad, and portions of the alewife run are released to the Brunswick headpond to continue their upstream migration.

A brief August shutdown for maintenance and inspection is typically undertaken during the first two weeks of August. This involves the dewatering of the fishway. In addition, the Brunswick Project units are shut down annually for routine inspection and maintenance, which may require dewatering all or portions of the units.

As a provision of the SPP, the Licensee has proposed to conduct effectiveness studies of upstream migrating adult Atlantic salmon at such time that there are 40 adult salmon returning to the Androscoggin River and observed at the Brunswick Project. BWPH indicates that if returns of Androscoggin-origin Atlantic salmon increase to the point that a meaningful study of adult upstream salmon migration can be undertaken, the Licensee proposes to consult with the fishery agencies about conducting a study at that time.

Downstream Passage

As indicated, downstream passage is provided at the Brunswick Project via a surface sluice and associated 18- inch pipe that discharges fish into the Project tailrace. BWPH proposes to continue operating the sluice for Atlantic salmon smolt and kelt passage from April 1 through June 15 and from November 1 through December 31, as river and ice conditions allow.

As the spillway provides another route for safe passage, BWPH is proposing to ensure that spill occurs regardless of flow in the river. Although the BA and SPP do not indicate the timing of these operational measures, the revised O&M plan indicates that it would be implemented during the month of May. They further define "night time" to be 20:00 (8:00 pm) to 07:00 (7:00 AM). The Project turbine capacity is about 6,800 cfs, and flows in excess of turbine capacity are

[3] The revised O&M Plan filed with FERC on April 12, 2021 indicates that the temperature threshold for handling and taking samples from Atlantic salmon is 21℃. MDMR indicated to us that this is inaccurate, and that the State of Maine's standard protocol is that salmon can be handled below 23℃ (Sean Ledwin, MDMR, personal communication, June 30, 2021).

generally spilled. Therefore, to ensure there are spillway flows during spillway flows, BWPH is proposing to shut down turbines depending on the river flow (Table 1).

Table 1. The operational measures that BWPH propose to implement to ensure that there is spill over the Brunswick spillway at all flows during the smolt migration period.

Total River Discharge (cfs)	Unit Operations
<7,615	Unit 1 - online day; offline night
	Unit 2/3 - both online day; one offline night
7,615 - 18,275	Unit 1 - online day; offline night
	Unit 2/3 - both online day; both online night
>18,275	Unit 1 - online day and night
	Unit 2/3 - online day and night

The Licensee will conduct a bypass bathymetry study to investigate potential for and possible solutions to fish stranding.

Under the provisions of the expired ISPP, the Licensee conducted downstream passage studies of Atlantic salmon smolts at the Brunswick Project in 2013-2015 (Brookfield, 2016). They conducted an additional survival study in 2018 (Brookfield, 2019). In 2018, BWPH monitored the effectiveness of the spill operational measures described in Table 1. Despite only monitoring these measures for a single passage season, BWPH is not proposing to conduct any additional downstream studies at this time. If additional smolt studies are conducted at the upstream Pejepscot Project, they are proposing to consult with the fishery agencies on whether and how to include the Brunswick Project in those evaluations.

As a provision of the new SPP, the Licensee has proposed to conduct effectiveness studies of downstream migrating adult Atlantic salmon kelts at such time that there are 40 adult salmon returning to the Androscoggin River and observed at the Brunswick Project.

Sturgeon Handling and Protection Plan

BWPH has proposed to implement a plan to protect Atlantic and shortnose sturgeon that would be in effect until the expiration of the existing license. This plan addresses how Atlantic and shortnose sturgeon will be handled should they be encountered in the project works, in the fishway, or in the area of ledges/pools downstream of the spillway. Procedures for handling fish and documenting these interactions are outlined below. All personnel counting fish at the fish lift or otherwise handling Atlantic or shortnose sturgeon will be trained to properly handle sturgeon by NMFS or a NNMFS designated representative.

Unit Inspection and Maintenance

Periodically, the Brunswick Project units are shut down for routine inspection and maintenance, which may require dewatering all or portions of the units. For routine inspections and maintenance, the Licensees will reduce the potential for sturgeon interaction with the project by scheduling such activities to occur outside the sturgeon spawning season. There is a known shortnose and Atlantic sturgeon spawning location in the area immediately below the Brunswick Project. At this site, spawning adult shortnose sturgeon are typically present when water temperatures range from 8.5 to 14.5°C (Squiers, 1983). In other northeast rivers, spawning has been documented between 9 and 15°C. These temperatures generally coincide with the months of April and May. By late May, river water temperatures are typically above 15°C, so it is unlikely that shortnose sturgeon will be present in the spawning area after June 1. Atlantic sturgeon spawning may occur through June. However, to minimize the potential for sturgeon being attracted into the project units during unit inspection and maintenance activities, BWPH will not schedule routine inspections or maintenance during the months of April and May. If unit maintenance is of an emergency nature, the Licensee shall immediately notify NMFS of the nature of the emergency and the maintenance required. For both scheduled and emergency unit inspection or repairs that require dewatering of any of the three project generating units, the Licensee will implement the following measures.

1. Prior to dewatering, areas upstream of the turbine tailrace tail logs and inside the scroll case that are accessible to the maintenance crew and/or divers, will be inspected. Divers with lights (or some other acceptable method) will inspect the tailrace area upstream of the tail logs before they are lowered into place. The tail logs may need to be alternately raised or lowered depending on sturgeon encountered. Flexible fencing may need to be deployed to coral the sturgeon out of the tailraces. Upon lowering the tail logs, an inspection inside of the tail logs will be conducted to confirm that no sturgeon are present prior to dewatering.

2. After the tail logs are in place and the unit dewatered, the scroll case will be inspected by maintenance crews for sturgeon. If sturgeon are found to be present, fish rescue operation procedures will be implemented:
   a. Removal of individuals from scroll case via dip net or other appropriate equipment;
   b. For each fish removed from the scroll case, record the weight, length, condition and collect fin clips as described below. Fish should also be scanned for PIT tags. River flow, bypass reach minimum flow, and water temperature will be recorded. All relevant information will be recorded on the reporting sheet.

3. Any live, uninjured sturgeon will immediately be returned to the Androscoggin River safely downstream of the project. A long-handled net outfitted with non-abrasive knotless mesh will be used to place the sturgeon back into the river downstream of the dam. The fish should be properly supported during transport in the net to ensure that it is not injured.

4. If any injured sturgeon are found in the units, BWPH proposes to report them immediately to NMFS. Injured fish will be photographed and measured, if possible, and the reporting sheet will be submitted to NMFS within 24 hours. If the fish is badly

injured, the fish will be retained by BWPH, if possible, until obtained by a NMFS recommended facility for potential rehabilitation.

5. If any dead sturgeon are found in the units, they will be recovered and immediately placed in a freezer if possible. NMFS should then be contacted immediately.

Fishway Maintenance, Inspection, and Operations

BWPH has proposed to implement the procedures outlined below if a sturgeon is detected in the fishway:

1. If sturgeon are observed in the fishway pools, BWPH proposes to remove them using dip nets or other appropriate equipment.

2. For each sturgeon detected, BWPH will record the weight, length, and condition of the fish. Fish will also be scanned for PIT tags. Fin clips will be taken and submitted to the NOAA repository in Charleston, SC for genetic analysis. A 1-cm^2 fin clip from one of the pelvic fins from living sturgeon will be taken and placed in a labeled vial with an o-ring cap containing 95% non-denatured ethyl alcohol (EtOH) for genetic analysis (the pelvic fin is regarded at the least intrusive, particularly for small individuals) (following the procedures described in Damon-Randall et al. 2010). River flow, bypass reach minimum flow, and water temperature will be recorded. All relevant information will be recorded on the reporting sheet.

3. BWPH proposes to record river flow, unit operation flow, fishway flow, and water temperature whenever a sturgeon is removed from the fishway. All relevant information will be recorded on the reporting sheet.

4. BWPH proposes to follow the contact procedure outlined below to obtain a contact with the appropriate ESA permit/approval for handling shortnose and Atlantic sturgeon.

5. If alive and uninjured, the sturgeon removed from the fishway will immediately be returned to the Androscoggin River downstream of the Brunswick dam. A long-handled net outfitted with non-abrasive knotless mesh will be used to place the sturgeon back into the river downstream of the dam. The fish will be properly supported during transport in the net to ensure that it is not injured.

6. If any injured sturgeon are found in the fishway, BWPH will report the occurrence to NMFS immediately. Injured fish will be photographed and measured, if possible, and the reporting sheet must be submitted to NMFS within 24 hours. If the fish is badly injured, the fish will be retained by the BWHP, if possible, until obtained by a NMFS recommended facility for potential rehabilitation.

7. If any dead sturgeon are found in the fishway, BWPH will report the occurrence to NMFS. Any dead specimens or body parts will be photographed, measured, scanned for tags, and all relevant information should be recorded on the approved Salvage Form.

Specimens will be stored in a refrigerator or freezer by BWPH until they can be obtained by NMFS for analysis.

Sturgeon Stranding

It is possible that a shortnose or Atlantic sturgeon could become stranded on the ledges or in pools below the spillway section of the dam following spill events. Generally, the ledges and pools below the dam spillway are not accessible on foot or by boat. Although BWPH is not proposing to survey the pools regularly, they indicate that their personnel or others may observe fish stranded on the ledges and in the pools. If BWPH becomes aware of such an occurrence, every effort will be made to determine if the stranded fish are sturgeon. If a sturgeon of either species is thought to be among the stranded fish, BWPH will make every effort, as river and crew safety conditions allow, to access the area where the fish is stranded. If, it is determined that one or more of the stranded fish is a sturgeon, BWPH proposes to undertake the following measures:

1. BWHP will follow the contact procedure to obtain a contact with the appropriate ESA permit/approval for handling sturgeon.

2. BWPH indicates that, if conditions allow, they will remove individuals from the ledges and/or pools via dip net or other appropriate equipment.

3. For each sturgeon removed from the pool, BWPH will record the weight, length, condition, and collect fin clips. Sturgeon will also be scanned for PIT tags and river flow, bypass reach minimum flow, and water temperature will be recorded. All relevant information will be recorded on the approved reporting sheet.

4. If stranded fish are found alive and uninjured, the sturgeon will be moved to an area of the Androscoggin River below the Brunswick Falls that will provide egress out of the area.

5. If any injured sturgeon are found on the ledges or in pools, BWPH will report immediately to NMFS. Injured sturgeon will be photographed and measured, if possible, and the reporting sheet must be submitted to NMFS within 24 hours. If it is badly injured, the sturgeon will be retained by BWPH, if possible, until obtained by a NMFS recommended facility for potential rehabilitation.

6. If any dead sturgeon are found on the ledges or in the pools, the BWPH shall report the dead fish immediately to NMFS. Any dead specimens or body parts should be photographed, measured, scanned for tags, and all relevant information should be recorded on the approved Salvage Form. Specimens should be stored in a refrigerator or freezer by the licensee until they can be obtained by NMFS for analysis.

2.2 Lewiston Falls

The Lewiston Falls Project consists of: (a) the Great Stone Dam, which is comprised of five sections with an elevation of 168.17 feet (ft) above mean sea level (msl); four stone masonry main sections capped with eight inches of reinforced concrete and one concrete section known as Island Spillway. The first four sections include inflatable rubber dams. The fifth section includes 1.34-foot-high flashboards; (b) a 200-acre impoundment with a storage capacity of 1,600 acre-feet at a full pond elevation of 168.17 ft. msl; (c) a powerhouse near the east end of Dam # 4 containing two turbine/generators with a total installed capacity of 28.44 MW and a hydraulic capacity of 6,600 cfs; (d) two gate house buildings impounding the reservoir; (e) 12.5-kV generator leads; (f) a 12.5/34.5-kV, 30 MVA transformer; (g) a short 34.5-kV service-drop; and (p) appurtenant facilities.

The Lewiston Falls Project originally included a canal system that delivered water to small generating facilities located in several mills. The Project was redeveloped in 1990 when a new powerhouse (Monty Station) was added. On February 27, 2017, the Licensee filed an application with the FERC to amend the Lewiston Falls Project license to remove the canal system and the associated generating and water conveyance facilities from the FERC-licensed project, for purposes of conveying these facilities to the City of Lewiston for potential non-hydropower redevelopment and public use. As part of that amendment application, the Licensee prepared and submitted a Lewiston Canal Decommissioning Plan. On November 9, 2017, FERC issued an Order amending the license, removing the canal system and canal generating facilities from the FERC-licensed project. As such, the canal system is no longer part of the licensed facilities and is not considered further here.

The Monty Station units (Units 1 and 2) are vertical Kaplan units each with a generating capacity of 12,500 kW when passing 3,300 cfs under a 54-foot gross head. The Lewiston Falls Project is licensed to operate with up to four feet of impoundment fluctuation to allow for peaking under normal conditions. The Project has a minimum flow requirement of 1,430 cfs.

2.2.1 PROPOSED ACTION

As explained above, FERC is proposing to amend BWPH's operating license for the Lewiston Falls Project to incorporate measures outlined in the SPP. Other than the requirements outlined in the new SPP and associated license amendment, the project will operate as authorized under its existing license. This license expires on August 31, 2026; after which, a new license is required to continue operations.

Lewiston Falls does not have upstream or downstream fish passage facilities, and BWPH is not proposing to install fishways as part of this SPP. Although Lewiston Falls represents the current upper extent of critical habitat for Atlantic salmon in the Androscoggin River, the historical upstream limit for salmon migration is believed to be Rumford Falls, which is approximately 80 miles upstream of the Project. Fish passage facilities at the dams downstream of Lewiston Falls allow upstream migrating adult salmon access to the river immediately downstream of the Project. As a result, it is possible that operation could affect migrating Atlantic salmon, particularly during and after spill events, by attracting and then trapping or stranding fish in the various pools downstream of the dam.

BWPH proposes to implement an Atlantic salmon Rescue Plan (Appendix B of the SPP). The plan is designed to ensure that adequate numbers of personnel are trained and available to safely identify and allow egress to any Atlantic salmon from the ledges during rubber dam reinflation activities, and/or during, or following, spill events. BWPH proposes to implement the plan from May 1 through July 31 of each year.

The provisions of the rescue plan include:

- If Atlantic salmon have been passed through the Brunswick, Pejepscot, and Worumbo projects' fishways, BWPH will notify NMFS, USFWS, and MDMR that the rescue plan has been put into place at Lewiston Falls.
- On the day of reinflation of rubber dams, environmental compliance personnel will coordinate with operations personnel, and fisheries technicians will be on site. The area on the ledges below the rubber dam will be surveyed with binoculars from the East and West sides of the dam to ensure no fish are stranded.
- If fish are observed in any of these pools, operations personnel will raise the headpond level above the height of the rubber dams, such that water and flows will pass over the rubber dam and the length of the ledges to allow egress.
- BWPH will record its actions following rubber dam re-inflation or spill events and the records of any Atlantic salmon observed stranded, rescued, or found dead or injured will be annually reported.

2.3 Action Area

The action area is defined as "all areas to be affected directly or indirectly by the Federal action and not merely the immediate area (project area) involved in the proposed action" (50 CFR 402.02). Operation of the Brunswick and Lewiston Falls Projects under the terms of the amended license affects a portion of the Androscoggin River. In addition to the immediate footprint of the Projects, the action area encompasses the impounded habitat upriver of the Brunswick Dam (salmon cannot access habitat in the Lewiston Falls impoundment), as well as the area downriver of each project affected by project flow modifications. Given the peaking operation of the Lewiston Falls Project, we anticipate that the action area for that project extends downstream as far as the Worumbo Dam impoundment, where the impoundment of that dam, as well as the input of two major tributaries (i.e., the Little Androscoggin and Sabattus Rivers) would be expected to significantly dampen the effects of peaking. The action area of the Brunswick Project encompasses the Brunswick impoundment (which extends up to the Pejepscot Project), to a point approximately 700 feet (0.2 km) downstream of the Brunswick dam where the flow from the powerhouse and spillway converge (Figure 1). The action area only includes mainstem habitat as we do not anticipate that tributary habitat will be affected by dam operation or the implementation of fish passage measures as the Projects.

Figure 1. The action area for the proposed action includes the footprint of the Brunswick and Lewiston Falls Projects, as well as the reach of river downstream of each dam, and the habitat impounded by the Brunswick Dam.

3. Status of the Species and Critical Habitat Rangewide

We have determined that the actions being considered in this Opinion may affect the following endangered or threatened species and critical habitat under our jurisdiction (Table 2). Note that Atlantic and shortnose sturgeon and critical habitat designated for the Gulf of Maine DPS of Atlantic sturgeon occurs only in the portion of the action area below the Brunswick Dam.

Table 2. 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[4]

[4] A Recovery Outline for the 5 distinct populations of Atlantic sturgeon was published by NMFS in 2018. It is available at: https://media.fisheries.noaa.gov/dam-migration/ats_recovery_outline.pdf (last accessed Oct 12, 2021).

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	Merrymeeting Bay Salmon Habitat Recovery Unit
Atlantic Sturgeon	*Acipenser oxyrinchus oxyrinchus*	Gulf of Maine	82 FR 39160	

3.1 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 (65 FR 69459). A subsequent rule issued by the Services expanded the geographic range for the GOM DPS of Atlantic salmon (June 19, 2009; 74 FR 29344). 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.

Coincident with the June 19, 2009 endangered listing, we designated critical habitat for the GOM DPS of Atlantic salmon (74 FR 29300).

3.1.1 ATLANTIC SALMON LIFE HISTORY

Atlantic salmon spend most of their 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 2). During their life cycle, Atlantic salmon go through several distinct phases that are identified by specific changes in behavior, physiology, morphology, and habitat requirements.

Spawning

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, 1997), 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).

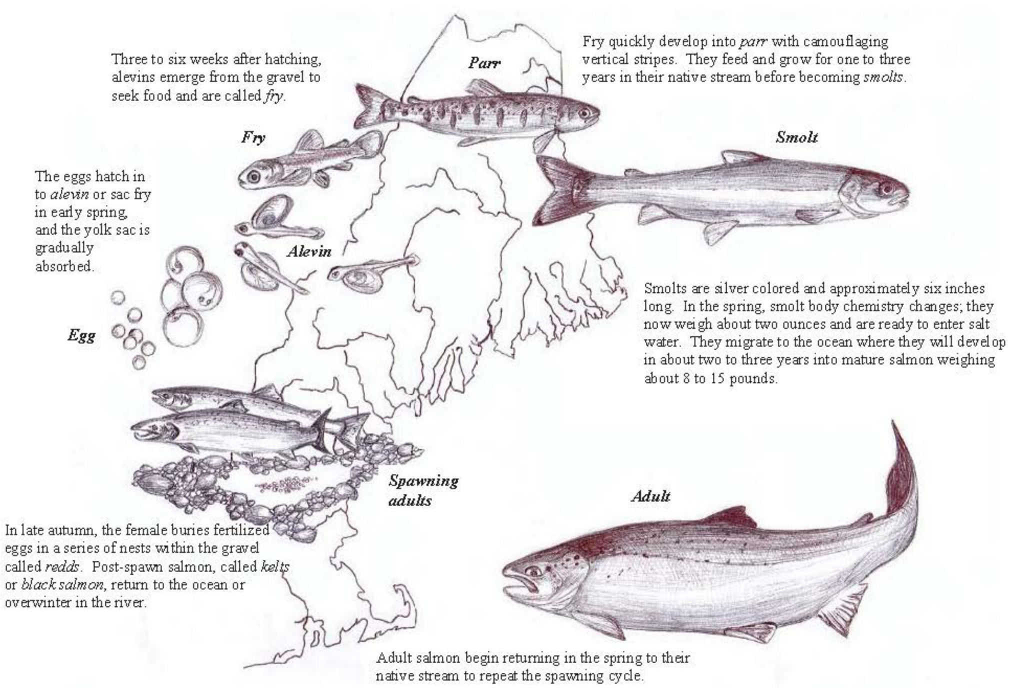

Figure 2. Life Cycle of the Atlantic salmon (diagrams courtesy of Katrina Mueller)

Atlantic salmon are iteroparous, which means they have the ability to spawn in multiple years. A run with a higher proportion of repeat spawners is believed to be more resilient and better able to compensate for the many threats posed throughout the salmon life cycle (Babin et al., 2021;

Baktoft et al., 2020; Lawrence et al., 2016; Maynard et al., 2018). It has been predicted that a run that has a high proportion of repeat spawners would reduce the probability of population decline by 8-27% depending on how many dams were obstructing downstream migration (Lawrence et al., 2016). Although post-spawn survival can be quite high (~80%) (Maynard et al., 2018), a much smaller proportion typically survives to spawn again. Although some salmon migrate back to the ocean in the fall after spawning, the majority (84%) overwinter in the river and then out migrate in the spring (Maynard et al. 2018). Overwintering mortality in the river can be quite high (~50%) and can be much higher, particularly in males (up to 100%) (Babin et al., 2021; Maynard et al., 2018). Survival in the marine environment can also be quite low (<10%), which means that the proportion of repeat spawners is typically quite small (Maynard et al. 2018). It is thought that repeat spawners can comprise up to 60% of a run (Lawrence et al. 2016), however the proportion has been low and declining in Maine; comprising only 1.7% on the Penobscot in the 1980's, and only 0.6% more recently (Maynard et al 2018).

Eggs

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 (i.e., smolts that were produced through spawning in the wild, or that were stocked as eggs or fry) 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 3). 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.

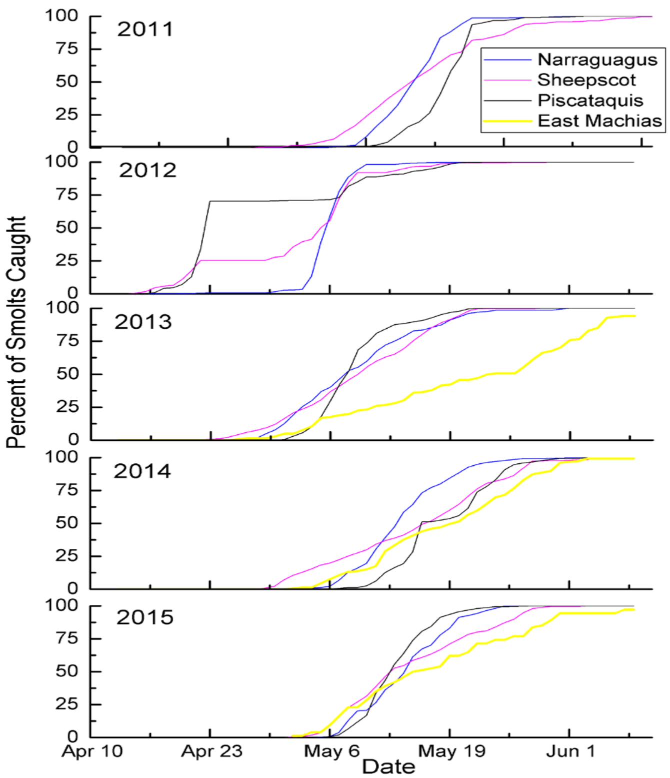

Figure 3. Cumulative percent smolt capture of all origins by date (run timing) on the Narraguagus (blue line), Sheepscot (pink line), Piscataquis (black line), and East Machias (yellow line) rivers, Maine (2011-2015)(USASAC, 2016).

A proportion of stocked salmon smolts may hold over in the vicinity of their stocking location, rather than migrating to sea, as they are not physiologically ready for the transition to saltwater. It is believed that approximately 5-10% of stocked smolts may hold over, and that it could vary based on whether the fish are graded (i.e., sorted based on size) prior to stocking (John Kocik, NOAA's Northeast Fisheries Science Center, personal communication, October 6, 2021). These juvenile salmon, technically parr, likely move to rearing habitat in the mainstem or in nearby tributaries prior to migrating to the ocean the following year.

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, 1997). 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 return to their natal river to spawn after their second sea winter (2SW) plus a smaller component of previous spawners who have returned to the sea prior to their next spawning event; these fish are from rivers in North America and Europe (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 eastern edge 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).

3.1.2 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 that has been ongoing since the 1990s. 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 4). 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.

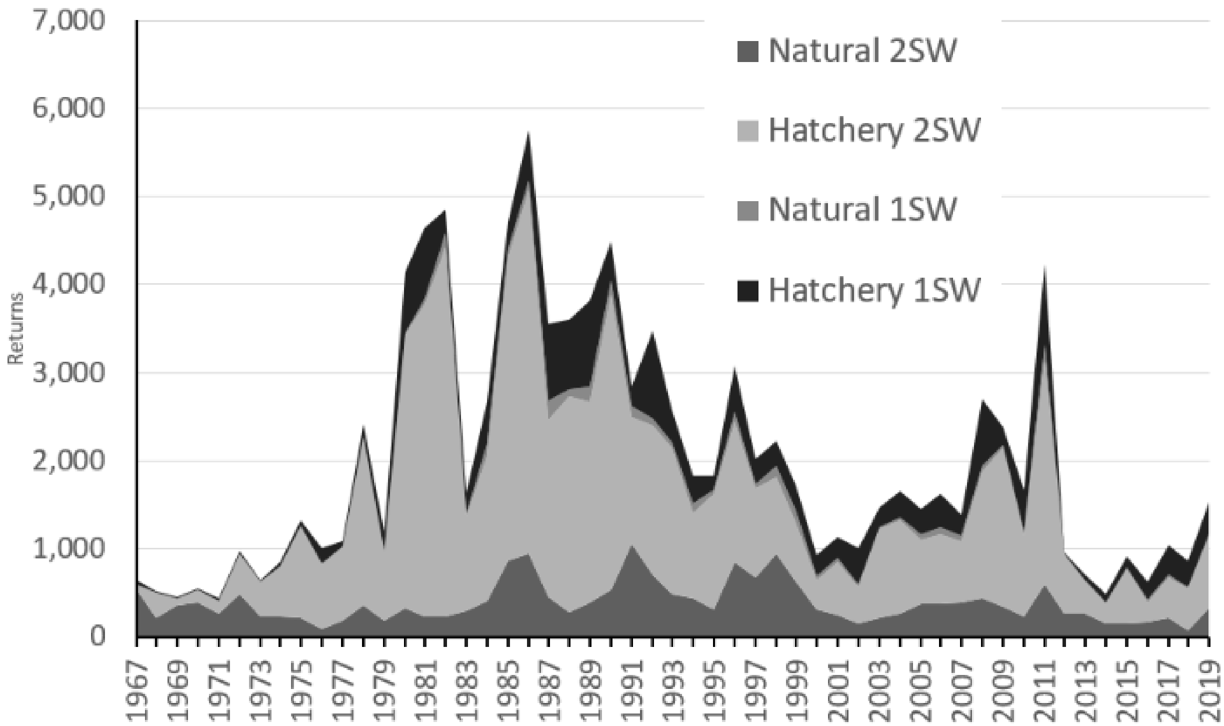

Figure 4. Summary of natural vs. hatchery adult salmon returns to the GOM DPS Rivers between 1967 and 2019 (USASAC, 2020).

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 and prevent extinction. 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, 1997; 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.

<u>Salmon Habitat Recovery Units</u>

We have divided the GOM DPS into three Salmon Habitat Recovery Units (SHRUs) (74 FR

29300, June 19, 2009). The three SHRUs are the Downeast Coastal SHRU, Penobscot Bay SHRU, and Merrymeeting Bay SHRU. 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.

3.1.3 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 uses the Recovery Enhancement Vision (REV) approach and focuses on the three statutory requirements for recovery plans. These include 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.

As described in 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 naturally reared adults (i.e., originating from spawning in the wild, or from hatchery stocked eggs, fry or parr), 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.

As described in 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.

3.1.4 Summary of Rangewide Status of Atlantic salmon

The GOM DPS of Atlantic salmon currently exhibits critically low spawner abundance, poor marine survival, and is confronted with a variety of additional threats. The abundance of GOM DPS Atlantic salmon has been low and either stable or declining over the past several decades. The proportion of fish that are of natural origin is 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.

3.2 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).

3.2.1 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[5]) (Table 3). 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.

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[5] 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.

Table 3. 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	
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 was designated in areas (HUC-10 watersheds) occupied by the species at the time of listing. 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. 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 4. 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 the action area contains spawning and rearing physical and biological feature (PBFs) 1 (SR 1) and the migratory PBFs 1-6 (M 1-6). We explain this determination and discuss these features and their current status in the action area in the Environmental Baseline (Section 4).

3.3 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 withdrawal
- 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. The three year regulatory measure agreed to in 2018 included a 30-ton annual quota with an overharvest provision, such that any overharvest in a given year would be subtracted from the allowable quota in the subsequent year. In addition, the measure included a number of elements that would significantly improve the management and control of the fishery. For example, all fishers for Atlantic salmon in Greenland, including both private and commercial fishers, are now required to obtain a license and will also be required to provide an accurate and detailed report of their fishing activities and landings. These requirements provide increased confidence in the accuracy of the reported landings and fishing activities moving forward. The 30 metric ton quota was exceeded in all three years of the regulatory measure (2018-2020), and Greenland was unwilling to reduce the quota or continue the overharvest provision in negotiations over a new regulatory measure in 2021. Therefore, NASCO has only agreed to a one-year 30 ton quota for the 2021 fishing year, with the understanding that a new measure will be negotiated in 2022.

3.4 Status and Trends of the Species in the Merrymeeting Bay SHRU

A summary of the status of the species rangewide and designated critical habitat in its entirety was provided above. This section will focus on the status of Atlantic salmon and designated critical habitat in the Merrymeeting Bay recovery unit.

The number of returning adults to the Merrymeeting Bay SHRU is small but has been increasing steadily in recent years as stocking effort in the Kennebec has increased (Figure 5). The number of prespawn Atlantic salmon returning to the three rivers where counts are made in the Merrymeeting Bay SHRU has ranged between 18 and 127 combined annually; with a 10-year average return of 55 individuals (derived from data in USASAC 2020 and CMS 2021). Of the prespawn adult salmon that return to the Merrymeeting Bay SHRU to spawn, approximately 60% return to the Kennebec River; 12% return the Androscoggin River, and 28% return to the Sheepscot River. It should be noted that with the exception of 2011, returns to the Androscoggin River have not exceeded 6 fish (average of 2) over the last decade. In 2011, 44 adult salmon returned to the Androscoggin, which is approximately twice the total return to the river over the other years in the time series.

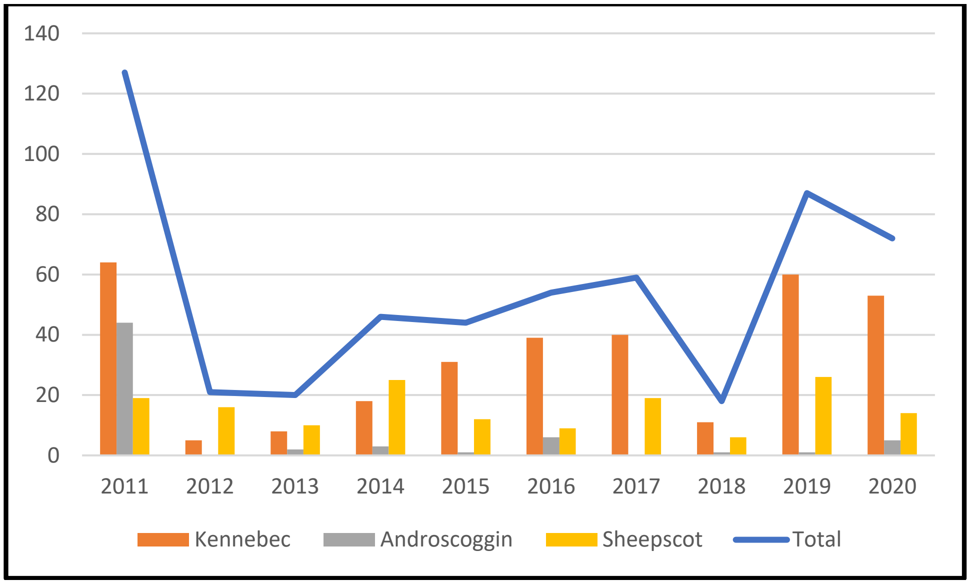

Figure 5. Adult Atlantic salmon returns to the rivers in the Merrymeeting Bay SHRU between 2011 and 2020 (derived from data in USASAC 2020 and CMS 2021).

Although relatively small, the Sheepscot River hosts one of the eight remaining river-specific stocks of Atlantic salmon. This stock is the only river-specific population in the Merrymeeting Bay SHRU, and is the southernmost population in the GOM DPS.

Smolts

Out-migrating Atlantic salmon smolts in the Merrymeeting Bay rivers are the result of wild production following natural spawning and juvenile rearing, or from stocking eggs, fry, parr, and smolts (Fay et al., 2006). The majority of the salmon run in the SHRU is the result of egg stocking in the Sandy River (a large tributary to the Kennebec), but egg, fry, and parr stocking also occurs in the SHRU (Table 5). Prior to 2020, the only smolts that were stocked over the last decade in the SHRU were tagged study fish that BWPH put in the river to test the efficiency of their downstream fishways. In 2020, with the stocking of almost 90,000 smolts, MDMR began a multi-year plan to stock smolts in the mainstem Kennebec River (CMS, 2021). Stocking in the Androscoggin has been limited to a small educational stocking effort conducted by the Fish Friends (i.e., Salmon in Schools) program. Over the last ten years stocking from this effort has ranged between zero and 2,000 fry per year in the Androscoggin. No stocking occurred in the river between 2016 and 2019, but in 2020 Fish Friends reported the stocking of 2,000 salmon fry (USASAC 2021).

Table 5. Stocking history by life stage in the Merrymeeting Bay SHRU between 2012-2019 (derived from data in USASAC 2021).

Lifestage	Kennebec	Androscoggin	Sheepscot
Egg	7,623,000	0	1,363,000
Fry	160,000	9,000	423,000
Parr	0	0	149,300
Smolt	600	500	0

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). Based on the habitat prediction model developed by Wright et al. (2008), we estimate that approximately one-third of habitat units within the Merrymeeting Bay SHRU are within the designated critical habitat for Atlantic salmon. Of that habitat, approximately three-quarters occurs within the Kennebec River (Table 6).

Table 6. The proportion of modelled rearing habitat units in designated critical habitat within the Merrymeeting Bay SHRU for Atlantic salmon (based on Wright et al. 2008). The estimate of the amount of high quality habitat within each watershed only includes stream reaches where the model indicated that approximately more than 50% of the reach contains suitable rearing habitat.

Watershed	% of Total Units	% of High Quality
Kennebec	74%	74%
Androscoggin	12%	5%
Sheepscot	6%	9%
St. George	6%	9%
Medomak	2%	3%

3.4.1 Factors Affecting the Merrymeeting Bay SHRU

Dams

Dams impact Atlantic salmon through habitat alteration, fish passage delays, and entrainment and impingement. There are approximately 200 dams in the Merrymeeting Bay SHRU watershed; 80 of which occur within critical habitat. For comparison, the Penobscot Bay SHRU and the Downeast Coastal SHRU have approximately 110 and 65 dams, respectively.

The Merrymeeting Bay SHRU contains a large number of FERC licensed and exempt dams that block or hinder access for diadromous fish species. These dams are concentrated on the Kennebec and Androscoggin Rivers; no FERC licensed dams exist on the smaller rivers in the basin. Of the 37 FERC licensed or exempt dams in the SHRU, 14 are within critical habitat. For comparison, the Penobscot Bay SHRU and the Downeast Coastal SHRU have approximately 26 and 3 FERC licensed or exempt dams, respectively.

The current number of accessible habitat units suitable for rearing in the Merrymeeting Bay SHRU is approximately 12,423 (i.e., 10% of the habitat in the critical habitat)(CMS, 2021). This estimate does not include habitat upstream of dams that may not be accessible due to passage inefficiencies. Therefore, the habitat above the first Kennebec (i.e., Lockwood) and Androscoggin (i.e., Brunswick) dams is not included in this estimate. Most of the accessible rearing habitat is located in the Sheepscot River and the Kennebec River downstream of the Lockwood Dam; with a small amount downstream of the Brunswick Dam (see section 4.1). There is also mapped spawning habitat in the lower Kennebec and Sheepscot, although none has been mapped downstream of the Brunswick Dam on the Androscoggin River[6].

Dams in the Lower Androscoggin River

In 1982, Central Maine Power Company (CMP) reconstructed the hydroelectric facility in Brunswick-Topsham, the first upstream dam on the Androscoggin River (Brown *et al*. 2006). CMP installed a slot fishway with a trapping and sorting facility. At that time, the MDMR began the Anadromous Fish Restoration Program in the lower Androscoggin River main stem and tributaries below Lewiston Falls. In 1987, the Pejepscot Project, the second dam on the Androscoggin River, had upstream fish passage installed. In 1988, upstream passage facilities were installed at the Worumbo Project, the third upstream dam on the river. This provided an opportunity for anadromous species to migrate upstream as far as Lewiston Falls (Brown *et al.* 2006). No fish passage exists at the Lewiston Falls Project and it is, therefore, the upper extent of salmon distribution in the river.

Although few Atlantic salmon are known to migrate upriver of all three passable dams in the lower Androscoggin River, annual counts of pre-spawn migrating Atlantic salmon trapped at the Brunswick and Worumbo Dams confirm that salmon enter the river and ascend all passable dams in some years. On average, only 20% of the adult salmon that pass the Brunswick Project pass the Worumbo Project (derived from return data at the two projects between 2003 and 2020 (USASAC 2021, MDMR annual reports). Fish counts are not recorded at the Pejepscot Project which lies between the two dams. The low proportion is likely related to passage inefficiencies at the three dams, but this has yet to be adequately assessed due to the small number of salmon in the river.

We anticipate that juvenile salmon production in the Androscoggin River could occur in the Little Androscoggin River (above the Worumbo Dam) and in the Little River (between the Pejepscot and Worumbo Dams), therefore, smolts have to migrate past two or three dams on their migration to the estuary. The route that a salmon smolt takes when passing a project is a major factor in its likelihood of survival. Given expected route utilization at the Worumbo and Pejepscot Projects (based on studies conducted between 2013 and 2015), we can estimate smolt survival through the two dams. We estimate that 8% of smolts that pass the Worumbo Project, and 6.5% of those that pass the Pejepscot Project, will be killed due to dam effects. The effects of passage at the Brunswick Project will be considered in the *Environmental Baseline* and *Effects of the Action* sections (sections 4 and 6) below.

Although very few adult salmon pass the hydro dams in the Androscoggin River, some proportion are killed as they migrate past the dams on their way back to the estuary. We estimate that 10% of adult salmon that pass downstream of the Worumbo Project, and 15% of those that pass downstream of the Pejepscot Project, will be killed due to dam effects.

Contaminants, Water Quality, Water Quantity

[6] Maine Stream Habitat Viewer. Atlantic salmon Surveyed Spawning Habitat. Layer maintained by MDMR. https://webapps2.cgis-solutions.com/MaineStreamViewer/

Pollutants discharged from point sources affect water quality within the Merrymeeting Bay 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 Merrymeeting Bay watersheds. TMDLs allocate a waste load for a particular pollutant for impaired waterbodies.

Summary

Adult returns for the Merrymeeting Bay recovery unit remain well below the biological criteria established for each SHRU in the 2019 Recovery Plan. The 2019 Recovery Plan identifies a self-sustaining annual escapement target of 2,000 wild origin adults for each SHRU before delisting of the species under the ESA can proceed. The abundance of Atlantic salmon in the SHRU remains low. The 10-year (2011-2020) average number of naturally-reared or wild adults returning to the Merrymeeting Bay SHRU is 39 (CMS, 2021). This constitutes 7.8% of the total needed for downlisting (reclassification to threatened), and 2.0% of what is needed for delisting. 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 significantly increase 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 Merrymeeting Bay SHRU will continue to impact the biological and physical features of spawning, rearing, and migration habitat for Atlantic salmon. These include dams, road-stream crossings, non-native fish predation, agriculture, forestry, changing land-use and development, hatcheries and stocking, and aquaculture.

3.5 Shortnose Sturgeon

Shortnose sturgeon occur in the portion of the action area below the Brunswick dam. Shortnose sturgeon are fish that occur in rivers and estuaries along the East Coast of the U.S. and Canada (SSSRT 2010). They have a head covered in bony plates, as well as protective armor called scutes extending from the base of the skull to the caudal peduncle. Other distinctive features include a subterminal, protractile tube-like mouth, and chemosensory barbels for benthic foraging (SSSRT 2010). Sturgeon have been present in North America since the Upper Cretaceous period, more than 66 million years ago. The information below is a summary of available information on the species. More thorough discussions can be found in the cited references as well as the SSSRT's Biological Assessment (2010).

3.5.1 Life History and General Habitat Use

There are differences in life history, behavior, and habitat use across the range of the species.

Current research indicates that these differences are adaptations to unique features of the rivers where these populations occur. For example, there are differences in larval dispersal patterns in the Connecticut River (MA) and Savannah River (GA) (Parker 2007). There are also morphological and behavioral differences. Growth and maturation occurs more quickly in southern rivers but fish in northern rivers grow larger and live longer. We provide general life history attributes in Table 7.

Table 7. Shortnose sturgeon general life history for the species throughout its range

Stage	Size (mm)	Duration	Behaviors/Habitat Used
Egg	3-4	13 days post spawn	stationary on bottom; Cobble and rock, fresh, fast flowing water
Yolk Sac Larvae	7-15	8-12 days post hatch	Photonegative; swim up and drift behavior; form aggregations with other YSL; Cobble and rock, stay at bottom near spawning site
Post Yolk Sac Larvae	15 - 57	12-40 days post hatch	Free swimming; feeding; Silt bottom, deep channel; fresh water
Young of Year	57 – 140 (north); 57-300 (south)	From 40 days post-hatch to one year	Deep, muddy areas upstream of the salt wedge
Juvenile	140 to 450-550 (north); 300 to 450-550 (south)	1 year to maturation	Increasing salinity tolerance with age; same habitat patterns as adults
Adult	450-1100 average; (max recorded 1400)	Post-maturation	Freshwater to estuary with some individuals making nearshore coastal migrations

Shortnose sturgeon live on average for 30-40 years (Dadswell et alet al. 1984). Males mature at approximately 5-10 years and females mature between age 7 and 13, with later maturation occurring in more northern populations (Dadswell et al. 1984). Females typically spawn for the first time 5 years post-maturation (age 12-18; Dadswell 1979; Dadswell et alet al. 1984) and then spawn every 3-5 years (Dadswell 1979; Dadswell et alet al. 1984;). Males spawn for the first time approximately 1-2 years after maturity with spawning typically occurring every 1-2 years (Kieffer and Kynard 1996; NMFS 1998; Dadswell et alet al. 1984). Shortnose sturgeon are iteroparous (spawning more than once during their life) and females release eggs in multiple "batches" during a 24 to 36-hour period (total of 30,000-200,000 eggs). Multiple males are likely to fertilize the eggs of a single female.

Cues for spawning are thought to include water temperature, day length and river flow (Kynard 2012). Shortnose sturgeon spawn in freshwater reaches of their natal rivers when water temperatures reach 9–15°C in the spring (Dadswell 1979; Taubert 1980a and b; Kynard 1997). Spawning occurs over gravel, rubble, and/or cobble substrate (Dadswell 1979, Taubert 1980a and b; Buckley and Kynard 1985b; Kynard 1997) in areas with average bottom velocities between 0.4 and 0.8 m/s. Depths at spawning sites are variable, ranging from 1.2 - 27 m (multiple references in SSSRT 2010). Eggs are small and demersal and stick to the rocky substrate where spawning occurs.

Shortnose sturgeon occur in waters between 0-34°C (Dadswell et al. 1984; Heidt and Gilbert 1978); with temperatures above 28°C considered to be stressful. Depths used are highly variable, ranging from shallow mudflats while foraging to deep channels up to 30 m (Dadswell et al. 1984; Dadswell 1979). Salinity tolerance increases with age; while young of the year must remain in freshwater, adults have been documented in the ocean with salinities of up 30 parts-per-thousand (ppt) (Holland and Yeverton 1973; Saunders and Smith 1978). Dissolved oxygen affects distribution, with preference for DO levels at or above 5mg/l and adverse effects anticipated for prolonged exposure to DO less than 3.2mg/L.

Shortnose sturgeon feed on benthic insects, crustaceans, mollusks, and polychaetes (Dadswell et al. 1984). Both juvenile and adult shortnose sturgeon primarily forage over sandy-mud bottoms, which support benthic invertebrates (Carlson and Simpson 1987; Kynard 1997). Shortnose sturgeon have also been observed feeding off plant surfaces (Dadswell et al. 1984).

Following spawning, adult shortnose sturgeon disperse quickly down river to summer foraging grounds areas and remain in areas downstream of their spawning grounds throughout the remainder of the year (Buckley and Kynard 1985, Dadswell et al. 1984; Buckley and Kynard 1985; O'Herron et al. 1993).

In northern rivers, shortnose aggregate during the winter months in discrete, deep (3-10m) freshwater areas with minimal movement and foraging (Kynard et al. 2012; Buckley and Kynard 1985a; Dadswell 1979, Li et al. 2007; Dovel et al. 1992; Bain et al. 1998a and b). In the winter, adults in southern rivers spend much of their time in the slower moving waters downstream near the salt-wedge and forage widely throughout the estuary (Collins and Smith 1993, Weber et al. 1998). Prespawning sturgeon in some northern and southern systems migrate into an area in the upper tidal portion of the river in the fall and complete their migration in the spring (Rogers and Weber 1995). Older juveniles typically occur in the same overwintering areas as adults while young of the year remain in freshwater (Jenkins et al. 1993, Jarvis et al. 2001).

Listing History

Shortnose sturgeon were listed as endangered in 1967 (32 FR 4001), and the species remained on the endangered species list with the enactment of the ESA in 1973. Shortnose sturgeon are thought to have been abundant in nearly every large East Coast river prior to the 1880s (see Catesby 1734; McDonald 1887; Smith and Clugston 1997). Pollution and overfishing, including bycatch in the shad fishery, were listed as principal reasons for the species' decline. The species remains listed as endangered throughout its range. While the 1998 Recovery Plan refers to Distinct Population Segments (DPS), the process to designate DPSs for this species has not been undertaken. The SSSRT published a Biological Assessment for shortnose sturgeon in 2010. The report summarized the status of shortnose sturgeon within each river and identified stressors that continue to affect the abundance and stability of these populations.

Current Status

There is no current total population estimate for shortnose sturgeon rangewide. Information on populations and metapopulations is presented below. In general, populations in the Northeast are larger and more stable than those in the Southeast (SSSRT 2010). Population size throughout the species' range is considered to be stable; however, most riverine populations are below the historic population sizes and most likely are below the carrying capacity of the river (Kynard 1996).

Population Structure

There are 19 documented populations of shortnose sturgeon ranging from the St. Johns River, Florida (possibly extirpated from this system) to the Saint John River in New Brunswick, Canada. There is a large gap in the middle of the species range with individuals present in the Chesapeake Bay separated from populations in the Carolinas by a distance of more than 400 km. Currently, there are significantly more shortnose sturgeon in the northern portion of the range.

Developments in genetic research as well as differences in life history support the grouping of shortnose sturgeon into five genetically distinct groups, all of which have unique geographic adaptations (see Grunwald et al. 2008; Grunwald et al. 2002; King et al. 2001; Waldman et al. 2002b; Walsh et al. 2001; Wirgin et al. 2009; Wirgin et al. 2002; SSSRT 2010). These groups are: 1) Gulf of Maine; 2) Connecticut and Housatonic Rivers; 3) Hudson River; 4) Delaware River and Chesapeake Bay; and 5) Southeast. The Gulf of Maine, Delaware/Chesapeake Bay and Southeast groups function as metapopulations[7]. The other two groups (Connecticut/Housatonic and the Hudson River) function as independent populations.

While there is migration within each metapopulation (i.e., between rivers in the Gulf of Maine and between rivers in the Southeast) and occasional migration between populations (e.g., Connecticut and Hudson), interbreeding between river populations is limited to very few individuals per generation; this results in morphological and genetic variation between most river populations (see Walsh et al. 2001; Grunwald et al. 2002; Waldman et al. 2002; Wirgin et al. 2005). Indirect gene flow estimates from mtDNA indicate an effective migration rate of less than two individuals per generation. This means that while individual shortnose sturgeon may move between rivers, very few sturgeon are spawning outside their natal river; it is important to remember that the result of physical movement of individuals is rarely genetic exchange.

Summary of Status of Northeast Rivers

In NMFS' Greater Atlantic Region, shortnose sturgeon are known to spawn in the Kennebec, Androscoggin, Merrimack, Connecticut, Hudson and Delaware Rivers. Shortnose sturgeon are also known to occur in the Penobscot and Potomac Rivers; although it is unclear if spawning is currently occurring in those systems.

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[7] A metapopulation is a group of populations in which distinct populations occupy separate patches of habitat separated by unoccupied areas (Levins 1969). Low rates of connectivity through dispersal, with little to no effective movement, allow individual populations to remain distinct as the rate of migration between local populations is low enough not to have an impact on local dynamics or evolutionary lineages (Hastings and Harrison 1994). This interbreeding between populations, while limited, is consistent, and distinguishes metapopulations from other patchy populations.

Gulf of Maine Metapopulation

Tagging and telemetry studies indicate that shortnose sturgeon are present in the Penobscot, Kennebec, Androscoggin, Sheepscot and Saco Rivers. Individuals have also been documented in smaller coastal rivers; however, the duration of presence has been limited to hours or days and the smaller coastal rivers are thought to be only used occasionally (Zydlewski et al. 2011).

Since the removal of the Veazie and Great Works Dams (2013 and 2012, respectively), in the Penobscot River, shortnose sturgeon range from the Bay to the Milford Dam. Shortnose sturgeon now have access to their full historical range. Adult and large juvenile sturgeon have been documented to use the river. While potential spawning sites have been identified, no spawning has been documented. Foraging and overwintering are known to occur in the river. Nearly all prespawn females and males have been documented to return to the Kennebec or Androscoggin Rivers. Robust design analysis with closed periods in the summer and late fall estimated seasonal adult abundance ranging from 636-1285 (weighted mean), with a low estimate of 602 (95%CI: 409.6-910.8) and a high of 1306 (95% CI: 795.6-2176.4) (Fernandes 2008; Fernandes et al. 2010; Dionne 2010 in Maine DMR 2010).

Kennebec/Androscoggin/Sheepscot Rivers

The estimated size of the adult population (>50cm TL) in this system, based on a tagging and recapture study conducted between 1977-1981, was 7,200 (95% CI = 5,000 - 10,800; Squiers et al. 1982). A population study conducted 1998-2000 estimated population size at 9,488 (95% CI = 6,942 -13,358; Squiers 2003) suggesting that the population exhibited significant growth between the late 1970s and late 1990s. Spawning is known to occur in the Androscoggin and Kennebec Rivers. In both rivers, there are hydroelectric facilities located at the base of natural falls thought to be the natural upstream limit of the species. The Sheepscot River is used for foraging during the summer months.

Merrimack River

The historic range in the Merrimack extended to Amoskeag Falls (Manchester, NH, RKM 116; Piotrowski 2002); currently shortnose sturgeon cannot move past the Essex Dam in Lawrence, MA (RKM 46). A current population estimate for the Merrimack River is not available. Based on a study conducted 1987-1991, the adult population was estimated at 32 adults (20–79; 95% confidence interval; B. Kynard and M. Kieffer unpublished information). However, recent gill-net sampling efforts conducted by Kieffer indicate a dramatic increase in the number of adults in the Merrimack River. Sampling conducted in the winter of 2009 resulted in the capture of 170 adults. Preliminary estimates suggest that there may be approximately 2,000 adults using the Merrimack River annually. Spawning, foraging and overwintering all occur in the Merrimack River.

Tagging and tracking studies demonstrate movement of shortnose sturgeon between rivers within the Gulf of Maine, with the longest distance traveled between the Penobscot and Merrimack rivers. Genetic studies indicate that a small, but statistically insignificant amount of genetic exchange likely occurs between the Merrimack River and these rivers in Maine (King et al. 2013). The Merrimack River population is genetically distinct from the Kennebec-

Androscoggin-Penobscot population (SSSRT 2010).

Connecticut River Population

The Holyoke Dam divides the Connecticut River shortnose population; there is currently limited successful passage downstream of the Dam. No shortnose sturgeon have passed upstream of the dam since 1999 and passage between 1975-1999 was an average of four fish per year. The number of sturgeon passing downstream of the Dam is unknown. Despite this separation, the populations are not genetically distinct (Kynard 1997, Wirgin et al. 2005, Kynard et al.2012). The most recent estimate of the number of shortnose sturgeon upstream of the dam, based on captures and tagging from 1990-2005 is approximately 328 adults (CI = 188–1,264 adults; B. Kynard, USGS, unpubl. Data in SSSRT 2010); this compares to a previous Peterson mark-recapture estimate of 370–714 adults (Taubert 1980a). Using four mark-recapture methodologies, the longterm population estimate (1989-2002) for the lower Connecticut River ranges from 1,042-1,580 (Savoy 2004). Comparing 1989-1994 to 1996-2002, the population exhibits growth on the order of 65-138%. The population in the Connecticut River is thought to be stable, but at a small size.

As described in SSSRT (2010), shortnose sturgeon in the Connecticut River inhabit a reach downstream of the Turners Falls Dam (Turners Falls, MA; rkm 198) to Long Island Sound. Construction of the Turners Falls Dam was completed in 1798 and built on a natural falls-rapids. Turners Falls is believed to be the historic upstream boundary of shortnose sturgeon in the Connecticut River; however, there have been anecdotal sightings of sturgeon upstream of the dam and in the summer of 2017 an angler reported a catch of a shortnose sturgeon upstream of the Turners Falls Dam. This information suggests that occasional shortnose sturgeon are present upstream to the dam; however, we have no information on how shortnose sturgeon accessed this reach or how many sturgeon may be present in this area, if any.

While limited spawning is thought to occur below the Holyoke Dam, successful spawning has only been documented upstream of the Holyoke Dam. Abundance of prespawning adults was estimated each spring between 1994–2001 at a mean of 142.5 spawning adults (CI =14–360 spawning adults) (Kynard et al. 2012). Overwintering and foraging occur in both the upper and lower portions of the river. Occasionally, sturgeon have been captured in tributaries to the Connecticut River including the Deerfield River and Westfield River. Additionally, a sturgeon tagged in the Connecticut River was recaptured in the Housatonic River (T. Savoy, CT DEP, pers. comm.). Three individuals tagged in the Hudson were captured in the CT, with one remaining in the river for at least one year (Savoy 2004). In spring 2021, the CT DEEP captured a number of shortnose sturgeon eggs on egg mats below the Holyoke Dam. Young of year shortnose sturgeon were also observed by divers monitoring for listed mussels at a construction site in Springfield, MA. These observations suggest that occasional spawning may occur below the dam; however, we do not have sufficient information to determine how frequently such an occurrence may happen.

Hudson River Population

The Hudson River population of shortnose sturgeon is the largest in the United States. Studies indicated an extensive increase in abundance from the late 1970s (13,844 adults (Dovel et al.

1992), to the late 1990s (56,708 adults (95% CI 50,862 to 64,072; Bain et al. 1998). This increase is thought to be the result of high recruitment (31,000 – 52,000 yearlings) from 1986-1992 (Woodland and Secor 2007). Woodland and Secor examined environmental conditions throughout this 20-year period and determined that years in which water temperatures drop quickly in the fall and flow increases rapidly in the fall (particularly October), are followed by high levels of recruitment in the spring. This suggests that these environmental factors may index a suite of environmental cues that initiate the final stages of gonadal development in spawning adults. The population in the Hudson River exhibits substantial recruitment and is considered to be stable at high levels.

Delaware River-Chesapeake Bay Metapopulation

Shortnose sturgeon range from Delaware Bay up to at least Scudders Falls (RKM 223); there are no dams within the species' range on this river. The population is considered stable (comparing 1981-1984 to 1999-2003) at around 12,000 adults (Hastings et al. 1987 and ERC 2006b). Spawning occurs primarily between Scudders Falls and the Trenton rapids. Overwintering and foraging also occur in the river. Shortnose sturgeon have been documented to use the Chesapeake-Delaware Canal to move from the Chesapeake Bay to the Delaware River.

The current abundance of shortnose sturgeon in the Chesapeake Bay is unknown. Incidental capture of shortnose sturgeon was reported to the USFWS and MDDNR between 1996-2008 as part of an Atlantic Sturgeon Reward Program. During this time, 80 shortnose sturgeon were documented in the Maryland waters of the Bay and in several tidal tributaries. To date, no shortnose sturgeon have been recorded in Virginia waters of the Bay.

Spawning has not been documented in any tributary to the Bay although suitable spawning habitat and two prespawning females with late stage eggs have been documented in the Potomac River. Current information indicates that shortnose sturgeon are present year round in the Potomac River with foraging and overwintering taking place there. Shortnose sturgeon captured in the Chesapeake Bay are not genetically distinct from the Delaware River population.

Southeast Metapopulation

There are no shortnose sturgeon between Maryland waters of the Chesapeake Bay and the Carolinas. Shortnose sturgeon are only thought to occur in the Cape Fear River and Yadkin-Pee Dee River in North Carolina and are thought to be present in very small numbers.

The Altamaha River supports the largest known population in the Southeast with successful self-sustaining recruitment. The most recent population estimate for this river was 6,320 individuals (95% CI = 4,387-9,249; DeVries 2006). The population contains more juveniles than expected. Comparisons to previous population estimates suggest that the population is increasing; however, there is high mortality between the juvenile and adult stages in this river. This mortality is thought to result from incidental capture in the shad fishery, which occurs at the same time as the spawning period (DeVries 2006).

The only available estimate for the Cooper River is of 300 spawning adults at the Pinoplis Dam spawning site (based on 1996-1998 sampling; Cooke et al. 2004). This is likely an underestimate of the total number of adults as it would not include non-spawning adults. Estimates for the Ogeechee River were 266 (95%CI=236-300) in 1993 (Weber 1996, Weber et al. 1998); a more recent estimate (sampling from 1999-2004; Fleming et al. 2003) indicates a population size of 147 (95% CI = 104-249). While the more recent estimate is lower, it is not significantly different than the previous estimate. Available information indicates the Ogeechee River population may be experiencing juvenile mortality rates greater than other southeastern rivers.

Spawning is also occurring in the Savannah River, the Congaree River, and the Yadkin-Pee Dee River. There are no population estimates available for these rivers. Occurrence in other southern rivers is limited, with capture in most other rivers limited to fewer than five individuals. They are thought to be extremely rare or possibly extirpated from the St. Johns River in Florida as only a single specimen was found by the Florida Fish and Wildlife Conservation Commission during extensive sampling of the river in 2002/2003. In these river systems, shortnose sturgeon occur in nearshore marine, estuarine, and riverine habitat.

3.5.2 THREATS

Because sturgeon are long-lived and slow growing, stock productivity is relatively low; this can make the species vulnerable to rapid decline and slow recovery (Musick 1999). In well studied rivers (e.g., Hudson, upper Connecticut), researchers have documented significant year to year recruitment variability (up to 10 fold over 20 years in the Hudson and years with no recruitment in the CT). However, this pattern is not unexpected given the life history characteristics of the species and natural variability in hydrogeologic cues relied on for spawning.

The small amount of effective movement between populations means recolonization of currently extirpated river populations is expected to be very slow and any future recolonization of any rivers that experience significant losses of individuals would also be expected to be very slow. Despite the significant decline in population sizes over the last century, gene diversity in shortnose sturgeon is moderately high in both mtDNA (Quattro et al. 2002; Wirgin et al. 2005; Wirgin et al. 2000) and nDNA (King et al. 2001) genomes.

A population of sturgeon can go extinct as a consequence of demographic stochasticity (fluctuations in population size due to random demographic events); the smaller the metapopulation (or population); the more prone it is to extinction. Anthropogenic impacts acting on top of demographic stochasticity further increase the risk of extinction.

All shortnose sturgeon populations are highly sensitive to increases in juvenile mortality that would result in reductions in the number of adult spawners (Anders et al. 2002; Gross et al. 2002; Secor 2002). Populations of shortnose sturgeon that do not have reliable natural recruitment are at increased risk of experiencing population decline leading to extinction (Secor et al. 2002). Elasticity studies of shortnose sturgeon indicate that the highest potential for increased population size and stability comes from YOY and juveniles as compared to adults (Gross et al. 2002); that is, increasing the number of YOY and juveniles has a more significant long term impact to the population than does increasing the number of adults or the fecundity of adults.

The Shortnose Sturgeon Recovery Plan (NMFS 1998) and the Shortnose Sturgeon Status Review Team's Biological Assessment of shortnose sturgeon (2010) identify habitat degradation or loss and direct mortality as principal threats to the species' survival. Natural and anthropogenic factors continue to threaten the recovery of shortnose sturgeon and include: poaching, bycatch in riverine fisheries, habitat alteration resulting from the presence of dams, in-water and shoreline construction, including dredging; degraded water quality which can impact habitat suitability and result in physiological effects to individuals including impacts on reproductive success; direct mortality resulting from dredging as well as impingement and entrainment at water intakes; and, loss of historical range due to the presence of dams. Shortnose sturgeon are also occasionally killed as a result of research activities. The total number of sturgeon affected by these various threats is not known. Climate change, particularly shifts in seasonal temperature regimes and changes in the location of the salt wedge, may impact shortnose sturgeon in the future (more information on Climate Change is presented in Section 6.0). More information on threats experienced in the action area is presented in the Environmental Baseline section of this Opinion.

3.5.3 SURVIVAL AND RECOVERY

The 1998 Recovery Plan outlines the steps necessary for recovery and indicates that each population may be a candidate for downlisting (i.e., to threatened) when it reaches a minimum population size that is large enough to prevent extinction and will make the loss of genetic diversity unlikely; the minimum population size for each population has not yet been determined. The Recovery Outline contains three major tasks: (1) establish delisting criteria; (2) protect shortnose sturgeon populations and habitats; and, (3) rehabilitate habitats and population segments. We know that in general, to recover, a listed species must have a sustained positive trend of increasing population over time. To allow that to happen for sturgeon, individuals must have access to enough habitat in suitable condition for foraging, resting and spawning. In many rivers, particularly in the Southeast, habitat is compromised and continues to impact the ability of sturgeon populations to recover. Conditions must be suitable for the successful development of early life stages. Mortality rates must be low enough to allow for recruitment to all age classes so that successful spawning can continue over time and over generations. There must be enough suitable habitat for spawning, foraging, resting and migrations of all individuals. Habitat connectivity must also be maintained so that individuals can migrate between important habitats without delays that impact their fitness. The loss of any population or metapopulation would result in the loss of biodiversity and would create (or widen) a gap in the species' range.

3.5.4 SUMMARY OF STATUS

Shortnose sturgeon remain listed as endangered throughout their range, with populations in the Northeast being larger and generally more stable than populations in the Southeast. All populations are affected by mortality incidental to other activities, including dredging, power plant intakes and shad fisheries where those still occur, and impacts to habitat and water quality that affect the ability of sturgeon to use habitats and impacts individuals that are present in those habitats. While the species is overall considered to be stable (i.e., its trend has not changed recently, and we are not aware of any new or emerging threats that would change the trend in the future), we lack information on abundance and population dynamics in many rivers. We also do not fully understand the extent of coastal movements and the importance of habitat in non-natal rivers to migrant fish. While the species has high levels of genetic diversity, the lack of effective movement between populations increases the vulnerability of the species should there be a significant reduction in the number of individuals in any one population or metapopulation as recolonization is expected to be very slow. All populations, regardless of size, are faced with threats that result in the mortality of individuals and/or affect the suitability of habitat and may restrict the further growth of the population. Additionally, there are several factors that combine to make the species particularly sensitive to existing and future threats; these factors include: the small size of many populations, existing gaps in the range, late maturation, the sensitivity of adults to very specific spawning cues which can result in years with no recruitment, and the impact of losses of young of the year and juveniles to population persistence and stability.

3.6 ATLANTIC STURGEON

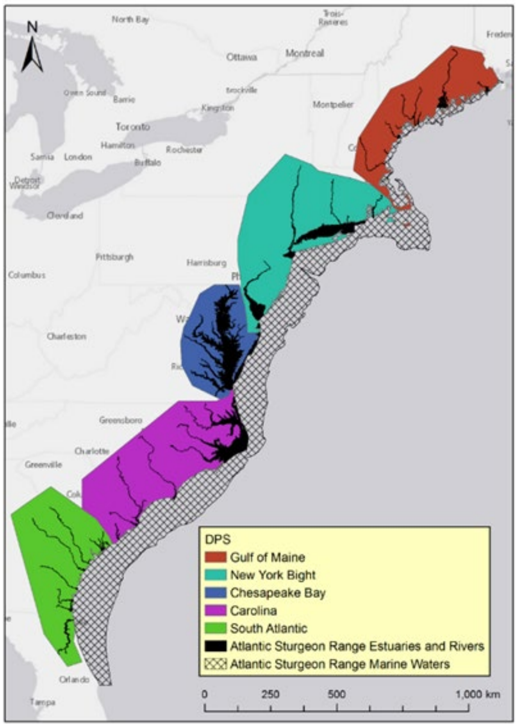
Atlantic sturgeon occur in the portion of the action area below the Brunswick Dam. An estuarine-dependent anadromous species, Atlantic sturgeon occupy ocean and estuarine waters, including sounds, bays, and tidal-affected rivers from Hamilton Inlet, Labrador, Canada, to Cape Canaveral, Florida (ASSRT, 2007) (Figure 6). On February 6, 2012, NMFS listed five DPSs of Atlantic sturgeon under the ESA: Gulf of Maine (GOM), New York Bight (NYB), Chesapeake Bay (CB), Carolina, and South Atlantic (77 FR 5880 and 77 FR 5914). The Gulf of Maine DPS is listed as threatened, and the New York Bight, Chesapeake Bay, Carolina, and South Atlantic DPSs are listed as endangered. As described below, only individuals from the Gulf of Maine DPS are expected to occur in the action area.

Determination of DPS Composition in the Action Area

As explained above, the range of all five DPSs overlaps and extends from Canada through Cape Canaveral, Florida (Figure 6). The distribution of Atlantic sturgeon is influenced by geography, with Atlantic sturgeon from a particular DPS becoming less common the further from the river of origin one moves. Areas that are geographically close are expected to have a similar composition of individuals. We have considered the best available information to determine from which DPSs individuals in the action area are likely to have originated.

As we will discuss in the Environmental Baseline (section 4.3), we do not expect subadult Atlantic sturgeon in the action area, and the only adults are expected to be spawning adults from the Gulf of Maine DPS. Because the best available information suggests that Atlantic sturgeon only spawn in their natal river, we expect all Atlantic sturgeon in the action area to be from the Gulf of Maine DPS.

Figure 6. U.S. range of Atlantic sturgeon DPSs



Information available from the 2007 Atlantic sturgeon status review (ASSRT, 2007), 2017 ASMFC benchmark stock assessment (ASMFC, 2017), final listing rules (77 FR 5880 and 77 FR 5914; February 6, 2012), and material supporting the designation of Atlantic sturgeon critical habitat (NMFS, 2017a) were used to summarize the life history, population dynamics, and status of the species.

Life History

Atlantic sturgeon are a late maturing, anadromous species (ASSRT, 2007; Balazik et al., 2010; Hilton et al., 2016; Sulak & Randall, 2002). Sexual maturity is reached between the ages of 5 to 34 years. Sturgeon originating from rivers in lower latitudes (e.g., South Carolina rivers) mature faster than those originating from rivers located in higher latitudes (e.g., Saint Lawrence River) (NMFS, 2017a).

Atlantic sturgeon spawn in freshwater (ASSRT, 2007; NMFS, 2017b) at sites with flowing water and hard bottom substrate (Bain et al., 2000; Balazik, Matthew T. et al., 2012; Gilbert, 1989; Greene et al., 2009; Hatin et al., 2002; Mohler, 2003; Smith & Clugston, 1997; Vladykov & Greeley, 1963). Water depths of spawning sites are highly variable, but may be up to 88.5 ft. (27 m) (Bain et al., 2000; Crance, 1987; Leland, 1968; Scott & Crossman, 1973). Based on tagging records, Atlantic sturgeon return to their natal rivers to spawn (ASSRT, 2007), with spawning intervals ranging from one to five years in males (Caron et al., 2002; Collins, Smith, et al., 2000; Smith, 1985) and two to five years in females (Stevenson & Secor, 1999; Van Eenennaam et al., 1996; Vladykov & Greeley, 1963). Some Atlantic sturgeon river populations may have up to two spawning seasons comprised of different spawning adults (Balazik & Musick, 2015; Collins, Smith, et al., 2000), although the majority likely have just one, either in the spring or fall.[8] There is evidence of spring and fall spawning for the South Atlantic DPS (77 FR 5914, February 6, 2012, Collins et al. 2000b, NMFS and USFWS 1998b) (Collins, Smith, et al., 2000; NMFS & USFWS, 1998) (Collins, Smith, et al., 2000; NMFS & USFWS, 1998) (Collins, Smith, et al., 2000; NMFS & USFWS, 1998) (Collins, Smith, et al., 2000; NMFS & USFWS, 1998) (Collins, Smith, et al., 2000; NMFS & USFWS, 1998) (Collins, Smith, et al., 2000; NMFS & USFWS, 1998) (Collins, Smith, et al., 2000; NMFS & USFWS, 1998) (Collins, Smith, et al., 2000; NMFS & USFWS, 1998) (Collins, Smith, et al., 2000; NMFS & USFWS, 1998) (Collins, Smith, et al., 2000; NMFS & USFWS, 1998) (Collins, Smith, et al., 2000; NMFS & USFWS, 1998) (Collins, Smith, et al., 2000; NMFS & USFWS, 1998) (Collins, Smith, et al., 2000; NMFS & USFWS, 1998) (Collins, Smith, et al., 2000; NMFS & USFWS, 1998) (Collins et al. 2000b, NMFS and USFWS 1998), spring spawning for the Gulf of Maine and New York Bight DPSs (NMFS, 2017a), and fall spawning for the Chesapeake and Carolina DPSs (Balazik, M. T. et al., 2012; Smith et al., 1984). While spawning has not been confirmed in the James River (Chesapeake Bay DPS), telemetry and empirical data suggest that there may be two potential spawning runs: a spring run from late March to early May and a fall run around September after an extended staging period in the lower river (Balazik, M. T. et al., 2012; Balazik & Musick, 2015).

Following spawning, males move downriver to the lower estuary and remain there until outmigration in the fall (Bain, 1997; Bain et al., 2000; Balazik, M. T. et al., 2012; Breece et al., 2013; Dovel, W. & Berggren, T., 1983; Greene et al., 2009; Hatin et al., 2002; Ingram et al., 2019; Smith, 1985; Smith et al., 1982). Females move downriver and may leave the estuary and travel to other coastal estuaries until outmigration to marine waters in the fall (Bain, 1997; Bain et al., 2000; Balazik, M. T. et al., 2012; Breece et al., 2013; Dovel, W. & Berggren, T., 1983; Greene et al., 2009; Hatin et al., 2002; NMFS, 2017a; Smith, 1985; Smith et al., 1982). Atlantic sturgeon deposit eggs on hard bottom substrate. They hatch into the yolk sac larval stage approximately 94 to 140 hours after deposition (Mohler, 2003; Murawski & Pacheco, 1977; Smith et al., 1980; Van Den Avyle, 1984; Vladykov & Greeley, 1963). Once the yolk sac is absorbed (eight to twelve days post-hatching), sturgeon are larvae. Shortly after, they become young of year and then juveniles. The juvenile stage can last months to years in the brackish waters of the natal estuary (ASSRT, 2007; Calvo et al., 2010; Collins, Rogers, et al., 2000; Dadswell, 2006; Dovel, W. L. & Berggren, T. J., 1983; Greene et al., 2009; Hatin et al., 2007; Holland & Yelverton, 1973; Kynard & Horgan, 2002; Mohler, 2003; Schueller & Peterson, 2010; Secor et al., 2000; Waldman et al., 1996). Upon reaching the sub-adult phase, individuals enter the marine environment, mixing with adults and sub-adults from other river systems (Bain, 1997; Dovel, W. & Berggren, T., 1983; Hatin et al., 2007; McCord et al., 2007) (NMFS, 2017a). Once sub-adult Atlantic sturgeon have reached maturity/the adult stage, they will remain in marine or estuarine waters, only returning far upstream to the spawning areas when they are ready to spawn (ASSRT, 2007; Bain, 1997; Breece et al., 2016; Dunton et al., 2012; Dunton et al., 2015; Savoy & Pacileo, 2003).

The life history of Atlantic sturgeon can be divided up into seven general categories as described in Table 8below (adapted from ASSRT 2007).

[8] Although referred to as spring spawning and fall spawning, the actual time of Atlantic sturgeon spawning may not occur during the astronomical spring or fall season (Balazik & Musick, 2015).

Table 8. Descriptions of Atlantic sturgeon life history stages

Age Class	Size	Duration	Description
Egg	~2 mm – 3 mm diameter (Van Eenennaam et al., 1996)(p. 773)	Hatching occurs ~3-6 days after egg deposition and fertilization (ASSRT, 2007)(p. 4))	Fertilized or unfertilized
Yolk-sac larvae (YSL)	~6mm – 14 mm (Bath et al., 1981)(pp. 714-715))	8-12 days post hatch (ASSRT, 2007)(p. 4))	Negative photo-taxic, nourished by yolk sac
Post yolk-sac larvae (PYSL)	~14mm – 37mm (Bath et al., 1981)(pp. 714-715))	12-40 days post hatch	Free swimming; feeding; Silt/sand bottom, deep channel; fresh water
Young of Year (YOY)	0.3 grams <410mm TL	From 40 days to 1 year	Fish that are > 40 days and < one year; capable of capturing and consuming live food
Juveniles	>410mm and <760mm TL	1 year to time at which first coastal migration is made	Fish that are at least age 1 and are not sexually mature and do not make coastal migrations.
Subadults	>760 mm and <1500 mm TL	From first coastal migration to sexual maturity	Fish that are not sexually mature but make coastal migrations
Adults	>1500 mm TL	Post-maturation	Sexually mature fish

Population Dynamics

A population estimate was derived from the NEAMAP trawl surveys.[9] For this Opinion, as we did in the prior 2013 Opinion, we are relying on the population estimates derived from the NEAMAP swept area biomass assuming a 50% catchability (i.e., net efficiency x availability)

[9] Since fall 2007, NEAMAP trawl surveys (spring and fall) have been conducted from Cape Cod, Massachusetts to Cape Hatteras, North Carolina in nearshore waters at depths up to 60 ft. (18.3 m). Each survey employs a spatially stratified random design with a total of 35 strata and 150 stations.

rate. We consider that the NEAMAP surveys sample an area utilized by Atlantic sturgeon but do not sample all the locations and times where Atlantic sturgeon are present. We also consider that the trawl net captures some, but likely not all, of the Atlantic sturgeon present in the sampling area. Therefore, we assume that net efficiency and the fraction of the population exposed to the NEAMAP surveys in combination result in a 50% catchability (NMFS, 2013). The 50% catchability assumption reasonably accounts for the robust, yet not complete, sampling of the Atlantic sturgeon oceanic temporal and spatial ranges and the documented high rates of encounter with NEAMAP survey gear. As these estimates are derived directly from empirical data with fewer assumptions than have been required to model Atlantic sturgeon populations to date, we believe these estimates continue to serve as the best available information. Based on the above approach, the overall abundance of Atlantic sturgeon in U.S. Atlantic waters is estimated to be 67,776 fish (see table16 in Kocik et al. 2013). Based on genetic frequencies of occurrence in the sampled area, this overall population estimate was subsequently partitioned by DPS (Table 9). Given the proportion of adults to sub-adults in the NMFS NEFSC observer data (approximate ratio of 1:3), we have also estimated the number of adults and sub-adults originating from each DPS. However, this cannot be considered an estimate of the total number of sub-adults because it only considers those sub-adults that are of a size that are present and vulnerable to capture in commercial trawl and gillnet gear in the marine environment.

It is important to note, the NEAMAP-based estimates do not include young-of-the-year (YOY) fish and juveniles in the rivers. The NEAMAP surveys are conducted in waters that include the preferred depth ranges of sub-adult and adult Atlantic sturgeon and take place during seasons that coincide with known Atlantic sturgeon coastal migration patterns in the ocean. However, the estimated number of sub-adults in marine waters is a minimum count because it only considers those sub-adults that are captured in a portion of the action area and are present in the marine environment, which is only a fraction of the total number of sub-adults. In regards to adult Atlantic sturgeon, the estimated population in marine waters is also a minimum count as the NEAMAP surveys sample only a portion of the action area, and therefore a portion of the Atlantic sturgeon's range.

Table 9. Calculated population estimates based upon the NEAMAP survey swept area model, assuming 50% efficiency

DPS	Estimated Ocean Population Abundance	Estimated Ocean Population of Adults	Estimated Ocean Population of Sub-adults (of size vulnerable to capture in fisheries)
GOM	7,455	1,864	5,591
NYB	34,566	8,642	25,925
CB	8,811	2,203	6,608
Carolina	1,356	339	1,017
SA	14,911	3,728	11,183
Canada	678	170	509

Precise estimates of population growth rate (intrinsic rates) are unknown for the five listed DPSs of Atlantic sturgeon due to a lack of long-term abundance data. The Commission's 2017 stock assessment referenced a population viability assessment (PVA) that was done to determine population growth rates for the five DPSs based on a few long-term survey programs, but most results were statistically insignificant or utilized a model for which the available did not or poorly fit. In any event, the population growth rates reported from that PVA ranged from -1.8% to 4.9% (ASMFC, 2017).

The genetic diversity of Atlantic sturgeon throughout its range has been well-documented (ASSRT, 2007; Bowen & Avise, 1990; O'Leary et al., 2014; Ong et al., 1996; Waldman et al., 1996; Waldman & Wirgin, 1998). Overall, these studies have consistently found populations to be genetically diverse, and the majority can be readily differentiated. Relatively low rates of gene flow reported in population genetic studies (Fritts et al., 2016; Savoy et al., 2017; Wirgin et al., 2002) indicate that Atlantic sturgeon return to their natal river to spawn, despite extensive mixing in coastal waters.

The marine range of U.S. Atlantic sturgeon extends from Labrador, Canada, to Cape Canaveral, Florida. As Atlantic sturgeon travel long distances in these waters, all five DPSs of Atlantic sturgeon have the potential to be anywhere in this marine range. Results from genetic studies show that, regardless of location, multiple DPSs can be found at any one location along the Northwest Atlantic coast, although the Hudson River population from the New York Bight DPS dominates (ASMFC, 2017; ASSRT, 2007; Dadswell, 2006; Dovel, W. & Berggren, T., 1983; Dunton et al., 2012; Dunton et al., 2015; Dunton et al., 2010; Erickson et al., 2011; Kynard et al., 2000; Laney et al., 2007; O'Leary et al., 2014; Stein et al., 2004b; Waldman et al., 2013; Wirgin, Breece, et al., 2015; Wirgin, Maceda, et al., 2015; Wirgin et al., 2012).

Based on fishery-independent, fishery dependent, tracking, and tagging data, Atlantic sturgeon appear to primarily occur inshore of the 164 ft. (50 m) depth contour (Dunton et al., 2012; Dunton et al., 2010; Erickson et al., 2011; Laney et al., 2007; O'Leary et al., 2014; Stein et al., 2004a, 2004b; Waldman et al., 2013; Wirgin, Breece, et al., 2015; Wirgin, Maceda, et al., 2015). However, they are not restricted to these depths and excursions into deeper (e.g., 250 ft. (75 m)) continental shelf waters have been documented (Colette & Klein-MacPhee, 2002; Collins & Smith, 1997; Erickson et al., 2011; Stein et al., 2004b; Timoshkin, 1968). Data from fishery-independent surveys and tagging and tracking studies also indicate that some Atlantic sturgeon may undertake seasonal movements along the coast (Dunton et al., 2010; Erickson et al., 2011; Hilton et al., 2016; Oliver et al., 2013; Post et al., 2014; Wippelhauser, 2012). For instance, studies found that satellite-tagged adult sturgeon from the Hudson River concentrated in the southern part of the Mid-Atlantic Bight, at depths greater than 66 ft. (20 m), during winter and spring; while, in the summer and fall, Atlantic sturgeon concentrations shifted to the northern portion of the Mid-Atlantic Bight at depths less than 66 ft. (20 m) (Erickson et al., 2011).

In the marine range, several marine aggregation areas occur adjacent to estuaries and/or coastal features formed by bay mouths and inlets along the U.S. eastern seaboard (i.e., waters off North Carolina; Chesapeake Bay; Delaware Bay; New York Bight; Massachusetts Bay; Long Island Sound; and Connecticut and Kennebec River Estuaries). Depths in these areas are generally no greater than 82 ft. (25 m) (Bain et al., 2000; Dunton et al., 2010; Erickson et al., 2011; Laney et al., 2007; O'Leary et al., 2014; Oliver et al., 2013; Savoy & Pacileo, 2003; Stein et al., 2004b;

Waldman et al., 2013; Wippelhauser, 2012; Wippelhauser & Squiers, 2015). Although additional studies are still needed to clarify why Atlantic sturgeon aggregate at these sites, there is some indication that they may serve as thermal refugia, wintering sites, or marine foraging areas (Dunton et al., 2010; Erickson et al., 2011; Stein et al., 2004b).

Status

Atlantic sturgeon were once present in 38 river systems and, of these, spawned in 35 (ASSRT, 2007). They are currently present in 36 rivers and are probably present in additional rivers that provide sufficient forage base, depth, and access (ASSRT, 2007). The benchmark stock assessment evaluated evidence for spawning tributaries and sub-populations of U.S. Atlantic sturgeon in 39 rivers. They confirmed (eggs, embryo, larvae, or YOY observed) spawning in ten rivers, considered spawning highly likely (adults expressing gametes, discrete genetic composition) in nine rivers, and suspected (adults observed in upper reaches of tributaries, historical accounts, presence of resident juveniles) spawning in six rivers. Spawning in the remaining rivers was unknown (ten) or suspected historical (four) (ASMFC, 2017). The decline in abundance of Atlantic sturgeon has been attributed primarily to the large U.S. commercial fishery, which existed for the Atlantic sturgeon through the mid-1990s. Based on management recommendations in the ISFMP, adopted by the Commission in 1990, commercial harvest in Atlantic coastal states was severely restricted and ultimately eliminated from most coastal states (ASMFC, 1998a). In 1998, the Commission placed a 20-40 year moratorium on all Atlantic sturgeon fisheries until the spawning stocked could be restored to a level where 20 subsequent year classes of adult females were protected (ASMFC, 1998a, 1998b). In 1999, NMFS closed the U.S. EEZ to Atlantic sturgeon retention, pursuant to the ACA (64 FR 9449; February 26, 1999). However, many state fisheries for sturgeon were closed prior to this.

The most significant threats to Atlantic sturgeon are incidental catch, dams that block access to spawning habitat in southern rivers, poor water quality, dredging of spawning areas, water withdrawals from rivers, and vessel strikes. Climate change related impacts on water quality (e.g., temperature, salinity, dissolved oxygen, contaminants) also have the potential to affect Atlantic sturgeon populations using impacted river systems.

In support of the above, the Commission released a new benchmark stock assessment for Atlantic sturgeon in October 2017 (ASMFC, 2017). Based on historic removals and estimated effective population size, the 2017 stock assessment concluded that all five Atlantic sturgeon DPSs are depleted relative to historical levels. However, the 2017 stock assessment does provide some evidence of population recovery at the coastwide scale, and mixed population recovery at the DPS scale (ASMFC, 2017). The 2017 stock assessment also concluded that a variety of factors (i.e., bycatch, habitat loss, and ship strikes) continue to impede the recovery rate of Atlantic sturgeon (ASMFC, 2017).

Despite the depleted status, the Commission's assessment did include signs that the coastwide index is above the 1998 value (95% probability). Total mortality from the tagging model was very low at the coastwide level. Small sample sizes made mortality estimates at the DPS level more difficult. By DPS, the assessment concluded that there was a 51% probability that the Gulf of Maine DPS abundance has increased since 1998 but a 74% probability that mortality for this

DPS exceeds the mortality threshold used for the assessment. There is a relatively high (75%) probability that the New York Bight DPS abundance has increased since 1998, and a 31% probability that mortality exceeds the mortality threshold used for the assessment. There is also a relatively high (67%) probability that the Carolina DPS abundance has increased since 1998, and a relatively high probability (75%) that mortality for this DPS exceeds the mortality threshold used in the assessment. However, the index from the Chesapeake Bay DPS (highlighted red) only had a 36% chance of being above the 1998 value and a 30% probability that the mortality for this DPS exceeds the mortality threshold for the assessment. There was not enough information available to assess the abundance for the for the South Atlantic DPS relative to the 1998 moratorium, but the assessment did conclude that there was 40% probability that the mortality for this DPS exceeds the mortality threshold used in the assessment (ASMFC, 2017).

5.3.1 Gulf of Maine DPS

The Gulf of Maine DPS includes the following: all anadromous Atlantic sturgeons that are spawned in the watersheds from the Maine/Canadian border and, extending southward, all watersheds draining into the Gulf of Maine as far south as Chatham, MA. Within this range, Atlantic sturgeon historically spawned in the Androscoggin, Kennebec, Merrimack, Penobscot, and Sheepscot Rivers (ASSRT, 2007).Spawning occurs in the Kennebec River. During the study period of 2009-2011, eight sturgeon, including one male in spawning condition, were also captured in the Androscoggin River estuary, which suggests that spawning may be occurring in the Androscoggin River as well (Wippelhauser et al. 2017). However, additional evidence, such as capture of a spawning female, sturgeon eggs or larvae, is not yet available to confirm that spawning for the Gulf of Maine DPS is occurring in that river (NMFS 2018).There is no evidence of recent spawning in the remaining rivers. Atlantic sturgeons that are spawned elsewhere continue to use habitats within all of these rivers as part of their overall marine range (ASSRT, 2007). The movement of subadult and adult sturgeon between rivers, including to and from the Kennebec River and the Penobscot River, demonstrates that coastal and marine migrations are key elements of Atlantic sturgeon life history for the Gulf of Maine DPS (ASSRT, 2007; Fernandes, *et al.*, 2010).

The current status of the Gulf of Maine DPS is affected by historical and modern fisheries dating as far back as the 1800s (Squiers *et al.*, 1979; Stein *et al.*, 2004; ASMFC 2007). Incidental capture of Atlantic sturgeon in state and Federal fisheries continues today. As explained above, we have estimates of the number of subadults and adults that are killed as a result of bycatch in fisheries authorized under Northeast FMPs. At this time, we are not able to quantify the impacts from other threats or estimate the number of individuals killed as a result of other anthropogenic threats. Habitat disturbance and direct mortality from anthropogenic sources are the primary concerns.

Some of the impacts from the threats that contributed to the decline of the Gulf of Maine DPS have been removed (e.g., directed fishing), or reduced as a result of improvements in water quality and removal of dams (e.g., the Edwards Dam on the Kennebec River in 1999, the Veazie Dam on the Penobscot River). There are strict regulations on the use of fishing gear in Maine state waters that incidentally catch sturgeon. In addition, there have been reductions in fishing effort in state and federal waters, which most likely would result in a reduction in bycatch mortality of Atlantic sturgeon. A significant amount of fishing in the Gulf of Maine is conducted using trawl gear, which is known to have a much lower mortality rate for Atlantic sturgeon caught in the gear compared to sink gillnet gear (ASMFC, 2007). Atlantic sturgeon from the GOM DPS are not commonly taken as bycatch in areas south of Chatham, MA, with only 8 percent (e.g., 7 of the 84 fish) of interactions observed in the Mid Atlantic/Carolina region being assigned to the Gulf of Maine DPS (Wirgin and King, 2011). Tagging results also indicate that Gulf of Maine DPS fish tend to remain within the waters of the Gulf of Maine and only occasionally venture to points south. However, data on Atlantic sturgeon incidentally caught in trawls and intertidal fish weirs fished in the Minas Basin area of the Bay of Fundy (Canada) indicate that approximately 35 percent originated from the Gulf of Maine DPS (Wirgin *et al.*, in draft).

As noted previously, studies have shown that in order to rebuild, Atlantic sturgeon can only sustain low levels of bycatch and other anthropogenic mortality (Boreman, 1997; ASMFC, 2007; Kahnle *et al.*, 2007; Brown and Murphy, 2010). NMFS has determined that the Gulf of Maine DPS is at risk of becoming endangered in the foreseeable future throughout all of its range (i.e., is a threatened species) based on the following: (1) significant declines in population sizes and the protracted period during which sturgeon populations have been depressed; (2) the limited amount of current spawning; and, (3) the impacts and threats that have and will continue to affect recovery.

Critical Habitat

Critical habitat has been designated for the five DPSs of Atlantic sturgeon (82 FR 39160, August 17, 2017) in rivers of the eastern United States. See section 4 for more information.

Recovery Goals

A Recovery Plan has not been completed for any DPS of Atlantic sturgeon. In 2018, NMFS published a Recovery Outline to serve as an initial recovery-planning document. In this, the recovery vision is stated, "Subpopulations of all five Atlantic sturgeon DPSs must be present across the historical range. These subpopulations must be of sufficient size and genetic diversity to support successful reproduction and recovery from mortality events. The recruitment of juveniles to the sub-adult and adult life stages must also increase and that increased recruitment must be maintained over many years. Recovery of these DPSs will require conservation of the riverine and marine habitats used for spawning, development, foraging, and growth by abating threats to ensure a high probability of survival into the future." The Outline also includes steps that are expected to serve as an initial recovery action plan. These include protecting extant subpopulations and the species' habitat through reduction of threats; gathering information through research and monitoring on current distribution and abundance; and addressing vessel strikes in rivers, the effects of climate change and bycatch.

3.7 Critical Habitat Designated for the GOM DPS of Atlantic Sturgeon

On August 17, 2017, we issued a final rule to designate critical habitat for the threatened Gulf of Maine DPS of Atlantic sturgeon, the endangered New York Bight DPS of Atlantic sturgeon, the endangered Chesapeake Bay DPS of Atlantic sturgeon, the endangered Carolina DPS of Atlantic sturgeon, and the endangered South Atlantic DPS of Atlantic sturgeon (82 FR 39160). The rule was effective on September 18, 2017. The action area overlaps with the Androscoggin River critical habitat unit designated for the Gulf of Maine DPS.

The conservation objective identified in the final rule is to increase the abundance of each DPS by facilitating increased successful reproduction and recruitment to the marine environment. We designated five critical habitat units to achieve this objective for the Gulf of Maine DPS: (1) Penobscot River mainstem from the Milford Dam downstream for 53 river kilometers (rkms) to where the mainstem river discharges at its mouth into Penobscot Bay; (2) Kennebec River mainstem from the Ticonic Falls/Lockwood Dam downstream for 103 rkms to where the mainstem river discharges at its mouth into the Atlantic Ocean; (3) Androscoggin River mainstem from the Brunswick Dam downstream for 10 rkms to where the mainstem river discharges at its mouth into Merrymeeting Bay; (4) Piscataqua River from its confluence with the Salmon Falls and Cocheco rivers downstream for 19 rkms to where the mainstem river discharges at its mouth into the Atlantic Ocean as well as the waters of the Cocheco River from its confluence with the Piscataqua River and upstream 5 rkms to the Cocheco Falls Dam, and waters of the Salmon Falls River from its confluence with the Piscataqua River and upstream 6 rkms to the Route 4 Dam; and, (5) Merrimack River from the Essex Dam (also known as the Lawrence Dam) downstream for 48 rkms to where the mainstem river discharges at its mouth into the Atlantic Ocean. In total, these designations encompass approximately 244 kilometers (152 miles) of aquatic habitat.

As identified in the final rule, the physical features that are essential to the conservation of the species and that may require special management considerations or protection are:

1) Hard bottom substrate (*e.g.,* rock, cobble, gravel, limestone, boulder, etc.) in low salinity waters (*i.e.,* 0.0 to 0.5 parts per thousand (ppt) range) for settlement of fertilized eggs, refuge, growth, and development of early life stages;
2) Aquatic habitat with a gradual downstream salinity gradient of 0.5 up to as high as 30 ppt and soft substrate (*e.g.,* sand, mud) between the river mouth and spawning sites for juvenile foraging and physiological development;
3) Water of appropriate depth and absent physical barriers to passage (*e.g.,* locks, dams, thermal plumes, turbidity, sound, reservoirs, gear, etc.) between the river mouth and spawning sites necessary to support:
   (i) Unimpeded movement of adults to and from spawning sites;
   (ii) Seasonal and physiologically dependent movement of juvenile Atlantic sturgeon to appropriate salinity zones within the river estuary; and
   (iii) Staging, resting, or holding of subadults or spawning condition adults.

   Water depths in main river channels must also be deep enough (*e.g.,* at least 1.2 m) to ensure continuous flow in the main channel at all times when any sturgeon life stage would be in the river.
4) Water, between the river mouth and spawning sites, especially in the bottom meter of the water column, with the temperature, salinity, and oxygen values that, combined, support:
   (i) Spawning;

(ii) Annual and interannual adult, subadult, larval, and juvenile survival; and

(iii) Larval, juvenile, and subadult growth, development, and recruitment (*e.g.,* 13 °C to 26 °C for spawning habitat and no more than 30 °C for juvenile rearing habitat, and 6 milligrams per liter (mg/L) dissolved oxygen (DO) or greater for juvenile rearing habitat).

The paragraphs that follow are excerpted from the ESA Section 4(b)(2) Report for Atlantic sturgeon critical habitat (NMFS 2017). That document provides background information on the current status and function of the four critical habitat units designated for the Gulf of Maine DPS, and summarizes their ability to support reproduction, survival, and juvenile development, and recruitment. Additional information on the status of the Gulf of Maine DPS relevant to the current status and function of critical habitat can be found in Section 4.5.

> The Kennebec River was the only known spawning river for the Gulf of Maine DPS when the DPS was listed as threatened (ASSRT, 2007; 77 FR 5880, and February 6, 2012). Spawning has since been confirmed in the Androscoggin River (Wippelhauser, 2012). The Brunswick Dam is the upstream limit of Atlantic sturgeon distribution in the Androscoggin River, and the likely historical upstream limit given the dam is built at the head of tide at Pejepscot Falls, a natural barrier to sturgeon passage. The Brunswick Dam is located approximately 10 RKMs upstream of the confluence of the Kennebec and Androscoggin rivers (ASMFC, 1998; ASSRT, 2007; NMFS, 2013; Wippelhauser and Squiers, 2015). The Lockwood Dam at RKM 103 is the current upstream limit for Atlantic sturgeon in the Kennebec River and is also located at the site of a natural falls; considered the historic upstream limit for Atlantic sturgeon on the River (ASSRT, 2007). From 1837 to 1999, the Edwards Dam was the upstream limit of Atlantic sturgeon in the Kennebec River. Located near the head of tide, approximately 29 RKMs downstream of the Lockwood Dam, the Edwards Dam (formerly at RKM 74) prevented Atlantic sturgeon from accessing historical habitat. Sturgeon were sighted above the former Edwards Dam site after removal of the dam. In June 2005, an Atlantic sturgeon was incidentally captured as far upriver as RKM 102 (ASSRT, 2007; Wippelhauser, 2012).
>
> Substrate type in the Kennebec estuary is largely sand and bedrock (Fenster and Fitzgerald 1996; Moore and Reblin, 2008). Mesohaline waters occur upstream of Doubling Point (approximately RKM 16) during summer low flows, transitioning to oligohaline waters and then essentially tidal freshwater from Chops Point (the outlet of Merrymeeting Bay at approximately RKM 30) 10 upriver to the head of tide on the Kennebec and Androscoggin rivers (ASMFC, 1998; Kistner and Pettigrew, 2001; Moore and Reblin; 2008; Wippelhauser, 2012).
>
> During the period 1977-2001, Atlantic sturgeon in spawning condition (i.e., ripe males releasing milt) or of size presumed to be sexually mature adults (i.e., > 150 centimeter total length) were caught between RKM 52.8 and RKM 74 of the Kennebec River during the months of June and July, the likely spawning season. From 2009 to 2011, 31 Atlantic sturgeon, including 6 ripe males, were caught in the Kennebec River between RKM 70 and RKM 75 (Wippelhauser, 2012; Wippelhauser and Squiers, 2015). Sturgeon in the Upper Kennebec Estuary (defined as RKM 45 to RKM 74 at head of tide in the cited

document) repeatedly moved between RKM 48 and RKM 75 (Wippelhauser, 2012). An additional eight sturgeon, including one ripe male, were caught in the Androscoggin in June and July of 2009-2011 (Wippelhauser, 2012). Three larvae were captured in the Upper Kennebec Estuary, 1 to 1.6 RKMs upstream of the former Edwards Dam site (RKM 74) (Wippelhauser, 2012).

Merrymeeting Bay and the Lower Kennebec Estuary were used by post-spawn adults, juveniles, and other life stages at least as late as November 7. Tagging detections the following spring suggest that some subadult Atlantic sturgeon may have overwintered in Merrymeeting Bay (Wippelhauser, 2012). Sturgeon captured and tagged in the Saco and Penobscot rivers were also detected in the Kennebec Estuary, typically Merrymeeting Bay and downstream locations, although at least one male, captured in the Saco in 2010, was the single ripe male also captured in the Androscoggin (Wippelhauser, 2012). Genetic information to identify this Atlantic sturgeon to the river of origin is not available.

The Penobscot River estuary is about 51 RKMs long from the head of tide to Searsport, ME. During spring freshets tidal freshwater extends to Winterport (RKM 29), and during low flow months the salt front extends upstream as far as Hamden (RKM 40) (ASMFC, 1998). The two lowermost dams on the Penobscot River, Great Works Dam and Veazie Dam (at RKM 56), were removed in 2012 and 2013, respectively, opening up all known historical Atlantic sturgeon habitat in the Penobscot River, and access to more of the tidal freshwater habitat.

The upper part of the Penobscot River estuary (RKM 34 to RKM 43) is characterized as freshwater, with depths of 2.5 – 9 meters depending on tide and position in the river, and are predominantly cobble and gravel substrate. The middle part (RKM 26 to RKM 31) has an average water depth of 7.5 meters with maximum salinity of 2.5 ppt (i.e., oligohaline waters) in June, and muddy substrate with high levels of organic matter (mostly decaying wood chips and sawdust), whereas the lower part of the estuary (RKM 21 to RKM 24) has salinities of approximately 15 ppt during summer, and a predominance of sand substrate (Dzaugis, 2013).

The Piscataqua River is formed by the confluence of the Salmon Falls and Cocheco Rivers, and is part of the Great Bay Estuary. The Piscataqua River is tidal throughout it length, approximately 21 RKMs, to its mouth at Portsmouth Harbor. Head of tide occurs upriver of the confluence, at the location of the lowermost dams on the Salmon Falls and Cocheco Rivers (Short, 1992; SBCC, 2009). Salinity of the Piscataqua River ranges from polyhaline at the mouth of the river to oligohaline at the head of tide on the Salmon Falls and Cocheco rivers. Overall, the estuary is heavily influenced by the tidal flow. Dissolved oxygen is typically above 6.0 mg/L, and is very consistent throughout the water column in the Piscataqua River. The average depth at mid-tide is approximately 3.2 meters although this varies with both tide and topography. Substrate varies from soft mud to hard sand to gravel. (Short, 1992; ASMFC, 1998; Trowbridge, 2007). The 2007 Atlantic sturgeon status review provided information on directed effort to catch Atlantic sturgeon in the Piscataqua River, and incidental capture of a large, ripe female Atlantic sturgeon near the head of tide in the Salmon Falls River in 1990. Between 2010 and 2016, three Atlantic sturgeon were detected in the Piscataqua River using passive acoustic array (M. Kieffer, USGS, pers. comm.). There are no current directed studies for Atlantic sturgeon in the Piscataqua River or Great Bay Estuary other than the use of the passive acoustic receivers for a part of the year in some areas of the river.

In the 1800s, construction of the Essex Dam on the Merrimack River (at RKM 48) blocked Atlantic sturgeon access to about 58 percent of historical habitat (ASMFC, 1998; Oakley, 2003; ASSRT, 2007). Tidal influence extends to RKM 35. The salt front extends upriver to RKM 16 in summer at the lowest river discharges (Kieffer and Kynard 1993; ASMFC, 1998). The non-tidal section is dominated by sand and gravel and depths less than three meters. Thus, there is approximately 19 RKMs of tidal freshwater and 11 RKMs of freshwater habitat available for the early life stages of Atlantic sturgeon during the summer months. Atlantic sturgeon are regularly present in the Merrimack River. Although there are no recent reports of Atlantic sturgeon spawning in the Merrimack River, the success of shortnose sturgeon spawning in the river suggests Atlantic sturgeon spawning would be successful as well.

While there is no current evidence that Atlantic sturgeon are spawning in Gulf of Maine rivers other than the Kennebec and Androscoggin, captures of sturgeon in the Merrimack, Penobscot and Piscataqua/Salmon Falls/Cocheco rivers indicate that there is the potential for spawning to occur in these rivers.

Gulf of Maine DPS Atlantic sturgeon travel great distances in the marine environment, and their marine range includes waters under Canadian jurisdiction. Genetics information is available for Atlantic sturgeon captured in six specific areas of their marine range: Bay of Fundy, Connecticut River estuary and Long Island Sound, New York and New Jersey coast, Delaware coast, Long Island coast off of Rockaway, New York, and waters off of the Virginia/North Carolina border. The Gulf of Maine DPS comprised 0 to 14.5 percent of Atlantic sturgeon sampled in these areas with the exception of the Bay of Fundy collection where the Gulf of Maine DPS comprised 35 percent of the Atlantic sturgeon sampled (Laney et al., 2007; Dunton et al., 2012; Wirgin et al., 2012; Waldman et al., 2013; O'Leary et al., 2014; Wirgin et al., 2015a). The greater concentration of Gulf of Maine DPS Atlantic sturgeon in some parts of its marine range suggests certain marine habitats are more useful to and perhaps also essential to the Gulf of Maine DPS. As previously noted, we cannot designate critical habitat in areas outside of U.S. jurisdiction.

The action area for the proposed work considered in this Opinion covers a portion of the Androscoggin River critical habitat unit. The critical habitat designation is bank-to-bank within the Androscoggin River. It contains three of the four PBFs; it does not contain PBF 2, aquatic habitat with a gradual downstream salinity gradient of 0.5 up to as high as 30 ppt and soft substrate (*e.g.,* sand, mud) between the river mouth and spawning sites for juvenile foraging and physiological development. Information on the PBFs within the action area is contained in the Environmental Baseline section below (section 4.4).

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 Brunswick and Lewiston Falls Projects. 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; as such, the existence of the dams and the resultant effects (e.g., barrier to passage, creation of the impoundment) are part of the environmental baseline for this consultation.

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 includes the mainstem of the Androscoggin River from the Lewiston Falls dam to where it flows into Merrymeeting Bay. Past impacts of the operation of the Brunswick and Lewiston Falls Projects are considered in the Environmental Baseline. State, Federal and private actions in other areas of the Androscoggin River may impact listed species 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 Androscoggin River watershed supports a very small run of Atlantic salmon and a modest fry stocking program. As such, all lifestages of Atlantic salmon could be present in entirety of the action area.

The Androscoggin River originates at Umbagog Lake near Errol, New Hampshire and flows roughly 260 km past several towns including, Rumford, Dixfield, Jay, Livermore Falls, and Brunswick as well as the city of Lewiston-Auburn (MDEP 1999). The upper portions of the Androscoggin are high gradient. The Androscoggin River drops over 305 meters from its headwaters to where it meets the sea, with an average gradient of 3.9 meters per kilometer. In the Androscoggin watershed, Rumford Falls was the historic upper extent of Atlantic salmon migration, while Lewiston Falls was believed to be the upper extent of alewife and shad migrations (Foster & Atkins, 1867). The Little Androscoggin River is the largest major sub-basin of the Androscoggin with historically important salmon habitat that was accessible as far up as Snow's Falls located 3.2 km outside of West Paris (Foster & Atkins, 1867). Prior to its damming, the Androscoggin River provided access to a large and diverse aquatic habitat for great numbers of diadromous and resident fish species.

Currently, sea-run fish can access habitat up to the Lewiston Falls Dam on the mainstem, the Lower Barker Dam on the Little Androscoggin, and up to the Farwell Dam on the Sabbattus River. This accessible habitat represents less than 5% of the total historical salmon habitat in the Androscoggin River watershed.

Upstream Migrating Adults

Based on historical reports, Atlantic salmon were abundant in the Androscoggin River. Adult returns have dwindled and native stocks of Atlantic salmon are considered extirpated south of the Androscoggin River watershed. Dams, pollution, oceanic conditions, and over-fishing have contributed to the decline of Atlantic salmon in the Androscoggin River. The returns of adult Atlantic salmon to the Androscoggin River in recent years have been small, and mostly comprised of stray, hatchery origin fish from active restoration programs on other rivers (USASAC 2021, Table 10). The 10-year (2011-2020) average annual return for the decade is six. However, if 2011 is excluded as an outlier, the average return is reduced to only two fish annually.

Table 10. Adult Atlantic salmon returns by origin to the Androscoggin River recorded from 1983 to 2019 at the Brunswick Project (USASAC, 2021).

	HATCHERY ORIGIN				NATURALLY REARED ORIGIN				
	1SW	2SW	3SW	Repeat	1SW	2SW	3SW	Repeat	Total
Androscoggin									
1983-2010	55	572	6	2	9	92	0	1	**737**
2011	2	27	0	0	1	14	0	0	**44**
2012	0	0	0	0	0	0	0	0	**0**
2013	0	1	0	0	0	1	0	0	**2**
2014	0	2	0	0	0	1	0	0	**3**
2015	0	0	0	0	0	1	0	0	**1**
2016	0	0	0	0	0	6	0	0	**6**
2017	0	0	0	0	0	0	0	0	**0**
2018	0	0	0	0	0	1	0	0	**1**
2019	0	1	0	0	0	0	0	0	**1**
2020	0	3	0	0	0	2	0	0	**5**
Total for Androscoggin	57	606	0	2	10	118	0	0	**800**

There have been few studies of Atlantic salmon in the Androscoggin River. In 2011, MDMR radio tagged 21 adult salmon (12 naturally reared and 9 hatchery raised) when they were trapped at the Brunswick Dam (MDMR, 2012). 29% (6 out of 21) of these fish dropped out of the Androscoggin soon after they were released, and at least four of these continued their migration in the Kennebec River. 43% (9 out of 21) of the tagged fish successfully migrated past the Pejepscot Project, whereas fewer than 10% (2 out of 21) successfully passed all three dams in the lower Androscoggin (MDMR, 2012). The remaining 29% (6 out of 21) passed the Brunswick Project but did not migrate any further in the River. The study showed minimal use of tributaries in the system, although many fish were detected in the mainstem, holding in the vicinity of cool water tributaries during the summer months (Little River and Meadow Brook downstream of the Worumbo project; Gerrish Brook upstream of the Worumbo Project; and Simpson Brook downstream of the Pejepscot Project). One female Atlantic salmon was detected several times in the Little River, and may have spawned with an untagged male in one of its tributaries. Likewise, one tagged male was detected in the bypass reach of Lower Barker Dam and may have spawned with an untagged female (MDMR, 2012).

Numerous adults were detected holding the Brunswick impoundment for at least a portion of the study period (MDMR, 2012). Individuals were detected in the impoundment every week of the six month study with an average of six tagged salmon (range 4 to14) located there per week. Of all the detections made of the 21 study fish from June to December, 42% were in the Brunswick impoundment. Salmon were also located downstream of the Brunswick Project, with 15% of the detections occurring in the tidal portion of the Androscoggin and Kennebec, or the non-tidal portions of the Kennebec. These salmon were released upstream of the dam, but then dropped back over the dam into the lower river and estuary. It is unknown if their failure to pass the dam again was associated with passage inefficiencies, or some other factor.

The known accessible spawning habitat in the Androscoggin is in the Little River (between second and third dams on the river) and in the tailrace of the Lower Barker Dam in the Little Androscoggin River (between the third and fourth (Lewiston Falls) dams on the river. It is not known how many Atlantic salmon migrate to this habitat and successfully spawn. Given the minimal stocking and the small number of adult salmon returning the Androscoggin there have been few surveys or studies to reference. As indicated above, salmon were documented in the Little River and the Little Androscoggin during the spawning season in the 2011 telemetry study (MDMR, 2012). Salmon redds have been documented in the Little River over the last decade (USASAC, 2019), and two salmon were observed spawning in that habitat in 2014 (USASAC, 2015). Young of year salmon (YOY) were sampled in the Little River the following year, which suggests that the spawning event was successful (USASAC, 2016). Given this information, we anticipate that salmon will use the habitat in the Little River, and potentially the Little Androscoggin River, for spawning and rearing if they can successfully access it.

<u>Juveniles</u>

Atlantic salmon are stocked throughout the range of the Gulf of Maine DPS of Atlantic salmon, although the Androscoggin River has been stocked with fewer fish than any other river with a stocking program. A total of 22,000 fry were stocked in the Androscoggin River between 2001 and 2020 (0 to 2,000 per year). No stocking occurred between 2017 and 2019, however 2,000 fry were stocked in 2020 (USASAC, 2021). The stocking of fry in the Androscoggin is the result of an outreach and education effort in area schools that is operated by the Fish Friends[10] program, and is not part of any larger restoration effort on the part of state and federal fisheries agencies. Given the early life stage and the small number of fish stocked, it is very unlikely that any adult returns result from this outreach effort. Given the low level of stocking, and an average of just two (2012-2020) prespawn salmon passing into the river per year, we anticipate that there are few smolts migrating through the system in any given year. However, we do anticipate that some natural spawning occurs in larger than normal return years (e.g., 44 adults in

[10] https://fishfriends.me/

2011) that would result in the production of some number of smolts. Although no studies have looked at the timing of the outmigration of naturally reared salmon smolts in the Androscoggin River, we can estimate it based on assessments that have occurred in the nearby Sheepscot River (USASAC, 2016, 2017, 2018, 2019, 2020). The timing of migration in the Sheepscot is consistent with what has been observed at other rivers in the DPS (Figure 3); with the initiation of migration beginning in late April or early May, and the completion of the run in late May or early June (Table 11). Given the distribution of capture dates in the Sheepscot River, we anticipate that at least 95% of the smolt run in the Androscoggin River occurs during the month of May.

Table 11. The timing of naturally reared smolt captures in rotary screw traps on the Sheepscot River between 2015 and 2019 (USASAC, 2016, 2017, 2018, 2019, 2020)

Year	**First Capture**	**Median Capture**	**Last Capture**
2015	May 2	May 12	May 29
2016	April 20	May 9	May 27
2017	April 29	May 10	May 21
2018	May 1	May 9	May 22
2019	April 30	May 16	June 4

Although there is variability in the time of day when smolts migrate, it is generally understood that they move during nighttime hours. Kocik et al. (2009) monitored run timing of naturally reared smolts in the Narraguagus River and documented that approximately 80-95% of smolts migrated during night and twilight hours while in freshwater. The proportion of smolts migrating during night and twilight hours declined to 35-75% in the tidal portion of the river (Kocik et al., 2009). Although we lack Androscoggin-specific studies on the timing naturally reared smolts migration, we anticipate that it would be similar to what has been observed on the Narraguagus.

In summary, there are very few Atlantic salmon returning annually to the Androscoggin River and the river is almost completely dependent on strays from other rivers where supplementation and natural spawning occurs (e.g., Kennebec). Suitable habitat for all life functions exists in the accessible portions of the Androscoggin River, although we expect the action area to primarily serve as a migratory corridor.

Critical Habitat

We have designated critical habitat for Atlantic salmon in the Androscoggin River, including the area that comprises the project action area around the Brunswick Dam (Figure 7). The Lewiston Falls Project is outside of designated critical habitat (approximately 700 feet upstream of the boundary), but flow fluctuations at the project do extend into critical habitat downstream of the project. 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 3.2.1).

Although the majority (>95%) of the modelled salmon rearing habitat in the Androscoggin is upstream of the Lewiston Falls Dam, and is therefore inaccessible, a small amount is present in the critical habitat in the lower river (Wright et al., 2008). Modelling conducted by Wright et al.

(2008) indicates that, of the modelled rearing habitat in the tributaries downstream of the Lewiston Falls Project, only 3% is downstream of Brunswick, and that 92% of the habitat is above the second and third dams (Table 12).

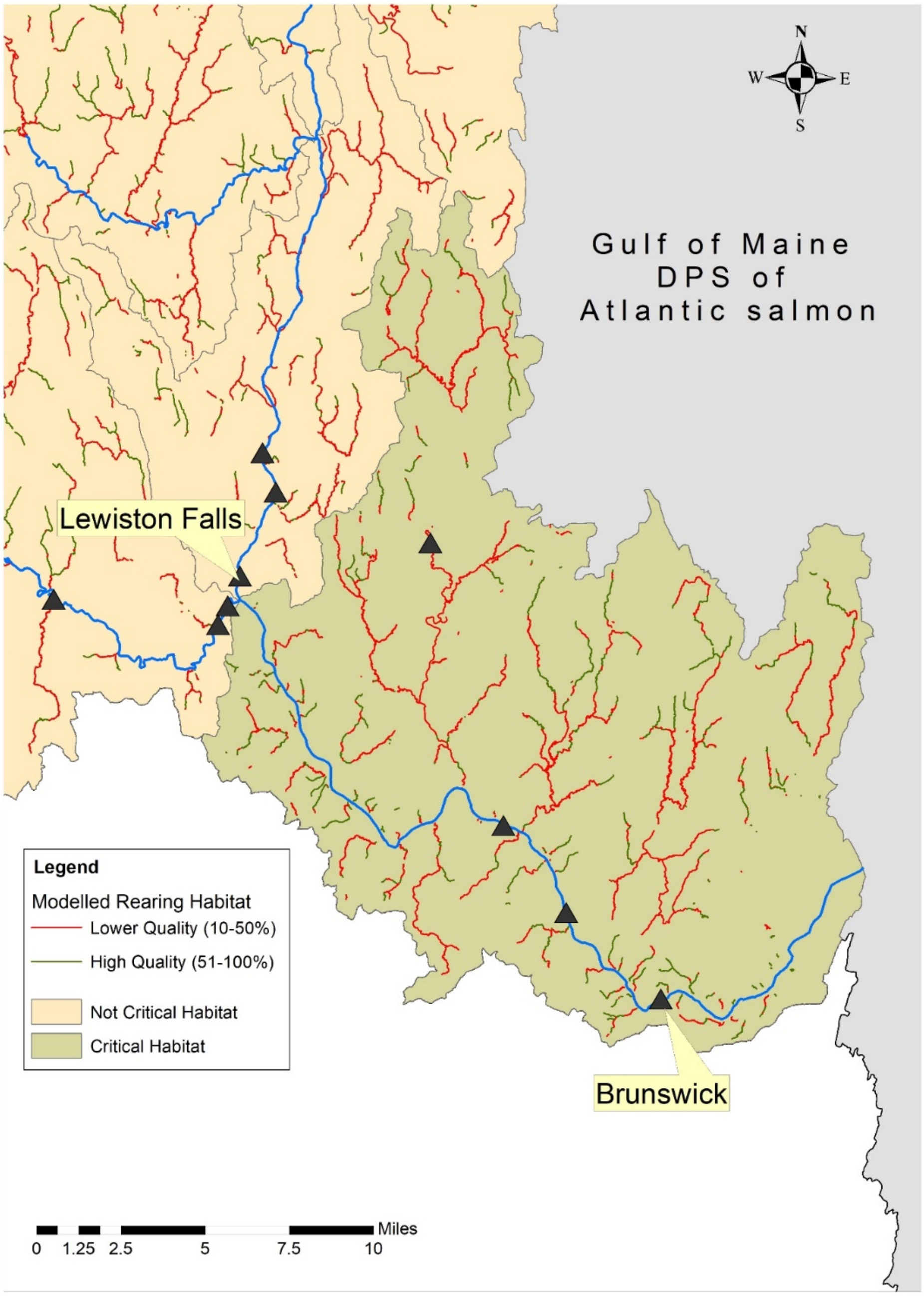


Figure 7. Modelled rearing habitat in critical habitat in the lower Androscoggin River (based on modelling by Wright et al. 2008). The quality score is based on the proportion of each stream reach that was predicted to be suitable for rearing.

Table 12. The amount of salmon habitat units suitable for rearing (not spawning) in the tributaries of the Androscoggin River watershed below Lewiston Falls (as derived from modelling conducted by Wright et al (2008).

River Reach	Habitat Units	% of Accessible Habitat
Estuary to Brunswick	80	3%
Brunswick to Pejepscot	156	5%
Pejepscot to Worumbo	967	34%
Worumbo to Lewiston Falls	1,683	58%
Total Accessible	2,886	

The critical habitat in the action area primarily provides a migratory pathway to a small amount of spawning and rearing habitat, which does not occur within action area, but occurs in tributaries accessible from the action area. The most likely spawning habitat is believed to occur in the following locations:

- The Little River, a small tributary that flows into the Androscoggin between the Pejepscot and Worumbo dams. In 2011, HDR evaluated the spawning habitat in the Little River and found numerous barriers and poor substrates. However, MDMR indicates that there is a significant amount of habitat in the Little River and that it could hold "tens of thousands of eggs" (MDMR, 2012). During the 2011 telemetry study, MDMR documented a radio tagged female Atlantic salmon moving throughout the Little River, and it is thought that it may have spawned in Gillespie Brook, one of its tributaries (MDMR, 2012).
- The Little Androscoggin River, a larger tributary that flows into the Androscoggin between the Worumbo and Lewiston Falls dams. The tributary is not in critical habitat, but in the 2011 telemetry study a tagged male was detected in the bypass reach of Lower Barker Dam and may have spawned with an untagged female (MDMR, 2012).

Above Worumbo Dam the only sizeable tributary other than the Little Androscoggin that might provide suitable spawning and rearing habitat would be in the Sabattus River; however, dams block access to the majority of the habitat.

Much of the action area (mainstem Androscoggin) has been modelled as rearing habitat (Wright et al., 2008). However, the modelling indicates that it is class 3 habitat, meaning that only 10% to 26% of the habitat likely contains rearing habitat[11]. It is unlikely that this habitat functions for parr development, given that several of the parameters described in Table 4 in section 3.2.1 are outside of the functional range. Most notably, the mainstem of the Androscoggin warms considerably in the summer months, regularly exceeding 25°C, is generally more than one foot in depth, and contains an abundance of non-native fish species that prey on juvenile salmon. Given this, we do not consider the mainstem of the Androscoggin as functional rearing habitat. It does, however provide a critical migratory corridor to habitat to spawning and rearing habitat in the Little River, and other tributaries.

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

4.2 Status of Shortnose Sturgeon in the Action Area

The Kennebec system includes the Kennebec, Androscoggin and Sheepscot Rivers. Shortnose sturgeon occur in the estuarine complex formed by the Sheepscot, Kennebec, and Androscoggin rivers. Atkins (1887) documented the presence of sturgeon in Maine rivers, though they were identified as common sturgeon (*Acipenser sturio*). Fried and McCleave (1973) discovered shortnose sturgeon within Montsweag Bay in the Sheepscot River in 1971 and 1972. This was the first reported occurrence of shortnose sturgeon in Maine. Shortnose were subsequently found in the Kennebec River by ME DMR in 1977 and 1978 (Squiers and Smith 1979). Historically, the upstream extent of shortnose sturgeon in the Kennebec is thought to have been Ticonic Falls (rkm 103) (NMFS & USFWS 1998).

Sturgeon were tagged with Carlin tags from 1977 to 1981, with recaptures in each of the following years. A Schnabel estimate of 7,222 (95% CI, 5,046 to 10,765) adults for the combined estuarine complex was computed from the tagging and recapture data from 1977 through 1981 (Squiers et al. 1982). A Schnabel estimate using tagging and recapture data from 1998 - 2000 indicates a population estimate of 9,488 (95% CI, 6,942 to 13,358) for the estuarine complex (Squiers 2003). The average density of adult shortnose sturgeon/hectare of habitat in the estuarine complex of the Kennebec River was the second highest of any population studied through 1983 (Dadswell et al, 1984). The Schnabel estimate from 1998-2000 is the most recent population estimate for the Kennebec River System shortnose sturgeon population; however, does not include an estimate of the size of the juvenile population. A comparison of the population estimate for the estuarine complex from 1982 (Squiers et al. 1982) to 2000 (Maine DMR 2003) suggests that the adult population has grown by approximately 30% in the last twenty years. Based on this information, we believe that the shortnose sturgeon population in the Kennebec River system is increasing; however, without more information on the status of more recent year classes (i.e., juveniles) it is difficult to speculate about the long term survival and recovery of this population.

Spawning in the Androscoggin River

In the Androscoggin River, shortnose sturgeon migration, and thus spawning, was likely limited historically by the natural falls located at the Brunswick Dam (rkm 8.4). From 1979-1982, MDMR conducted gillnet studies to identify spawning areas. During this period large numbers of shortnose sturgeon were captured between Brunswick and Topsham. Water temperatures ranged between 8.5 and 14.5°C (late April until the end of May), many of the males captured were freely expressing milt and several females were ripe (Squiers et al. 1982). Tracking studies to delineate spawning habitat were performed on the Androscoggin River during 1993 (Squiers et al. 1993). Gill nets were used to capture study animals and catch rates were recorded. Gill net catch-per-unit-effort during this study was the highest recorded in this area, suggesting that the population in the Androscoggin has increased since last surveyed. Using cement blocks fitted with plastic mesh, this study also confirmed spawning by collecting eggs at two different discrete spawning areas (May 13 and 19) at approximately rkm 7.7. One larval shortnose sturgeon was also captured in the same general area (May 28) using a plankton net. This study indicated that spawning was concentrated in the reach of river between approximately rkm 7.7 and 8.4 (the

Brunswick Dam).

Adding to this research, Wippelhauser et al. 2015 (discussed above) used telemetry data to record 14 spawning events (presence of late-stage females in known spawning grounds during the spawning season) from early April to early June. In data provided to MaineDOT for their BA on the replacement of the Brunswick-Topsham bridge, Wippelhauser (2016) stated that shortnose spawning below the Brunswick Dam (rkm 7.7-8.4) occurs from April 7 – June 11. During spawning, bottom temperatures in the spawning area ranged from 8.8-16.4°C, and spawning adults spent an average of 4 days at the spawning site (range 0.1-7.8 days) (Wippelhauser et al. 2015).

Overwintering

Studies indicate that at least a portion of the shortnose sturgeon population in the Kennebec River overwinters in Merrymeeting Bay (Squiers and Robillard 1997). The seasonal migrations of shortnose sturgeon are believed to be correlated with changes in water temperature. In 1999, when a tracking study was performed by Normandeau Associates, the water temperature near Bath Iron Works (BIW) reached the 8-9ºC threshold (believed to be the trigger prompting spawning fish to migrate to the spawning area) in mid-April. Also during the tracking study, several fish presumed to be non-spawning sturgeon, were documented in the Chops Point and Swan Island areas (north of Doubling Point) in late March and then were found to have migrated south to the BIW region (e.g., north and south of the BIW Pier and Museum Point) early in April.

Until a study aimed at specifically determining overwintering locations was conducted by the MDMR in 1996 for the MaineDOT, the sites thought to be the most likely overwintering sites were deep pools below Bluff Head, and possibly in adjacent estuaries such as the Sheepscot (Squiers and Robillard 1997). The 1996 study of overwintering activity suggests that at least one overwintering site is located above Bath. This is based on tracking 15 shortnose sturgeon collected and released in the vicinity of the Sasanoa River (Pleasant Cove), Winnegance Cove (near the Doubling Point reach), and Merrymeeting Bay (north of Bath and the Sasanoa River entrance). Tracking was done from October through January. Eleven of these fish were relocated in Merrymeeting Bay. Two of the fish from Pleasant Cove were never found in Merrymeeting Bay; one Pleasant Cove fish moved to Winnegance Cove and back to Pleasant Cove and another moved to Days Ferry (half way between Bath and Merrymeeting Bay). All of the fish that continued to transmit after November were only found in upper Merrymeeting Bay on the east-side of Swan Island (~rkm 40-42). Fish departed the wintering site between April 7-25, with most moving downstream toward the lower Kennebec estuary (Wippelhauser and Squiers 2015). This is consistent with the trends for movement of shortnose sturgeon in the Delaware River (O'Herron et al. 1993). Overwintering sturgeon in the Delaware River are found in the area of Newbold Island, in the Trenton to Kinkora river reach, in an area geographically similar to the area around Swan Island.

Expected Seasonal Distribution of Shortnose Sturgeon in the Action Area

The discussion below summarizes the expected seasonal distribution of shortnose sturgeon in the action area.

Adult shortnose sturgeon move into the action area to spawn in early April, departing by mid-June. As described above (section 3.5), eggs and yolk-sac larvae remain near the spawning site (rkm 7.7-8.4). The egg development, hatching, and yolk-sac larvae (YSL) stage takes approximately 25 days. The post yolk-sac larvae (PYSL), a phase ends ~12-40 days post hatch). Table 13 illustrates anticipated timing of the presence of shortnose sturgeon early life stages in the Androscoggin River, with the dates at the end of each time period based on the latest dates of spawning. Based on the information above, we do not expect any shortnose sturgeon life stages to be in the action area once the adults and early life stages have moved downstream following the spawning season.

Table 13. Timing of shortnose sturgeon lifestages and behaviors in the action area

Lifestage	Time of Year Present in Action Area	Behavior in Action Area
Adults	April 1-June 15	Migration of spawning adults in the spring to and from spawning site.
Eggs & Yolk-Sac Larvae (YSL)	April 1-July 10	Eggs adhere to the substrate quickly after being deposited. Hatch times range from approximately 8-13 days post spawn. The YSL phase lasts approximately 8-12 days and is characterized by "swim up and drift" behavior. YSL are photonegative and seek cover in hard substrate. YSL remain near the spawning site.
Post Yolk-Sac Larvae (PYSL)	April 16-August 7	PYSL begin feeding (on aquatic insects, insect larvae and other invertebrates) and are free-swimming; they disperse downstream of the spawning/rearing area. The PYSL phase ends at about 12-40 days post-hatch. PYSL are typically found in the deepest water available

4.3 Status of Atlantic Sturgeon in the Action Area

As noted above, historical records provide evidence of commercial fisheries for Atlantic sturgeon in the Kennebec and Androscoggin Rivers dating back to the 17th century (Squiers et al. 1979). Following the 1880s, the sturgeon fishery was almost non-existent due to a collapse of the sturgeon stocks. While directed fishing and retention as by-catch has been prohibited since 1998, the GOM DPS of Atlantic sturgeon remains threatened. Based on the NEAMAP survey data, we estimate an ocean population of 7,455 adult and subadult GOM DPS Atlantic sturgeon. In the marine range, GOM DPS Atlantic sturgeon are still incidentally captured in federal and state managed fisheries, reducing survivorship of subadult and adult Atlantic sturgeon (Stein et al., 2004; ASMFC 2007). Habitat disturbance and direct mortality from anthropogenic sources are primary concerns. Due to the lack of recaptures, to date, we do not have a population estimate for adult Atlantic sturgeon in the Kennebec River system (Wippelhauser and Squiers

2015). For a summary of threats faced by the GOM DPS of Atlantic sturgeon, see section 3.6.4.

Coastal Movements

As part of a study to assess coastal movements of Atlantic sturgeon in the Gulf of Maine, Wippelhauser et al. 2017 captured 681 sub-adult and adult Atlantic sturgeon within four study rivers (Merrimack, Saco, Kennebec, and Penobscot). Approximately 25% (169) were tagged with acoustic transmitters for tracking using a series of acoustic receiver arrays in each of the rivers, as well as compatible arrays in the marine coastal environment. Of the 169 tagged sturgeon, 20 were captured and tagged in the Merrimack, 51 in the Saco, 55 in the Kennebec, and 43 in the Penobscot. Fifty-nine (59) individuals tagged elsewhere were detected in the Kennebec system. Non-spawning Atlantic sturgeon entered the Kennebec system in late May (median date of May 30) and departed early in the late summer or early fall (median date of August 25).

Spawning in the Kennebec River System

To date, despite captures of sturgeon in the Merrimack, Penobscot and Piscataqua/Salmon Falls/Cocheco rivers, as well as the necessary physical and biological features to support spawning in each of those rivers, the only confirmed spawning locations for the GOM DPS of Atlantic sturgeon are in the Kennebec River system (upper Kennebec River estuary and the Androscoggin River).

In the Wippelhauser et al. 2017 study, between 2010 and 2014, most tagged Atlantic sturgeon entered the Kennebec system during April and May (May 6 on average, with a range of April 11-June 17). They then moved to the spawning grounds mostly in June (average of June 14, range May 8-July 20), and remained at the spawning grounds through July (average of July 13, range of June 12-August 20). Water temperatures were typically over 16°C when Atlantic sturgeon occupied spawning areas, and freshwater discharge was usually less than 399 m^3/s. After spawning, some tagged individuals from the 2009-2011 study remained in Merrymeeting Bay or the lower Kennebec estuary for approximately 60 days before departing the system in October (Wippelhauser et al. 2017).

Spawning in the Androscoggin River

From 2009-2017, 11 adult Atlantic sturgeon have been captured and/or detected in the Androscoggin River near rkm 7.7. One of the sturgeon (captured on June 21, 2011) was a spawning condition ripe male (188.5 cm TL). Two of the sturgeon, including the ripe male, had been caught and PIT tagged in the Saco River the previous year (Wippelhauser et al. 2017; Wippelhauser, pers. comm. 2018). With one exception, all of the sturgeon had left the spawning area by the end of July (one left on August 7). While these captures confirm likely spawning, Atlantic sturgeon eggs and larvae have not yet been recovered in the Androscoggin (Wippelhauser, pers. comm. 2018).

Expected Seasonal Distribution of Atlantic Sturgeon in the Action Area

The discussion below summarizes the expected seasonal distribution of Atlantic sturgeon in the action area.

Adult Atlantic sturgeon move into the action area to spawn in early June, departing by the end of July. Because we only expect Atlantic sturgeon to spawn in their natal river, all Atlantic sturgeon in the action area will be from the GOM DPS (ASSRT 2007). As described above, eggs and yolk-sac larvae remain near the spawning site (rkm 7.7-8.4). The egg development, hatching, and yolk-sac larvae (YSL) stage lasts approximately 18 days. Post yolk-sac larvae (PYSL, a phase which ends ~40 days post hatch), could be in the action area from approximately mid-June until mid-September (i.e., 46 days from latest spawning date, September 15, all Atlantic sturgeon PYSL will become young of the year); however, only those larvae whose eggs were fertilized near the end of the spawning period (end of July) could possibly be present this late in the season (Table 14). We expect all Atlantic sturgeon to have entered the PYSL stage by approximately August 18, at which point they will begin to move downstream out of the action area, which is practically at the upstream limit of the spawning area. Based on the information above, we do not expect any Atlantic sturgeon life stages to be in the action area once the adults and early life stages have moved downstream following the spawning season.

Table 14. Timing of Atlantic sturgeon lifestages and behaviors in the action area.

Lifestage	Time of Year Present in Action Area	Behavior in Action Area
Adults	June 1-July 31	Migration of spawning adults in the spring to and from spawning site.
Eggs & Yolk-Sac Larvae (YSL)	June 1-August 18	Eggs adhere to the substrate quickly after being deposited. Hatching occurs ~3-6 days after egg deposition and fertilization. The YSL phase lasts approximately 8-12 days and is characterized by "swim up and drift" behavior. YSL are photonegative and seek cover in hard substrate. YSL remain near the spawning site.
Post Yolk-Sac Larvae (PYSL)	June 11-September 15	PYSL begin feeding (on aquatic insects, insect larvae and other invertebrates) and are free-swimming; they disperse downstream of the spawning/rearing area. The PYSL phase ends at about 40 days post-hatch. PYSL are typically found in the deepest water available

4.4 Status of Atlantic Sturgeon Critical Habitat in the Action Area

As noted in section 2.3, the action area considered in this Opinion extends from the Lewiston Falls Dam downstream to a point 700 feet (0.2 km) downstream of the Brunswick Dam. The Androscoggin River critical habitat unit extends from the point where the Androscoggin River empties into Merrymeeting Bay to the Brunswick Dam, which was also likely the natural upstream limit for Atlantic sturgeon (i.e., Pejepscot Falls).[12]

The Androscoggin River is entirely freshwater (salinity <0.5ppt); therefore, PBF 2 of Atlantic sturgeon critical habitat, or aquatic habitat with a gradual downstream salinity gradient of 0.5 up to as high as 30 ppt and soft substrate (*e.g.,* sand, mud) between the river mouth and spawning sites for juvenile foraging and physiological development, is not present in the action area. The other three PBFs are found in the action area, and we discuss their status below.

PBF 1

Hard bottom substrate in low salinity waters suitable for the settlement of fertilized eggs, refuge, growth, and development of early life stages (i.e., PBF 1) can be found within the action area, which extends from rkm 8.4 (the dam) downstream to rkm 8.2.

The channel topography below the Brunswick Dam is highly variable and significantly influences the flow and bottom habitat. Just below the Dam, the flow splits into two channels then flowing together under the bridge. Downstream of the bridge the substrate in the river is less scoured by high velocities and diversifies into hard bottom boulder and cobble substrate with pockets of sand. The dominant flow channel moves water through the powerhouse and downstream tailrace. Substrate within the tailrace is scoured ledge.

As stated above, spawning condition shortnose sturgeon, which require similar habitat spawning conditions to Atlantic sturgeon, have been captured and tagged between rkm 7.7 and 8.4. Shortnose sturgeon eggs and larvae have also been recovered from this area (rkm 7.7) (Wippelhauser et al. 2015).

Squiers et al. 1993 set out to delineate the spawning sites for shortnose sturgeon in the upper tidal reach of the Androscoggin River. Divers participating in the study swam several transects. On one transect located at the lower extent of the action area (i.e., from an area just below the Route 201 Bridge up to the bridge) the depth was approximately 2.4 m and they reported that the substrate consisted of ledge, boulders, and rocks interspersed with sand and gravel.

The capture and detection of 11 adult Atlantic sturgeon, including a ripe male, just downstream of the action area (rkm 7.7) during the spawning season (June-July) suggests that Atlantic sturgeon may also use the hard bottom substrate in the action area.

We do not have substrate maps for the action area, but based on the collection of resources referenced above, we have general information on the substrate in the action area. Hard bottom habitat exists throughout the action area below Brunswick Dam (rkm 8.4 to rkm 8.2). Within that reach, some of the habitat is scoured ledge (particularly where flows are strongest coming out of the tailrace) without the interstitial spaces needed for spawning and rearing. There are

[12] The final rule designating Atlantic sturgeon critical habitat states that the Androscoggin River critical habitat unit extends from the Brunswick Dam approximately 10 rkms downstream to the confluence of the Kennebec and Androscoggin rivers (82 FR 39160). For ease of reference to papers describing sturgeon use of the Androscoggin River and identify the Brunswick Dam as rkm 8.4 instead of 10.0, we are using the former delineation of rkms (i.e., Brunswick Dam at rkm 8.4) to describe sturgeon behavior and habitat.

also pockets of sand that lack the hard bottom substrate. Therefore, we have estimated that the action area above rkm 8.2, and removing the upper pool on the Topsham side upstream of the bridge (which is inaccessible to sturgeon), has approximately 4.5 acres of habitat meeting the criteria of PBF 1 (Figure 8). The areas directly below the Brunswick-Topsham bridge, extending toward rkm 8.2, have less scoured ledge from the tailrace flows, and therefore, likely have the most conservation value for Atlantic sturgeon.

Figure 81. Portion of the action area with potential spawning habitat meeting criteria for PBF 1

PBF 3

PBF 3 requires water of appropriate depth and absent physical barriers to passage between the river mouth and spawning sites necessary to support:

(i) Unimpeded movement of adults to and from spawning sites;

(ii) Seasonal and physiologically dependent movement of juvenile Atlantic sturgeon to appropriate salinity zones within the river estuary

(iii) Staging, resting, or holding of subadults or spawning condition adults.

PBF 3 also requires that water depths in main river channels are deep enough (*e.g.,* at least 1.2 m) to ensure continuous flow in the main channel at all times when any sturgeon life stage would be in the river. Following these criteria, PBF 3 is present throughout the action area, except for in the upper pool on the Topsham side of the river above the existing bridge, as this area is inaccessible to sturgeon.

Both historically and today, the location of the Brunswick Dam (Pejepscot Falls) is the upstream limit for Atlantic sturgeon in the Androscoggin River. Aside from the dam, the bridge support piers, and some exposed boulders, there are no physical obstructions preventing passage in the portion of the action area that overlaps with the critical habitat. In addition to navigating around existing structures, sturgeon movements can also be impacted by gear set in the river, vessel traffic, and in-water stressors from ongoing construction projects (e.g., turbidity from dredging, sound pressure waves from pile driving, etc.). We are not aware of any construction projects in the action area. The nearby boat ramp is available for the public, so there is some recreational vessel traffic and fishing in the action area, but it is anticipated to be minimal.

The width of the Androscoggin River below the dam varies from about 75m (just below the bridge) to approximately 300m around rkm 7.2. The depth in the main channel varies from approximately 2.4-6.7m (8-22ft) (Squiers et al. 1993). The Androscoggin River discharges through the Brunswick Dam at several points including the tailrace on the Brunswick side, the flood gates on the Topsham side, and the mid-channel spillway. The various release points depend on several factors including water levels, turbine maintenance, or management agreements with regulatory agencies. At lower flows, the majority of water flows through the powerhouse into the tailrace. During times of increased flows, or scheduled maintenance, water may flow over the spillway, or through opened flood gates.

Given these various discharge points, velocities downstream of the dam vary depending on the stage of river flow and which release points are flowing. At the lowest flows, the ponded area may be nearly stagnant and the majority of flow moves through the powerhouse and tailrace. River velocity patterns change during moderate and high flows. At increased flows, water may discharge into the river over the spillway causing flow through the pond. At the highest flows, the flood gates on the Topsham side open causing increased flows and higher velocity through the left side of the river. At normal flows, velocities in the tailrace range from approximately 6.0 to 8.0 feet per second. These velocities lessen as the river extends downstream towards the Bay. At increased flows, water discharges over the spillway and flood gates causing flow through the pond on the river left side of the channel. Higher flows form a channel of increased flow through deeper sections of the pond, spilling over the bedrock ridge. At normal flows, velocities in the pond range from 2.0 feet per second along the edges of the pond to 10.0 feet per second through the center of the pond.

PBF 4

PBF 4 (water between the river mouth and spawning sites, especially in the bottom meter of the water column, with the temperature, salinity, and oxygen values that combined support spawning, survival, and larval, juvenile, and subadult development and recruitment), is present throughout the action area; however, we do not expect juvenile or subadult development to occur.

Spawning sites for the Atlantic sturgeon DPSs are well-oxygenated areas with flowing freshwater at the time of spawning, ranging in temperature from 13°C to 26°C (NMFS 2017). Water quality factors of temperature, salinity and dissolved oxygen are interrelated environmental variables, and are constantly changing from influences of the tide, weather, season, etc. Dissolved oxygen concentrations in water can fluctuate given a number of factors including water temperature (e.g., cold water holds more oxygen than warm water) and salinity (e.g., the amount of oxygen that can dissolve in water decreases as salinity increases). This means that, for example, the dissolved oxygen levels that support growth and development will be different at different combinations of water temperature and salinity. Similarly, the dissolved oxygen levels that we would expect Atlantic sturgeon to avoid would also vary depending on the particular water temperature, salinity, and life stage. As dissolved oxygen tolerance changes with age, the conditions that support growth and development and likewise, the dissolved oxygen levels that would be avoided, change (82 FR 39160; NMFS 2017).

Before the Clean Water Act of 1972, textile, pulp and paper, and municipalities discharged directly into the Androscoggin River causing it to be one of the most heavily polluted rivers in the United States. Pollution caused reductions in fish and other aquatic organisms due to anoxic conditions during the summer months. However, even with this pollution, dissolved oxygen levels in the Androscoggin River just above the Brunswick Dam were measured at ~6 mg/L in the 1930s (Brennan et al. 1931 in Moore and Reblin 2010). With the implementation of legal mandates on pollution discharge, water quality improved but significant damage had been done to aquatic life. Sampling in the 1980s found high levels of dioxin associated with paper mills in New Hampshire and Western Maine and modern dioxin levels still warrant fish consumption warnings to anglers along the river. That said, dissolved oxygen levels continued to improve in the Kennebec and Androscoggin Rivers (Moore and Reblin 2010).

At the present time, water quality in the action area is affected by pollutant discharge from urban and industrial non-point and point sources. Upstream land-use practices such as urban development and agricultural run-off contribute to non-point sources. Common point-source pollutants include upstream publicly operated waste treatment facility outfalls, industrial sites, and other discharges. The State of Maine classifies the portion of the Androscoggin River in which the project area occurs as Class C waters. Class C waters are of such quality that they are suitable for the designated uses of drinking water supply after treatment, fishing, agriculture, recreation in and on the water, industrial process and cooling water supply, hydroelectric power generation, navigation, and as a habitat for fish and other aquatic life.

Outflow for the Brunswick Sewer District is approximately 2.1 rkm (1.3 miles) downstream of Brunswick Dam. However, a water quality study conducted by Maine Department of Environmental Protection (Maine DEP) in 2011 found the Brunswick outflow was not the primary cause of low water quality below the dam. The report concluded that low dissolved oxygen (DO) levels below the dam were likely caused by upstream river conditions between Lewiston Falls and the Brunswick Dam, paired with tidal flow from Merrymeeting Bay.

Based on known water quality parameters of the action area (12-28°C between May and August (Wippelhauser et al. 2017); salinity below 0.5 ppt; dissolved oxygen levels at or above 6 mg/L), as well as past captures of shortnose sturgeon eggs and larvae, and the capture and tracking of adult shortnose and Atlantic sturgeon during the spawning season, we are confident that the action area has the temperature, salinity, and oxygen values that combined support Atlantic sturgeon spawning and the survival of early life stages (eggs and larvae).

4.5 Consideration of Federal, State and Private Activities in the Action Area

4.5.1 Federal Activities in the Action Area

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. Although Biological Opinions have been issued for the Species Protection Plans at the Worumbo and Pejepscot Projects, which occur between the two projects being considered in this consultation, they do not occur in the action area and therefore are not considered here. Effects from these two dams are considered in section 3.4.1.

On March 30, 2018, we issued an Opinion to the Federal Highway Administration for the Maine Department of Transportation's replacement of the Topsham-Brunswick Bridge, which is located approximately 100 meters downstream of the Brunswick Project. In this Opinion, we concluded that the proposed action was likely to adversely affect, but not likely to adversely modify or destroy critical habitat designated for the GOM DPS of Atlantic sturgeon. We also concluded that the proposed action would affect, but was not likely to adversely affect, the GOM DPS of Atlantic sturgeon, endangered shortnose sturgeon, endangered GOM DPS of Atlantic salmon, or critical habitat designated for the GOM DPS of Atlantic salmon. Since we concluded that the action as proposed would not adversely affect any ESA-listed species in the action area we did not anticipate the take of any listed species.

4.5.2 State or Private Activities in the Action Area

State of Maine stocking program

The State of Maine stocks other salmonids into the Androscoggin River watershed, including brook trout, rainbow trout, brown trout, and landlocked salmon[13]. Although only native brook trout were stocked in the action area and in the Little River in 2021, where salmon are known to occur, the other species were stocked in tributaries and could enter the action area. 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

[13] Maine Department of Inland Fisheries and Wildlife. 2021 Stocking Report. https://www.maine.gov/ifw/docs/current_stocking_report.pdf

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.

4.5.3 IMPACTS OF OTHER HUMAN ACTIVITIES IN THE ACTION AREA

4.5.3.1 DAMS AND HYDROELECTRIC FACILITIES

There are five FERC-licensed dams within the lower Androscoggin River that are currently accessible to Atlantic salmon (i.e., Lewiston Falls, Lower Barker (on the Little Androscoggin R.), Worumbo, Pejepscot, and Brunswick). Of these, only the Lewiston Falls and Brunswick Projects are within the action area of this consultation. The effects of the proposal to amend the licenses for the Brunswick and Lewiston Falls Projects is the subject of this Opinion; therefore, we will analyze the future effects of these projects over the remainder of the existing licenses under the terms of the proposed SPP in the *Effects of the Action* section (section 6.0). However, as the dams have been in place for more than a century, they have significantly affected listed salmon and sturgeon, as well as designated critical habitat, within the action area. Here, we will consider the past and ongoing effects of the Brunswick and Lewiston Falls Projects, including the effects to riverine processes (e.g., flow fluctuations, impoundments) and fish passage in the Androscoggin River (i.e., passage efficiency, passage survival and injury, and migratory delay) that comprise the environmental baseline. Impoundment effects are considered solely as an aspect of the environmental baseline, as they are not influenced by the proposed action. Other effects are associated with the operation of the projects to produce electricity or to pass fish, and are therefore, considered both in this Environmental Baseline section and in the Effects of the Action section, where we consider how the proposed action will affect the environmental baseline for the action.

<u>Riverine Processes</u>

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).

Functioning of the habitat in the action area is likely affected by the peaking operation of the Lewiston Falls impoundment by up to 4-feet to generate power. Compared to a natural hydrograph, the operation of the Lewiston Falls Project in peaking 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 mainstem. The extent to which these streamflow modifications in the Androscoggin River watershed impact salmon habitat (including migratory corridors during applicable seasons), and restoration efforts is unknown. However, diminished flows during prespawn adult, smolt, and kelt migration, 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.

BWPH conducted an instream flow study in 2014 and 2015 to demonstrate how the fluctuation influenced velocities, water depth, and wetted width at four transects in the habitat downstream of the Project. All four transects were located within one mile of the project spillway, but still provide an indicator of the scale of the effect that the fluctuation might have throughout the action area. BWPH evaluated two Project discharge conditions, 2,421 cfs and 7,812 cfs. The study demonstrated that peaking operations at Lewiston Falls likely have a small impact on all the monitored parameters. The difference in wetted width between low flow and generation flow conditions varied between 0.8% and 2.6% of the total river width. Average depth at the monitored transects ranged between 2.3 and 13.8 feet under low flow conditions, and between 4.4 and 16.0 feet at generation flows. Flow velocities ranged between 1.0 and 3.6 ft/s during low flow conditions, and between 2.7 and 4.9 ft/s at generation flows. We anticipate that these effects would be dampened further downstream due to flow contributions from the major tributaries (e.g., Lower Androscoggin, Sabattus River, Little River), as well as by the operation of the three downstream hydro projects.

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 Androscoggin River watershed. There is abundant information that demonstrates that large project impoundments 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.

Although the Brunswick Project operates as run-of-river and does not have significant fluctuations in headpond level, it does have a 4.5 mile long, 300-acre impoundment. Information was collected during the four years of smolt survival studies that can be used to determine what level of impoundment mortality occurs at the project (BWPH, 2014, 2015, 2016, 2019). We can derive the per kilometer survival rate in a portion of the impoundment for each of the four study years, and compare it to the rates observed in the control reaches to discern if there is a significant impoundment effect associated with the project (Table 15).

Table 15. The estimated mortality rate through the Brunswick Dam impoundment compared to an estimate of background survival (derived from BWPH study reports from 2014-2016 and 2019).

	Impoundment		Control	
	Survival (per km)	Study Reach (km)	Survival (per km)	Study Reach (km)
2013	0.97	2	0.98	1.25
2014	0.99	2	0.94	1.25
2015	0.94	2	0.98	1.25
2018	0.99	4.5	0.98	13.4
Average	0.97		0.97	

The information suggests that, although there are some years where mortality in the impoundment is higher, the average survival in the impoundment does not differ significantly from the background survival level in the river. It should be noted that the control reach for three of the four years (2013-2015) was immediately below the Brunswick Dam, which is an area that is likely affected by the presence of the dam. Although the available information suggests that the mortality throughout the 4.5-mile long impoundment does not vary much from background, it appears that the area within at least a kilometer of the dam may experience elevated mortality. In the 2018 smolt study, survival in the two reaches (A12-A13: 3.8 km long, A13-A14: 0.7 km long) above the Brunswick Dam were monitored (BWPH, 2019). Although the upper reach (A12-A13) had a survival rate of 99.3% per km, the lower reach (A13-A14) had a survival rate of only 97.2% per km. This would suggest that an additional 2% of the salmon smolts died in the reach closest to the dam, most likely due to congregating predators and the reduction in smolt migration speed as they approached the dam.

Fish Passage

The Lewiston Falls Project does not have upstream or downstream fishways. Therefore, the project acts as a complete barrier to upstream passage, which limits the accessible portion of the Androscoggin River to approximately 5% of what is available in the watershed. The Brunswick Project has both an upstream fishway and a downstream fishway and, as described previously, adult salmon migrate upstream of the project, and juvenile salmon have historically been stocked in low numbers in upstream habitat.

Smolts

The Brunswick Project affects out migrating diadromous fish by injuring and killing juveniles and adults directly though turbine entrainment and indirectly by creating pond-like 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 out migrating fish.

As required by the 2013 ISPP and Biological Opinion, BWPH completed a three-year (2013-2015) radio telemetry study to evaluate whole station survival of Atlantic salmon smolts at the Brunswick Project. Approximately 160 smolts were released in the vicinity of Brunswick Project in May of each study year. The results of the studies indicated that the majority of the tagged smolts passed the project via the spillway or the project turbines. The downstream bypass effectiveness rate was found to range between 0%-10% over the three years (BWPH, 2016). Whole station survival for smolts in each of the three years was 82.8% (2013), 94.9% (2014), and 83.8% (2015), with an average three year survival of 87.1%.

Some proportion of the salmon smolts that pass the Brunswick Project survive but are subjected to internal or external injury, scale loss, or loss of equilibrium. These injuries can lead to mortality that occurs after the smolts leave the study area, or else may reduce overall fitness which may reduce an individuals' ability to evade predators or locate prey. Other injured smolts may recover completely and show no latent adverse effects. An empirical injury assessment has not been conducted at the Brunswick Project, but FPL Energy conducted a desktop assessment of injury rate that was included in their Biological Evaluation for the interim species protection plan in 2013 (FPL Energy 2013; Accession #20130221-5160). Based on numerous injury studies with similar turbine characteristics, FPL Energy estimated that the injury rate of smolts passing through the powerhouse at the Brunswick Project was approximately 7.5%. Although they did not model the injury rate for non-turbine passage routes, it is possible that a small number of smolts that pass the project via the spillway will be injured due to contact with the downstream ledges. However, given the relatively low head of the dam as well as the pool at the base of the spillway, we expect that this is a relatively rare event.

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 Brunswick Project causes migratory delay of Atlantic salmon smolts in the Androscoggin River. In the three years of telemetry studies that occurred in 2013-2015, smolts were delayed at the project with 2-9% (average of 5%) of study fish taking longer than 24 hours to pass once they have come within approximately 200 meters of the dam (Table 16)(BWPH, 2016). Although the median passage time was a half hour or less, in each of the three years some smolts were delayed multiple days.

Table 16. Migratory delay measured at the Brunswick Dam during smolt telemetry studies. Delay is measured from the time when the fish approaches within 200 meters of the dam to when it passes.

Year	Median	Range	% > 24 hours
2013	0.5	<0.1-122.2	9%
2014	0.4	<0.1-134.6	2%
2015	0.3	0.1-59.6	5%

Hydrosystem Delayed Mortality

In addition to direct mortality sustained by Atlantic salmon at the Brunswick 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 hydrosystem delayed mortality.

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).

Stich et al. 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 9). 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.

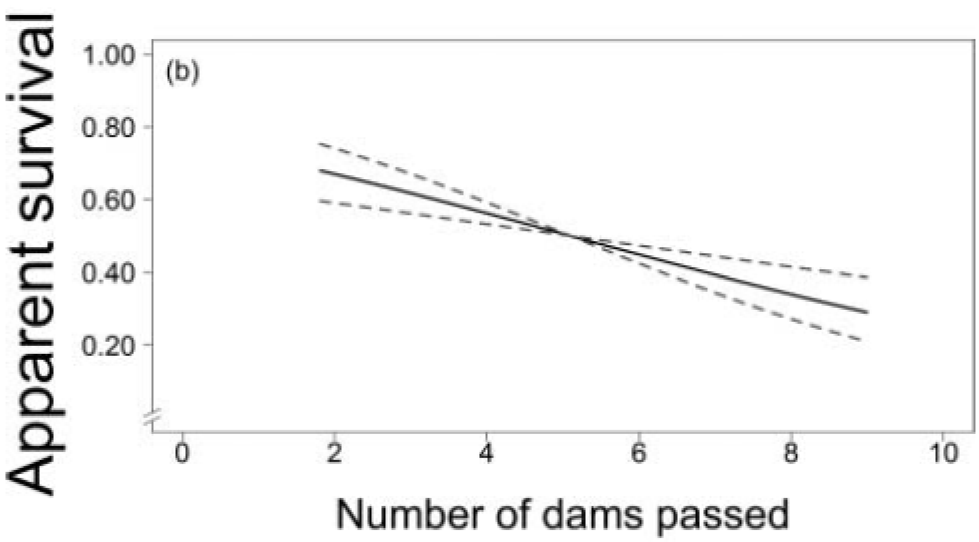


Figure 9. Apparent (or estimated) survival of Atlantic salmon smolts in the Penobscot River estuary based on the number of dams they passed during freshwater migration. The dark line is the mean survival and the dashed lines show the 95% confidence interval. The figure is excerpted from Stich et al. 2015.

Stevens et al. (2019) indicates that the latent mortality effects associated with passage at multiple dams significantly affects mortality rates through the estuary. Based on Stich et al. (2015), Stevens et al estimated the estuarine survival for fish that zero to eight dams. The relevant estimates for a three-dam system like the Androscoggin are: : 87.2% of smolts would survive estuarine migration if no dams were passed; 67.7% would survive if one dam was passed, 66.9%

if they pass two dams, and 61.7% if they have to pass three dams (Stevens et al., 2019). The system Stevens et al. was analyzing was the Penobscot River, which has an estuary length of 38 kilometers. In order to extrapolate to other systems (which have different length estuaries) it is more appropriate to consider the per-kilometer mortality rate rather than the total mortality. Therefore, using the information from Stevens et al. (2019), we can estimate that estuarine mortality would be 0.4% per kilometer if there were no dams in the system, 1.0% per kilometer if one dam was passed, and 1.3% per kilometer if three dams were passed. Therefore, conceptually, the presence of the dams in the Androscoggin (where there are three accessible mainstem dams) leads to an estuarine mortality rate that is more than three times higher than what we would expect if there weren't any dams in the river.

No directed studies have been conducted to assess the amount of hydrosystem delayed mortality that occurs at the Brunswick Project. However, given the occurrence of migratory delay and sublethal injury, it is reasonable to assume that delayed mortality occurs. As described above, we estimate that the project leads to an injury rate of 7.5% under existing conditions, and that approximately 2-9% of smolts are delayed by more than 24 hours during downstream migration. It is not clear to what degree these two factors contribute to hydrosystem delayed mortality at the dam. 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 Brunswick Dam has the same delayed mortality rate as what was described by Stich et al (2015) (i.e., 6%). We acknowledge that 6% is an average estimate of delayed mortality based on smolts that passed two to nine dams on the Penobscot River, and that an individual project's contribution may vary significantly from that average. However, lacking project or river specific information we believe that this estimate constitutes the best available information regarding the contribution to hydrosystem delayed mortality caused by a given dam. Therefore, we assume that 6% of the smolts that survive passage at the Brunswick 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 Brunswick Project, including passage mortality through the dam, and hydrosystem delayed mortality. Given the mortality rates estimated above (i.e., average of 12.1% mortality through the project (including impoundment mortality within 200 meters of the dams), and an additional 6% delayed mortality) we anticipate that if 100 smolts migrated through the action area, only 82 would survive (direct survival x delayed survival = 81.9%). This does not include background levels of mortality in the action area that would occur regardless of the presence of the dam.

Kelts

As the Lewiston Falls Project does not have an upstream fishway, no Atlantic salmon kelts pass through the project area. However, based on recent returns to the Androscoggin River, we anticipate that a small number of kelts pass downstream through the Brunswick Project annually in the spring and late fall. At the Brunswick 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 Brunswick Dam are 3.5-inches, we anticipate that some kelts could become entrained in the turbines. Although no kelt survival studies have been conducted at the Brunswick Project, the Licensee conducted a desktop assessment of potential mortality at the project in their Biological Evaluation for the interim species protection plan in 2013 (FPL Energy 2013; Accession #20130221-5160). The assessment assumed that downstream passage of out migrating kelts must occur via one of three routes:1) unregulated spillage, 2) permanent or interim downstream bypass facilities, or, 3) the Project turbines. These three potential routes of passage were considered and incorporated into the whole station kelt survival model. FPL Energy calculated whole station kelt survival for the project by integrating river flows, project operating flows, spill effectiveness, downstream bypass effectiveness rates, turbine entrainment rates, and spillway and turbine survival rates using the Advanced Hydro Turbine model (Franke et al., 1997). Given the lack of site-specific empirical data related to the route selection of Atlantic salmon kelts through the various turbine units, it was assumed (for modeling purposes) that the distribution of kelt passage through the turbines would be equal to the distribution of outflow through those units at maximum discharge. A fork length – body width relationship was applied to the length frequency distribution of sea-run returns to the Penobscot River (1978-2009) to determine the proportion of kelts that could fit through the trash rack spacing at the project intakes. The Licensee estimated that 70.9% of kelts can swim through the racks in front of the units, which have 3.5-inch spacing. Based on the characteristics of the propeller units, they concluded that 75.5% of kelts survive passage through those units. Using the estimated passage route utilization and modelled survival, the Licensee determined that kelt survival at median flow is 85%. They further concluded that at higher flows, more fish pass over the spillway, which increases survival, and that at lower flows more kelts move through the propeller units, which decreases survival. Therefore, lacking empirical studies, we anticipate that 15% of adult salmon (pre- or postspawn) passing downstream are killed.

Prespawn Adult Atlantic salmon

The Lewiston Falls Project does not have any upstream passage facilities and is a complete barrier to all diadromous species. Although there is abundant high quality salmon habitat in the upper Androscoggin River, only three miles of impounded mainstem habitat is available upstream of the Lewiston Falls Dam due to the presence of another impassable dam. Within that reach there is almost no modelled rearing habitat (Wright et al 2008). In order to access the significant amount of rearing habitat in the Nezinscot River, prespawn Atlantic salmon would need to ascend three additional dams, including the Lewiston Falls Dam, that all currently lack fish passage.

The Brunswick Project has a vertical slot fishway that provides upstream passage for diadromous fish. Although the fishway can be operated so that fish can pass volitionally, it is run as a trap to facilitate the capture of river herring, which are trucked upstream, as well as to prevent invasive fish from moving further into the river. While the fishway has been documented to trap shad, herring, and salmon, there is no empirical evidence regarding the proportion of fish that are able to find and enter the fishway, nor how long they are delayed prior to being captured.

In order for endangered salmon to access habitat in the Androscoggin River under current conditions they need to be trapped, sorted, and then returned to the headpond. There are benefits to this method of passing fish (e.g., opportunity to handle, collect samples, or transport fish), assuming that the fishway and trap are efficient and that upstream migrants are able to locate the entrance. However, traps are only operated when staff are onsite monitoring the fishway, which can significantly impact the effectiveness of the fishway.

Atlantic salmon are known to successfully utilize the upstream fishway at the Brunswick Project, but as no studies have been conducted, we do not know how effective it is. It is possible to estimate effectiveness, however, by evaluating studies on salmonid passage at other vertical slot fishways. Hershey (2021) has conducted a meta-analysis of fishway efficiency by analyzing passage studies described in 60 peer-reviewed articles at 75 unique fishways (Hershey, 2021). Not all of these studies were with salmonids, and most were not at dams with vertical slot fishways similar to the one at the Brunswick Project. That said, relevant information can be extracted from his analysis. Hershey (2021) considered 18 studies (described in seven peer-reviewed articles) that specifically studied the effectiveness of vertical slot fishways for salmonids[14]. As described by Hershey (2021) and others, upstream passage of a dam with a fishway can be divided into two phases: the proportion of fish attracted to a fishway (i.e., attraction efficiency) and the proportion of fish that successfully navigate and exit the fishway once they have found it (i.e., passage efficiency). Combining (multiplying) these two rates will provide the overall efficiency of a given fishway. When this is done for all 18 studies considered by Hershey (2021), we can approximate the expected range of fishway efficiencies that can be expected for salmonids at vertical slot fishways. The median passage rate of the 18 studies was 58%. However, as the range of efficiencies observed is exceedingly broad (5% to 97%), it is likely the median is an underestimate of passage efficiency at the Brunswick Project, as it was designed specifically to pass Atlantic salmon. A similar fishway at the West Enfield Project on the Penobscot River has been found to be 88-89% effective at passing salmon (Shepard 1995). Given this, we have determined that it is more appropriate to consider the 75th percentile rather than the 50th percentile (i.e., the median), when determining the likely efficiency of the project. Therefore, we anticipate that the fishway efficiency (i.e., attraction efficiency x passage efficiency) at the Brunswick Project is approximately 77%.

Adult salmon that are unable to safely pass the Brunswick dam either spawn in other nearby rivers (most likely the Kennebec River), return to the ocean without spawning, or die in the river. Salmon that stray due to the lack of passage at the Lewiston Falls dam will likely behave similarly, but have the additional alternative to spawn in the small amount of habitat available in the tributaries downstream (i.e., the Little Androscoggin and Little Rivers). Although no studies have looked directly at the fate of fish that fail to pass upstream on the Androscoggin 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 Hydro's 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. Given that Brunswick Dam is the first dam on the river and within close proximity to

[14] Information on the individual studies considered by Hersey 2021 can be found on this website: https://onlinelibrary.wiley.com/doi/full/10.1111/faf.12547?casa_token=CJAYwj5CKwkAAAAA%3AS92V-jrsOSZeSdjnlEIk4Jz_hb6NgTGCtswON2p-Y5CyviYUhwGo9gPEdMQ3ZKCXOAPZrmgfoWYB3gv1

the estuary, we anticipate that it would fall into this category, but that Lewiston Falls would not. In addition, projects closest to the ocean were estimated to have a certain proportion drop back into the ocean. In the Androscoggin, there is no known spawning habitat downstream of the Brunswick 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 Brunswick Dam stray to neighboring rivers and attempt to spawn.

The number of adult salmon actually exposed to these dams is low due to the small amount of stocking and natural production in the Androscoggin River. Given the estimated passage rate of 77% at the Brunswick Dam and 0% at the Lewiston Falls Dam, we do not expect that the existing mortality rate exceeds 0.5% (2% x 23%=0.5%) or 1% (1% x 100%=1%), respectively. We expect that the majority of salmon that fail to pass survive and stray to habitat downstream of the dams. Therefore, we estimate that 22.5% (98.0% x 23.0%=22.5%) of the total run at the Brunswick Dam and 99.0% (99.0% x 100.0% = 99.0%) of the total run at the Lewiston Falls Dam, strays to one of the nearby rivers (e.g. Kennebec) where they may have the opportunity to spawn.

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 prespawn female salmonids (de Gaudemar & Beall, 1998). Additionally, migratory delay has adverse energetic effects that may reduce the likelihood that salmon will successfully spawn and out migrate 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 in a single year) and die after spawning, Atlantic salmon have evolved to be iteroparous (i.e., spawn in multiple years) and are capable of returning to the ocean after spawning and subsequently returning to their natal river to spawn again. The threshold for iteroparity has been hypothesized to be 80% energy expenditure during migration and spawning (Glebe & Leggett, 1981). That is, an individual that uses more than 80% of its energy reserves will likely die after spawning, while those that use less have the potential to survive to spawn in multiple years. At the completion of their spawning migration, the energy loss for Atlantic salmon during spawning has been estimated to be 60-70% (Jonsson et al 1997). The amount of energy used likely varies based on the length of the migration and the environmental conditions they are exposed to during migration. Salmon that migrate under warmer conditions use more energy than those that migrate under cool conditions. Water temperature directly affects the rate of all biochemical reactions in ectothermic animals, such as Atlantic salmon, including metabolic processes (Angilletta Jr et al., 2002). This effect predicts a theoretical doubling of biological processes every 10ºC, and this theoretical trend is validated 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°C and 20°C, 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 Androscoggin River (and other rivers in the GOM DPS) to exceed 23°C 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.

The energetic implications of migratory delay are compounded by the fact that adult salmon are delayed both in their upstream migration to spawning habitat, as well as on their downstream migration after spawning, due the effects of dams. It has been estimated that a kelt that is delayed by 30 days (cumulative) at hydro dams during their outmigration, may utilize an additional 4% or 5% of their energy reserves, which could lead to an additional 10% mortality (Baktoft et al., 2020). During high flow periods when excess water spills over dams (including Brunswick), kelts are found to migrate quickly through the project area. However, in low flow periods when spill is not an optional egress route for salmon, delay may be more of a problem. According to the Brunswick flow duration curves, the project does not spill 100% of the time during the months when we anticipate kelts would be migrating through the Androscoggin River. It is anticipated that kelts could pass the project quickly via spill in October 20% of the time, in November 50% of the time, December 50% of the time, April 88% of the time, May 63% of the time, and June 30% of the time (FPL Energy, 2013). At times when spill is unavailable, it is probable that some amount of migratory delay occurs, which exacerbates the energetic effects of dam passage. As most kelts migrate during high flows in the spring, they are likely able to pass the Brunswick Dam quickly.

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., flow, 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, 2016). 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 Brunswick 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 Brunswick 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 Brunswick Dam as we expect attraction to be better given that fish cannot access the spillway and are guided towards the tailrace (in the vicinity of the fishway entrance) by the ledge outcropping downstream of the dam. As such, we assume that under existing conditions at the Brunswick Dam, 50% of the salmon that passed the project took more than 48-hours to pass.

4.5.4 PREDATION

In addition to direct mortality during downstream passage, kelts and smolts are exposed to indirect mortality caused by sub-lethal injuries, increased stress, and/or disorientation. A large proportion of indirect mortality is a result of disorientation caused by downstream passage, which can lead to elevated levels of predation immediately downstream of the project (Mesa 1994).

Smallmouth bass and chain pickerel are each significant predators of Atlantic salmon within the range of the GOM DPS (Fay *et al.* 2006). Smallmouth bass are a warm-water species whose range now extends through north-central Maine and well into New Brunswick (Jackson 2002). Smallmouth bass are abundant in the action area. Smallmouth bass are important predators of smolts in mainstem habitats, although bioenergetics modeling indicates that bass predation is insignificant at 5°C and increases with increasing water temperature during the smolt migration (Van den Ende 1993).

Chain pickerel are known to feed upon smolts within the range of the GOM DPS and 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.

Northern pike were illegally stocked in Maine, and their range now includes portions of the lower Androscoggin River. Northern pike are ambush predators that rely on vision and thus, predation upon smolts occurs primarily in daylight with the highest predation rates in low light conditions at dawn and dusk (Bakshtansky *et al.* 1982). Hatchery smolts experience higher rates of predation by fish than wild smolts, particularly from northern pike (Ruggles 1980, Bakshtansky *et al.* 1982).

Many species of birds prey upon Atlantic salmon throughout their life cycle (Fay *et al.* 2006). Blackwell *et al.* (1997) reported that salmon smolts were the most frequently occurring food items in cormorant sampled at mainstem dam foraging sites. Common mergansers, belted kingfishers cormorants, and loons prey would likely prey upon Atlantic salmon in the Androscoggin River. 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).

4.5.5 WATER QUALITY

Pollutants discharged from point sources affect water quality within the action area of this consultation. Common point sources of pollutants include publicly operated waste treatment facilities, overboard discharges (OBD, a type of waste water treatment system), and industrial sites and discharges. The Maine Department of Environmental Protection (MDEP) 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. Generally, the impacts of point source pollution are greater in the larger rivers of the GOM DPS.

Poor water quality within segments of the Androscoggin River is of particular concern for fisheries restoration. MDEP classifies the portion of the Androscoggin River in which the Brunswick Project occurs, as Class C waters. Class C waters must be of such quality that they are suitable for the designated uses of drinking water supply after treatment; fishing; agriculture; recreation in and on the water; industrial process and cooling water supply; hydroelectric power generation; navigation; and as a habitat for fish and other aquatic life (MDEP 2014).

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[15]). 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

[15] IPCC 2014 is used as a reference here consistent with NMFS 2016 Revised Guidance for Treatment of Climate Change in NMFS Endangered Species Act Decisions (Available at: https://s3.amazonaws.com/media.fisheries.noaa.gov/2020-09/guidance-treatment-climate-change-nmfs-esa-decision-wieting-2016.pdf , last accessed October 12, 2021.)

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 0.2ºC 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 (Elliott 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 & 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 (Elliott 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). 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 (<23° Celsius), which could affect an individual's ability to access suitable spawning habitat. In addition, elevated temperatures will make some areas unsuitable for spawning and rearing due to effects to egg and embryo development.

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 Androscoggin 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 (Peterson et al., 1977; Spence et al., 1996; 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.

5.3 Anticipated Effects to Atlantic and shortnose sturgeon

Hare et al. (2016) assessed the vulnerability to climate change of a number of species that occur along the U.S. Atlantic coast. The authors define vulnerability as "the extent to which abundance or productivity of a species in the region could be impacted by climate change and decadal variability." Atlantic sturgeon were given a Vulnerability Rank of Very High (99% certainty from bootstrap analysis) as well as a Climate Exposure rank of Very High. Three exposure factors contributed to this score: Ocean Surface Temperature (4.0), Ocean Acidification (4.0) and Air Temperature (4.0). The authors concluded that Atlantic Sturgeon are relatively invulnerable to distribution shifts and that while the effect of climate change on Atlantic Sturgeon is estimated to be negative, there is a high degree of uncertainty with this prediction. Secor and Gunderson (1998) found that juvenile metabolism and survival were impacted by increasing hypoxia in combination with increasing temperature. Niklitschek and Secor (2005) used a multivariable bioenergetics and survival model to generate spatially explicit maps of potential production in the Chesapeake Bay; a 1°C temperature increase reduced productivity by 65% (Niklitschek and Secor, 2005). These studies highlight the importance of the availability of water with suitable temperature, salinity and dissolved oxygen; climate conditions that reduce the amount of available habitat with these conditions would reduce the productivity of Atlantic sturgeon. Changes in water availability may also impact the productivity of southern populations of Atlantic sturgeon. Spawning and rearing habitat may be restricted by increased salt water intrusion in rivers with dams or other barriers that limit access to upstream freshwater reaches;

however, no estimates of the impacts of such change are currently available. Hare et al. conclude that most climate factors have the potential to decrease productivity (sea level rise; reduced dissolved oxygen, increased temperatures) but that understanding the magnitude and interaction of different effects is difficult.

As described by Hare et al., the effect of climate on shortnose sturgeon populations is not well understood. Like Atlantic sturgeon, shortnose sturgeon were given a Vulnerability Rank of Very High (99% certainty from bootstrap analysis) as well as a Climate Exposure rank of Very High. While many aspects of Shortnose Sturgeon life history and ecology are linked to temperature, river flow, dissolved oxygen, salinity, but the effect of change in these environmental variables on Shortnose Sturgeon is unclear (Cech and Doroshov, 2005; Ziegeweid et al., 2008a, 2008b). At the southern end of their range, productivity could be reduced by salt-water intrusion and decreases in summer dissolved oxygen (Jager et al., 2013). Changes in water availability may also impact the productivity of southern populations of shortnose sturgeon. Studies in the Hudson River indicate that flow volume and water temperature in the fall months preceding spawning were significantly correlated with subsequent year-class strength (Woodland and Secor 2007), which suggests increased vulnerability in some future scenarios. Spawning and rearing habitat may be restricted by increased salt water intrusion in rivers with dams or other barriers that limit access to upstream freshwater reaches; however, no estimates of the impacts of such change are currently available. Hare et al. conclude that the effect of climate change on Shortnose Sturgeon is estimated to be neutral, but this estimate has a high degree of uncertainty (<66% certainty in expert scores) and that climate factors have the potential to decrease (sea level rise; reduced dissolved oxygen) or increase (temperature) productivity of Shortnose Sturgeon. The authors also conclude that the effect of ocean acidification over the next 30 years is likely to be minimal.

As stated above for Atlantic salmon, information on how climate change will impact the action area is extremely limited, but we generally expect Maine's annual temperature and total precipitation (especially in the form of rain) to increase, and we expect the salt wedge may shift up further in the Kennebec River estuary (see section 6.2.1 for more details).

Water availability, either too much or too little, as a result of global climate change is expected to have an effect on the features essential to successful sturgeon spawning and recruitment of the offspring to the marine environment (for Atlantic sturgeon). The increased rainfall predicted by some models in some areas may increase runoff, scour spawning areas, and create flooding events that dislodge early life stages from the substrate where they refuge in the first weeks of life. High freshwater inputs during juvenile development can influence juveniles to move further downriver and, conversely, lower than normal freshwater inputs can influence juveniles to move further upriver potentially exposing the fish to threats they would not typically encounter. Increased number or duration of drought events (and water withdrawal for human use) predicted by some models in some areas may cause loss of habitat including loss of access to spawning habitat. Drought conditions in the spawning season(s) may also expose eggs and larvae in rearing habitats. If a river becomes too shallow or flows become intermittent, all sturgeon life stages, including adults, may become susceptible to stranding or habitat restriction. Low flow and drought conditions are also expected to cause additional water quality issues including effects to the combined interactions of dissolved oxygen, water temperature, and salinity.

Elevated air temperatures can also impact dissolved oxygen levels in the water, particularly in areas of low water depth, low flow, and elevated water temperature. Rising temperatures predicted for all of the U.S. could exacerbate existing water quality problems affecting dissolved oxygen and temperature.

The action area is upstream from the present upper limit of salt water intrusion. The relatively short timeframe of the proposed action (2021-2029) makes any prediction of large scale and long-term climate change effects difficult. That said, over the next eight years, we do not expect the salt front to shift far enough upstream to change the salinity of the action area and result in any restriction of spawning or nursery habitat.

In the action area, it is possible that changing seasonal temperature regimes could result in shifts in the timing of seasonal migrations through the area as sturgeon move throughout the river. Atlantic sturgeon prefer water temperatures up to approximately 28°C (82.4°F); these temperatures are experienced naturally in some areas of rivers during the summer months. If river temperatures rise and temperatures above 28°C are experienced in larger areas, Atlantic sturgeon may be excluded from some habitats. Additionally, temperature cues for spawning migration and spawning could occur earlier in the season causing a mismatch in prey that are currently available to developing sturgeon in rearing habitat. Any of the conditions associated with climate change are likely to disrupt river ecology causing shifts in community structure and the type and abundance of prey.

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 difficult to predict how any change in water temperature or river flow will affect the seasonal movements of sturgeon through the action area. However, it seems most likely that spawning would shift to earlier in the year.

Any forage species that are temperature dependent may also shift in distribution as water temperatures warm. However, because we do not know the adaptive capacity of these individuals or how much of a change in temperature would be necessary to cause a shift in distribution, it is not possible to predict how these changes may affect foraging sturgeon. If sturgeon distribution shifted along with prey distribution, it is likely that there would be minimal, if any, impact on the availability of food. Similarly, if sturgeon shifted to areas where different forage was available and sturgeon were able to obtain sufficient nutrition from that new source of forage, any effect would be minimal. The greatest potential for effect to forage resources would be if sturgeon shifted to an area or time where insufficient forage was available; however, the likelihood of this happening is low because sturgeon feed on a wide variety of species and in a wide variety of habitats.

Limited information on the thermal tolerances of Atlantic and shortnose sturgeon is available. Atlantic sturgeon have been observed in water temperatures above 30°C in the south (see Damon-Randall et al. 2010); in the wild, shortnose sturgeon are typically found in waters less than 28°C. In the laboratory, juvenile Atlantic sturgeon showed negative behavioral and bioenergetics responses (related to food consumption and metabolism) after prolonged exposure to temperatures greater than 28°C (82.4°F) (Niklitschek 2001). Tolerance to temperatures is thought to increase with age and body size (Ziegweid et al. 2008 and Jenkins et al. 1993), however, no information on the lethal thermal maximum or stressful temperatures for subadult or adult Atlantic sturgeon is available. Shortnose sturgeon, have been documented in the lab to experience mortality at temperatures of 33.7°C (92.66°F) or greater and are thought to experience stress at temperatures above 28°C. For purposes of considering thermal tolerances, we consider Atlantic sturgeon to be a reasonable surrogate for shortnose sturgeon given similar geographic distribution and known biological similarities. Rising temperatures could meet or exceed the preferred temperature of shortnose and Atlantic sturgeon (28°C) on more days and/or in larger areas. This could result in shifts in the distribution of sturgeon out of certain areas during the warmer months. Information from southern river systems suggests that during peak summer heat, sturgeon are most likely to be found in deep water areas where temperatures are coolest. Thus, we could expect that over time, sturgeon would shift out of shallow habitats on the warmest days. This could result in reduced foraging opportunities if sturgeon were foraging in shallow waters.

As described above, over the long term, global climate change may affect shortnose and Atlantic sturgeon by affecting the location of the salt wedge, distribution of prey, water temperature and water quality. However, there is significant uncertainty, due to a lack of scientific data, on the degree to which these effects may be experienced and the degree to which shortnose or Atlantic sturgeon will be able to successfully adapt to any such changes. Any activities occurring within and outside the action area that contribute to global climate change are also expected to affect shortnose and Atlantic sturgeon in the action area. While we can make some predictions on the likely effects of climate change on these species, without modeling and additional scientific data these predictions remain speculative. Additionally, these predictions do not take into account the adaptive capacity of these species which may allow them to deal with change better than predicted.

Additional modeling for climate change impacts, particularly salt water intrusion, are needed for the action area, to better assess the potential effects on shortnose and Atlantic sturgeon, as well as Atlantic sturgeon critical habitat.

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 effects of the proposed action on the GOM DPS of Atlantic salmon, shortnose sturgeon, the GOM DPS of Atlantic sturgeon, and critical habitats designated for Atlantic salmon and Atlantic sturgeon. We consider these effects on the species and their habitats within the context of the species status now and projected over the course of the action.

FERC is proposing to amend the licenses for the Brunswick and Lewiston Falls Projects for a term of 8 years and 5 years, respectively (i.e., through the remaining term of the licenses). As described previously, the past and ongoing effects of the Projects that are not affected by the amendment of the licenses to operate under the terms of the SPP are considered as part of the environmental baseline (section 4.5.3), and therefore are not addressed in this section. In this section we will consider the effects of amending the licenses for the Brunswick and Lewiston Falls Projects to incorporate fish passage measures for Atlantic salmon, as well as measures to survey and rescue sturgeon and salmon that are stranded or entrained in ledges downstream of the dams, or within the Brunswick fishway or draft tubes. We anticipate that the passage measures will affect salmon passage efficiency, downstream survival and injury, and migratory delay.

6.1 Species Presence

6.1.1 Atlantic salmon

As described in section 4.1, there are few salmon naturally produced or stocked in the Androscoggin River (average of six per year over the last decade; two per year if 2011 is excluded from the dataset)(CMS, 2021; USASAC, 2020). In the last decade, there were only six years when more than one adult salmon was documented in the river. Stocking effort in the Androscoggin River has been minimal since the 1990s, and was reduced to zero in 2017 through 2019. Therefore, under current passage and stocking conditions, salmon presence is likely limited to salmon straying from the nearby Kennebec River. Based on information from the last decade, we anticipate a very small number of prespawn salmon will stray and pass upstream of the Brunswick Project, and a much smaller number will pass the lower three dams on the river to access the tailrace of the Lewiston Falls Project. Correspondingly, we would expect few spawning events that would lead to juvenile production upstream of the Brunswick project. As salmon cannot pass the Lewiston Falls project, there will be no production upstream of that project.

A significant increase in salmon returning to the Androscoggin River will require 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 Merrymeeting Bay 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 Androscoggin River.

Aspects of the proposed action (i.e., operational modifications to upstream and downstream passage) will improve survival and passage effectiveness to the point that the number of salmon in the river is expected to increase compared to baseline conditions. With higher upstream passage rates, we anticipate that more straying salmon will be passed into upstream reaches of the river. Additionally, with higher downstream survival at the Brunswick project, more smolts will survive to the estuary, which will lead to more adult Atlantic salmon homing back to the Androscoggin River.

6.1.2 ATLANTIC AND SHORTNOSE STURGEON

Sturgeon are not passed above the Brunswick Project as it is believed to be the historical upstream limit for both species in the Androscoggin River. As described above, however, they are known to spawn in habitat just downstream of the Brunswick Project, so we anticipate that they will occur in the action area during the timeframe of the proposed action.

6.2 HYDROELECTRIC OPERATIONS

6.2.1 FISH PASSAGE

6.2.1.1 DOWNSTREAM FISH PASSAGE

As no endangered fish species occur upstream of the Lewiston Falls Project, there are no effects associated with downstream passage at that Project. Sturgeon are not passed at the Brunswick Project, so downstream effects associated with the proposed action are limited to a small number of Atlantic salmon smolts and kelts that pass that project annually on their way to the marine environment.

Under the proposed action, the Brunswick Project will continue to affect out migrating 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 4.5.2.1 describes the past effects of the project on out migrating salmon. Based on the results of the smolt survival studies in 2013-2015 survival at the project averages 87.1%, ranging between 82.8% and 94.9% (BWPH, 2016). The 2013-2015 studies also indicated that the downstream bypass pipe is ineffective at all flows, that survival is significantly lower through the turbines (78.5%-85.5%) than over the spillway (100.0%), and that turbine entrainment is higher during low flow/low spill years (BWPH, 2016). For example, in 2014 (a high flow year) two-thirds of the smolts went over the spillway, whereas in 2013 (a low flow year) only 11% did. Given these results, and as a result of survival being less than what was anticipated, BWPH has proposed operational measures that would reduce turbine entrainment and increase spillway flows during low flow years. The proposal includes three operational scenarios based on river flow that would ensure that spill occurs at the project at night during the month of May (Table 1 is Section 2.1) regardless of flow.

The anticipated benefit of the proposed operational measures is that shutting down units would reduce turbine passage, and increase passage over the spillway. BWPH conducted an additional telemetry study in 2018 to test the effectiveness of the proposed scenario. Although Unit 3 was not working for the duration of the evaluation, BWPH still operated the project in a way (shutdown of unit 1 at night) that decreased generation at night to provide additional spill at low to medium flows (less than 18,275 cfs). The results of the 2018 study indicated that 96.3% of the smolts that passed the project survived. Although this is nearly a 10% increase over the 2013-2015 average of 87.1%, it is quite similar to what was observed at the project in 2014 (i.e., 94.9%), which was a high flow year with abundant spill (Figure 10). The results indicated that approximately two-thirds of radio-tagged smolts passed via spill (either the ogee spillway or the Taintor gates), which is nearly twice the average proportion observed during the 2013-2015 studies. However, as indicated, 2014 was a high flow study year similar to what was observed in 2018, and in that year almost exactly the same proportion of smolts (2018-68.8%; 2014-67.9%) passed the project via the spillway. Therefore, we are unable to state with certainty whether it was the high river flow or the implementation of the operational measures that led to a significant shift in passage route selection in 2018. However, the shutdown of unit 1 at night for the medium range of flows appears to have led to a significant reduction in the number of smolts using that route (Table 20). Of the tagged smolts that passed the project during the 2013-2015 survival studies an average of 36.8% passed via unit 1 (2013-72.3%; 2014-24.7%; 2015-20.7%), whereas in 2018 only 0.6% of the salmon smolts passed through that route (Brookfield, 2019; BWPH, 2016). As the average survival through unit 1 in the 2013-2015 studies was only 78.5% (versus 100.0% at the spillway routes), it is likely that diverting smolts away from that route led to an improvement in overall passage survival. That said, the results of the 2018 study were not fully representative of the proposed operational scenario since unit 3 was not functioning throughout the study (Brookfield, 2019). Full implementation of the operational measures (as described in Section 2.1) requires that units 2 and 3 operate 24 hours a day during the high (>18,275 cfs) and medium (7,615-18,275 cfs) flow conditions (Table 1). The river flow was in this range for the majority of the 2018 study (until approximately May 14; last smolt passed on May 18). Presumably, if unit 3 had been operating as anticipated some proportion of the smolts that passed through unit 2, or one of the spillway routes, would have gone through unit 3 instead.

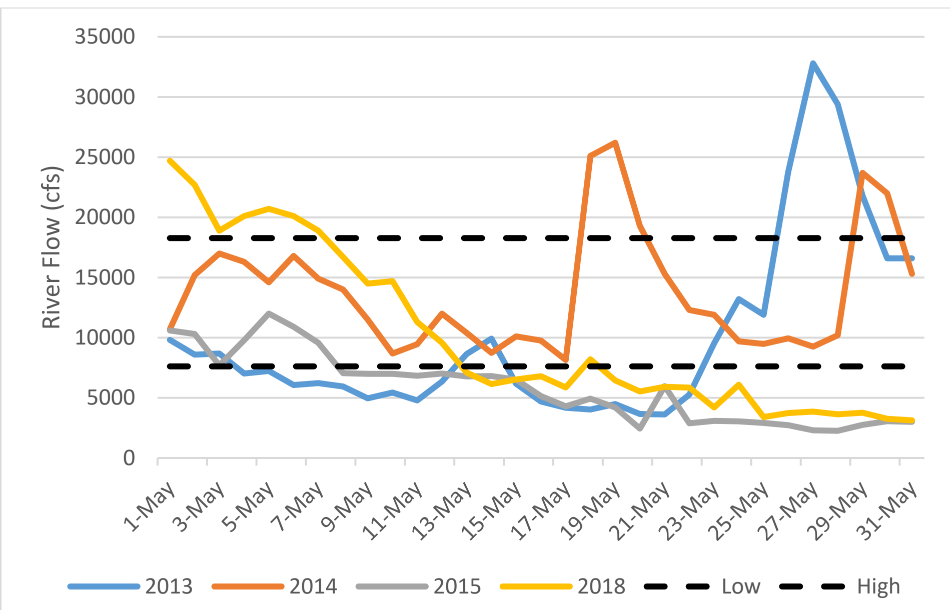


Figure 10. The flow in the Androscoggin River in Auburn during the month of May (derived from data from the USGS National Water Information System) for the four study years at the Brunswick Project. The High and Low flow lines indicate the threshold flows for the proposed operational scenario ((i.e., above high flow (upper dashed line) BWPH will operate all turbines, between high and low flow they will shutdown unit 1 at night, and below low flow (lower dashed line) they will shut down unit 1 and either unit 2 or unit 3 at night to increase spillway flows).

Although we cannot say with certainty what survival would have been in the 2018 study if the proposed spill measures had been fully implemented, or if it had been a low flow year, we can estimate generally what survival is assuming that unit 1 is no longer an available passage route. If we apply the passage route proportions observed in 2018 (i.e., two-thirds to the spillway, one-third to units 2 and 3) to the study fish in the other three study years when the measures were not being implemented (by assigning fish that would have gone through unit 1 to the spillway and other units based on a 75:25 ratio, due to the higher proportion of flow going to the spillway and the fact that either unit 2 or 3 would be shutdown at the flows seen in 2013 and 2015), and assume average route specific survival estimates from the 2013-2015 studies (i.e., 100% spillway, 85.5% units 2 and 3) (BWPH, 2016) applied to all study years, than we would have a hypothetical annual survival ranging from 92% to 98%, with an average of 95% survival. The hypothetical survival in 2015 is 92% because a high proportion of smolts went through units 2 and 3 in that year. The estimate does not account for the fact that either unit 2 or 3, not both, would have been operating at night given that flows were low for much of the study. Therefore, 92% is likely an underestimate of the survival we could have expected in that year if the operational measures were in effect. Therefore, we will assume that an average of the three hypothetical study years, as well as the actual results from 2018, adequately represents what would be observed at the Brunswick Project with the implementation of the proposed operational measures. Thus, we anticipate that while the spill measures are being fully implemented 95% of smolts would survive the direct effects of passage. This is likely an overestimate of survival for the entire smolt run, however, as the proposed measures are only being implemented at night during the month of May. Study results from all four years (2013-2015, 2018) indicate that some proportion of the run passes the project during daylight hours (Brookfield, 2019; BWPH, 2016). Additionally, smolt migration is not restricted to the month of May, and may start as early as mid-April and not end until mid-June (Figure 3) (USASAC, 2016). Therefore, any smolts that pass the dam during the day, or outside of the May 1 to May 31 timeframe, could experience the same survival rate as what was observed between 2013 and 2015 (i.e., three year average of ~87%). Based on information provided on smolt run timing in section 4.1, we expect that in the Androscoggin River at least 95% smolts pass during the month of May (USASAC 2016-2020), and that 80-95% pass at night or twilight (Kocik et al., 2009). Given that, we expect that at least 76% (95% that pass in May x 80% that pass at night) of the smolt run will pass when the operational measure is being implemented; and 24% (100% - 76%) will pass when it is not being implemented. Therefore, assuming the survival rates described above, we anticipate that 93% ((87% x 24% of smolts) + (95% x 76% of smolts)) of smolts will survive passage at the Brunswick Project annually. This constitutes a 7% improvement over the average survival detected at the project prior to the implementation of the spill measures, and a 12% improvement over the survival detected during the low flow years in 2013 and 2015.

Table 17. Atlantic salmon smolt passage route selection at the Brunswick Project in 2018 (when Unit 1 was shutdown at certain flows to induce spillway flow) as compared to the 2013-2015 average (Brookfield, 2019; BWPH, 2016).

Passage Route	Route Selection	
	2018	2013-2015
Spill Routes	65.9%	36.8%
Downstream Bypass	2.4%	NA
Upstream Fishway	0.6%	NA
Unit 1	0.6%	36.8%
Unit 2	29.3%	26.3%
Unit 3	NA	

We anticipate that a certain amount of sublethal injury will occur when smolts pass the Brunswick Project. These fish will either succumb to their injuries in the estuary, be predated upon due to their reduced fitness, or continue their migration without obvious fitness consequences; 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. As described in section 4.5.2, sublethal injury is believed to be one of the causes of hydrosystem delayed mortality in the estuary. Although no empirical studies have been conducted, FPL Energy estimated that the sublethal injury rate for fish passing through the turbines at the Brunswick Project to be 7.5% (FPLE, 2013). Given the consistently high survival rates over the spillway (100%) we assume the injury rate associated with passage through that route is zero. Using these assumptions regarding route-specific injury rate, we can estimate what the injury rate is through the Project as a whole under current conditions, and how the proposed action will affect it. Of all the smolts that passed the Brunswick Project during the 2013-2015 smolt survival studies, 63% passed via the turbine units, and 37% passed via non-turbine routes (Table 19) (BWPH, 2016). Applying the assumed route-specific injury rates, we anticipate that the whole project injury rate under baseline conditions is approximately 5%. The proposal to shutdown turbines should reduce turbine entrainment and increase spillway passage for smolts that pass at night in the month of May, which should lead to a reduction in injury rates. To quantify the potential reduction, we can use the assumptions used in the smolt survival estimate above (i.e., applying passage route distribution from 2018 to the 2013-2015 study years and assigning the smolts that went through unit 1 to the remaining passage routes; as well as the 76%/24% ratio of fish that would benefit from the measures due to the proposed timing), to estimate that the sublethal injury rate at the Brunswick Project. Through this basic analysis, we anticipate that the sublethal injury rate will be reduced from 5% to 3.5% ((5% x 24%) + (3% x 76%)).

Migratory Delay

In section 4.5.2.1., we describe the ongoing migratory delay currently caused by the Brunswick Dam (Table 18). As indicated previously, migratory delay can lead to smolts missing their physiological smolt window and result in increased exposure to predation. The annual median residence time (i.e., defined as the amount of time it takes a smolt to pass the project once it comes within approximately 200 meters of the dam) at the project varied between 0.3 and 0.5 hours during the 2013-2015 smolt survival studies; whereas, the proportion of smolts that took longer than 24 hours to pass the project averaged approximately 5% (range 2% to 9%). As the proposed operational measures are designed to increase spill passage, we anticipate that there would be a reduction in migratory delay. The 2018 study, which occurred after the implementation of the new operational measures, indicated that 2% of smolts took longer than 24 hours to pass, which constitutes a 60% reduction from the 5% average from the earlier studies (Brookfield, 2019). It is unclear whether this reduction in migratory delay was associated with the spill measures, or with the high flow conditions that occurred in 2018. The proportion of smolts (2%) that took longer than 24 hours to pass the project in 2018 was the same as what was observed in 2014 (median non-bypass spill of 4,331 cfs), which was a similar year in terms of river flow. The other two years (2013 and 2015) were low flow years (median non-bypass flow of 0-146 cfs), where there was significantly less flow over the spillway. Therefore, it is possible that the higher river flow, rather than the nighttime shutdown of unit 1, is what led to the smolts moving relatively quickly through the project area in 2018. That said, we anticipate that in low flow years (such as 2013 and 2015), the practice of shutting down one or two turbines at night will induce additional flow over the spillway that would not occur otherwise under those flow conditions. Therefore, we anticipate that the proposal would lead to delay rates that approximate what has been observed in higher flow years (i.e., <2% of smolts taking longer than 24 hours to pass) at times when they are implementing the measure. There is some uncertainty around this estimate, however, as the proposed measures are only being implemented at night during the month of May. Therefore, any smolts that pass the dam during the day, or outside of the May 1 to May 31 timeframe, could be exposed the same amount of delay as what was observed between 2013 and 2015. Given these parameters which are defined above, we estimate that the proportion of smolts that are delayed by more than 24 hours will be reduced from 5% to 2.7% ((5% x 24%) + (2% x 76%)).

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. We can reasonably expect that 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 delay of 24-hours or less 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)[16] 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

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

exposed animal to a stressor or disturbance (e.g., startle, flight, alteration [including abandonment] of important behaviors); and; 4) Whether the nature and duration or intensity of that response is a significant disruption of those behavior patterns which include, but are not limited to, breeding, feeding, or sheltering, resting or migrating.

Here, we carry out that four-step assessment. We have established that all out migrating smolts will encounter the dam and that it will result in a disruption of their downstream migrations (step 1) and that 2% of smolts will be delayed for more than 24 hours (step 2). We have established the expected response of the exposed smolts (step 3): individual smolts delayed more than 24 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 24 hours on their downstream migration are likely to be adversely affected and that effect amounts to harassment. Therefore, we anticipate that up to 2% of salmon smolts that pass the project will be exposed to significant delay (i.e., take more than 24 hours to pass the dam), which we consider to meet the definition of harassment.

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 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 smolts 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.

Hydrosystem Delayed Mortality

As explained in section 4.5.2.1, some of the smolt mortality that occurs in the estuary downstream of the Brunswick 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. Lacking an Androscoggin-specific estimate of hydrosystem delayed mortality, we rely on this estimate from the Penobscot River as the best available information. We therefore estimate that the total hydrosystem delayed mortality associated with the Brunswick Project is currently 6%. 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 45% reduction in the proportion of fish that take more than 24 hours to pass the Project (2.7%

compared to 5%), and a 30% reduction in sublethal injury (3.5% compared to 5%), 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 30% 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 4%. Therefore, we anticipate that no more than 4% of smolts will die as a result of hydrosystem delayed mortality in the Androscoggin River.

Given the above information, we anticipate that during the term of the SPP, direct smolt mortality associated with downstream passage will not exceed 7%. With an anticipated 4% hydrosystem delayed mortality rate, we expect that during this period approximately 89% of out migrating smolts will survive passage at the Brunswick Project. This estimate includes the mortality that occurs within 200 meters upstream of the dam, and was corrected for background mortality.

We expect that the mortality rate of salmon kelts will continue at the levels described in the Environmental Baseline (section 4.5.2). Lacking empirical information, FPL Energy (2013) estimated that the project leads to the mortality of 15% of out migrating adult salmon. Unlike smolts, kelts out migrate across a longer time frame (November-December, April-June), and are less influenced by the time of day. Therefore, although it is possible that some postspawn salmon might pass at night in the month of May, and thus benefit from the proposed spill measures, it is unlikely that this would make a meaningful difference in the number of salmon that are killed at the Project. Therefore, as the proposed action will not significantly affect the probability of turbine entrainment of kelts, we do not anticipate that the level of mortality will change due to the proposed action.

Although we expect salmon mortality and injury to occur at the project during the years of the SPP, we anticipate that the actual number of affected salmon would be very low given the number expected to occur in the river during this period. As stated previously, there is no significant stocking and very limited natural production occurring in the Androscoggin River at this time. Therefore, we expect very few salmon to be exposed to passage effects during the 8 year term of the SPP. That said, with the proposed improvements to passage at the project, our expectation is that salmon abundance may increase.

6.2.1.2 UPSTREAM FISH PASSAGE

The Brunswick and Lewiston Falls Projects both pose a barrier to sea-run fish migration in the Androscoggin River. As described above, the Lewiston Falls Project has no upstream fishway and is therefore the upstream limit of sea-run fish distribution in the river. The Brunswick Dam has a vertical slot fishway that is operated with a trap to prevent the passage of invasive species (e.g., white catfish), and to capture alewives that are trucked to lakes further upstream in the river. Sturgeon are not passed at the Project as the falls underneath the dam are thought to be the upstream historical limit for both species. Atlantic salmon pass the Project in small numbers in most years. There have not been any effectiveness studies for salmon at this project. We have estimated, based on supplemental information from Hershey (2021), that fishway efficiency for salmonids at vertical slot fishways range between 5% and 97%. Lacking project specific information, we determined that the 75th percentile (77%) of the 18 studies analyzed by Hersey is a reasonable estimate of passage efficiency at this project. However, we expect that this may be a conservative estimate for Atlantic salmon given the 88- 89% effectiveness observed at the West Enfield Project on the Penobscot River (Shepard, 1995).

The number of salmon passing the Brunswick Project has been less than 6 annually over the last 9 years. Given the low level of stocking, we anticipate that this represents a conservative estimate of the number of salmon that will pass the project annually during the term of the SPP. Over the eight year term we assume that no more than 48 salmon (6 per year for eight years) will pass the project. Based on a 77% effectiveness rate for the fishway, we estimate an additional 14 salmon (48 salmon/77%=62 salmon; 62-48=14) will approach the project but will fail to pass. We expect that all 14 will survive and will stray to spawning habitat downstream of the Project, most likely migrating to the neighboring Kennebec River.

The proposed action includes the implementation of an operations plan that ensures that the fishway and trap are being adequately monitored during the times when Atlantic salmon could be migrating into the river. The major provisions of the plan, as described in Section 2.1.1, are relevant to the timing of the operation of the trap as sea run fish, including salmon, are unable to pass the fishway unless staff are present. Although not well documented, it appears that the trap has not been consistently staffed during these hours, particularly near the end of the fish passage season (i.e., August 1 to November 15) after the alewife run has concluded. The proposed plan would ensure that the fishway and trap are being operated between 7:00 am and 7:00 pm between May 1 and June 15; and between 9:00 am and 7:00 pm between June 15 and November 15. To account for the fact that BWPH and MDMR staff cannot always be onsite during these hours to monitor the trap, BWPH has proposed to install a camera at the viewing window to be monitored by staff at the Lockwood Project on the Kennebec River. They have also proposed to automate the gate on the trap so that it can be opened remotely if the staff at Lockwood observe a salmon to allow it to swim through.

The ability to monitor and pass salmon remotely greatly increases the probability that the fishway will be operated in such a way as to effectively pass salmon that approach. However, as there have never been any studies that evaluated salmon passage prior to the enhanced monitoring measures it is not possible to estimate to what degree passage will be improved. As the estimated passage effectiveness rate of 77% did not account for staffing of the fishway (as it assumes a free-swim fishway without a trap), it is still an appropriate estimate of the passage effectiveness expected at the project over the term of the SPP.

Adult salmon that are unable to safely pass the Brunswick dam will either spawn in other nearby rivers (e.g., the Kennebec), return to the ocean without spawning, or die in the river. Adult salmon that are unable to safely pass the Lewiston Falls dam will either spawn in available spawning habitat between the Worumbo Dam and the Lewiston Falls dam, fall back below the Worumbo dam and spawn in lower tributaries, 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 upstream on the Androscoggin 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 Brunswick Dam would fall into this category, but that Lewiston Falls would not. In addition, projects closest to the ocean were estimated to have a certain proportion drop back into the ocean. In the Androscoggin, there is no known spawning habitat downstream of the Brunswick Dam. Therefore, if there were a large run of salmon in river, we would 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 Brunswick Dam would stray to neighboring rivers and attempt to spawn.

The number of adult salmon actually exposed to these passage rates will be low until natural reproduction and/or stocking increases in the Androscoggin River. We cannot predict the number of returning salmon to the river if these things happen. However, with the anticipated passage rate of 77% at the Brunswick Dam and 0% at the Lewiston Falls Dam, we would not expect the mortality rate to exceed 0.5% (2% x the 23% that fail to pass) or 1% (1% of the 100% that fail to pass), respectively. Given the very low mortality rate and the expected low returns to the river, we would not expect any salmon to die due to passage inefficiencies. Therefore, we anticipate that all of the salmon that fail to pass will survive, but will be delayed in their migration, and will stray to habitat downstream of the dams, or to one of the nearby rivers (e.g. Kennebec) where they would have the opportunity to spawn.

Here, we carry out the four-step assessment to determine whether the failure to pass salmon leads to harassment. We have established that prespawn migrating adult salmon in the action area will encounter the dams and that they will cause a disruption of their upstream migrations (step 1) and that 23% and 100% of adults will be blocked from passing the Brunswick and Lewiston Falls Projects, respectively (step 2). We have established the expected response of the exposed adults (step 3): individual adults blocked from migrating upstream will stray to downstream habitat where they will spawn in downstream habitat or return to the ocean without 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 individual adults blocked from continuing their upstream migration are likely to be adversely affected and that effect amounts to harassment. Therefore, we anticipate that up to 23% and 100% of migrating adult salmon at the Brunswick and Lewiston Falls Projects, respectively, will be blocked from accessing spawning habitat in the action area, which will lead to potential spawning delay or failure, which we consider to meet the definition of harassment.

In June of 2021, an adult Atlantic salmon was killed in the Brunswick fishway. This was the first documented mortality of an Atlantic salmon in the Brunswick fishway. NMFS engineering staff conducted an evaluation and identified deficiencies in the fishway that could be corrected to minimize the probability of such an event occurring again. The conclusion of the engineering evaluation was that the salmon was most likely caught in the gap between the traveling screen and the areas on either side of the trap gate while the traveling screen was moving. The recommended repairs included the replacement of rubber around the trap gate and the top edge of the hopper, as well as closing the gap between the isolation gate and the traveling screen. These repairs were implemented during the annual drawdown of the fishway in August 2021. As the identified problems with the fishway have been fixed, and as this is the only occurrence of a salmon mortality in the fishway, we do not anticipate that any salmon will be killed in the fishway during the eight year term of the SPP.

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. In addition, delays in migration can cause over-ripening of eggs, increased chance of egg retention, and reduced egg viability in prespawn female salmonids (de Gaudemar & Beall, 1998). As detailed previously, migratory delay of adults associated with upstream and downstream passage at dams has adverse energetic effects that may reduce the likelihood that salmon will successfully spawn and out migrate 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 48 hours to meet the definition of harassment.

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 design of the fishway, and the concentration of flow in the vicinity of the fishway entrance suggests that prespawn adults will be able to locate the entrance at the Brunswick Project in less time than what occurs at the Milford Project (average of 10.5 days). In section 4.5.2.1, we estimated that the Brunswick Dam would pass 50% of motivated prespawn salmon within 48 hours under baseline conditions. That is, 50% of the 77% that we expect to pass the project successfully, which equates to 39% of the total run. To be conservative, we can also assume that the 23% of the salmon that fail to pass the project will also be subject to excessive delays; as that delay is likely one of the contributing factors in their failure to pass. Additionally, there is likely some delay associated with dropping back in the river to seek alternative spawning habitat. Therefore, we can assume that 62% (i.e., 39% +23%) of the entire run is delayed by more than 48 hours. Although it is likely that the new operations plan (which includes enhanced monitoring methods as well as more consistent hours of operation) will reduce migratory delay, we do not have any information to quantify that change. Therefore, to be conservative, we assume that the estimated delay at the Brunswick Project under baseline conditions will persist throughout the duration of the proposed action.

A small proportion (no more than 30% according to return data) of the salmon that successfully migrate past the Brunswick Project will pass the fishways at the next two dams and approach the Lewiston Falls Project. As indicated, there isn't a fishway at the Lewiston Falls Dam so any fish that are attracted to the flow at the dam will be delayed for some undetermined amount of time with the only option being to stray to downstream habitat. It is unknown how long salmon stay below the dam before moving downstream. In a 2011 telemetry study, MDMR documented only one tagged salmon that successfully passed the lower dams that approached the Lewiston Falls Dam (MDMR 2012):

> *Only one tagged Atlantic salmon (tag 24) used both the Pejepscot lift and the Worumbo lift to migrate upstream. It moved upstream to Lower Barker Dam in the Little Androscoggin river (Figure 1, site D1) and Great Falls [the location of Lewiston Falls Dam] in Lewiston/Auburn (Figure 1, site D2) before moving downstream to Gerrish Brook (Figure 1, site C2 and ultimately to the mouth of Dyer Brook in Durham (Figure 1, site C1) where it remained for the summer. This fish passed upstream in the Worumbo lift with at least one other untagged salmon (visual observation by the operator).*

Although MDMR does not indicate in their study report how long the salmon spent downstream of the Lewiston Falls Dam, it does not appear to have been for long as they indicate that the fish was captured on June 12, and then moved back and forth between the two impassable dams (Lewiston Falls and Lower Barker), before dropping downstream to cold water refuge provided by Gerrish and Dyer Brooks 15-km downstream of the dam where it "remained for the summer". This information is not sufficient to assess the duration that a salmon might be delayed downstream of the dam, but it does indicate that salmon that are delayed may make use of habitat in the Little Androscoggin as well as cold water streams in the mainstem. To estimate the amount of delay that might be expected at a dam without a fishway, we assessed the range of delay that was observed at the Lockwood Project on the Kennebec River that was observed in tagged adult salmon that failed to pass. During the 2016 and 2017 adult passage studies, six Atlantic salmon failed to pass. The study report indicates that the combined project residence time for these fish ranged between 3.3 and 65.6 days, with an average of 32 days (BWPH, 2017, 2018). As none of these fish left the project in under 48 hours (2 days), we anticipate that 100% of the fish that approach the Lewiston Falls Dam will be delayed for at least that long, and likely longer.

Here, we carry out the four-step assessment for determining harassment. We have established that all prespawn adult salmon will encounter the dam and that the dam will result in a disruption of their upstream migrations (step 1). We expect that 50% and 100% of prespawn adults will be delayed by more than 48 hours at the Brunswick and Lewiston Falls Projects, respectively (step 2). We have established the expected response of the exposed adults (step 3). Individual adults delayed more than 48 hours at the dam 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 for more than 48 hours at the Brunswick and Lewiston Falls Projects during their upstream migration are likely to be adversely affected and that effect meets the definition of harassment. Therefore, we anticipate that up to 50% of adult salmon that pass the Brunswick Project will be harassed. As there are no upstream passage facilities at Lewiston Falls, 100% of the salmon that approach the Project will be harassed.

As defined above, we consider "harm" in the definition of "take" as "an act which actually kills or injures fish or wildlife." We have determined that delay of greater than 48 hours would significantly disrupt the behaviors of individual adults; at some time period, migratory delay could rise to the level of "harm," that is, it could result in the injury or mortality of salmon (e.g., an adult could die either before or after spawning because of the energy loss associated with migratory delay). Such injury or death could, for example, be a result of loss of energy reserves or to exposure to high water temperatures without access to thermal refugia. At this time, we are not able to quantify the extent of delay that would equate to harm, and note that we expect it to be specific to the circumstances of an individual river as well as the circumstances of individual fish (e.g., a fish may be more tolerant to long delay if it enters the river early in the year when there are months before the spawning period and if that fish has suitable habitat for resting and escaping predators). However, we do not anticipate that to occur at these projects. The distance to spawning habitat in the Little River is relatively short so delayed fish will be less likely to fully deplete their energy reserves during migration. Similarly, the distance between the Lewiston Falls tailrace and the habitat in the Little Androscoggin River is also quite short. The adult telemetry study conducted by MDMR in 2011 indicated that adults spent much of the summer at the confluence of small streams that occur in the Brunswick headpond and downstream of the Lewiston Falls Projects (MDMR, 2012), which suggests that these streams contain cold water where salmon can hold. This habitat would be available to fish that successfully pass Brunswick Dam, but are either low on energy due to delay at Brunswick dam, or are significantly delayed at the next dam on the river (Pejepscot). Likewise, salmon that approach Lewiston Falls can drop back down in the river to the tributary streams upstream of the Worumbo Dam, as the one salmon in the 2011 study was observed doing. 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".

Despite the high rate of harassment, it should be noted that delay at these projects is affecting a relatively small number of fish. The maximum return to the Brunswick Dam in recent years has only been six salmon, and on average only 20% of salmon returning to the Androscoggin River migrate above the Worumbo Dam. Using conservative estimates we therefore anticipate that 48 salmon (estimated above) could pass the Brunswick Dam during the eight year SPP, 24 (50% of 48 salmon) of which may be harassed due to delay. At the Lewiston Falls Project, which has a five year SPP term, we would anticipate no more than six salmon ((6 salmon*5 years) * 20%) * 100%) to be delayed by the Lewiston Falls Project. However, this likely overestimates what actually may occur given that the average return is only two salmon per year. Using the average return, the number of salmon passing Brunswick would equate to 16 fish (eight would be delayed by more than 48 hours), with approximately two migrating above the Worumbo Project. These fish would not be able to pass further upstream due to the lack of passage at Lewiston Falls.

Trapping and Handling

As explained above, any Atlantic salmon adults that enter the Brunswick fishway will be captured, held in a tank, handled, and then released into the headpond. Trapping and handling 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 Androscoggin River will be affected by the Project as they potentially all could be trapped and handled, prior to being released into the headpond. The effect that the trapping 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) on migrating Atlantic salmon. By agreement, BWPH and MDMR are responsible for the handling of salmon at the project. 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 Brunswick Dam (an average of two per year), we do not anticipate that this mortality rate equates to any fish being killed due to effects of trapping and over the period when these activities will occur. However, removing salmon from the water and handling them to take biological samples can lead to stress and minor injury (due to potential scale loss and fin clipping). We do not anticipate that handling will lead to harassment as we do not expect that their migration or ability to spawn will be significantly disrupted.

Stranding

It is possible that operation of the Lewiston Falls could affect migrating Atlantic salmon by inadvertently trapping or stranding them in the various pools downstream of the Projects, particularly during flashboard replacement and/or during and after spill events. To reduce the potential effects of stranding on Atlantic salmon and other fish species, the licensee will monitor downstream pools after significant spill events and during flashboard replacement and collect any stranded Atlantic salmon and release them back into the river. The licensee will record its monitoring actions following each significant spill event. The addition of rubber dams along the spillways at the Lewiston Falls Projects will help reduce the potential impacts to Atlantic salmon in two ways: 1) by allowing better control of the location of spill, and 2) by reducing the time it currently takes to replace failed flashboard sections. Combined, these modifications are anticipated to reduce the potential for stranding of Atlantic salmon in the various pools in and around Great Falls.

The licensee has proposed to continue implementation of the Atlantic Salmon Rescue and Handling Plan for the Lewiston Falls Project. The licensee has proposed to implement the rescue plan at Lewiston Falls between May 1 and July 31 annually, despite the fact that the salmon passage season extends until November. The licensee has been surveying the ledges downstream of the Lewiston Falls Dam since 2009 and has yet to document a stranded salmon. Regardless, Atlantic salmon could be present in the habitat downstream of Lewiston Falls and, given the flow and ledge conditions could become stranded in the pools downstream of the Project. Given that no stranded salmon are known to have been detected to date, it is assumed that no more than one Atlantic salmon will become stranded over the five year SPP period for that project. Although BWPH has not proposed surveying the area downstream of the Brunswick Project for Atlantic salmon, they have proposed to do so for sturgeon species. Given the drop at the outlet of the spillway pool, it seems at least as likely that a salmon could be stranded given their proficiency at leaping. Therefore, we anticipate that no more than one Atlantic salmon could become stranded in the large pool downstream of the Brunswick spillway over the term of the eight year SPP at that project. Any stranded fish could potentially be injured due to abrasions caused with contact with ledges, and from the effects of handling and transport. Given the implementation of the handling plan, this injury and stress is not likely to be long lasting and should have no effect on the survival of the fish.

6.3 Effects of Aquatic Monitoring and Evaluation

BWPH has not proposed any studies involving Atlantic salmon at the Lewiston Falls Project, nor have they proposed any downstream passage studies for salmon smolts at the Brunswick Project during the term of the SPP. However, they have indicated that they will consult with the agencies if and when studies occur at the Pejepscot Project regarding whether Brunswick should be included in those evaluations. BWPH has proposed to conduct upstream (prespawn adults) and downstream (kelts) passage studies to assess the effectiveness of the existing passage facilities at the Brunswick Project. The studies will be initiated if, and when, there are two consecutive years of at least 40 returning adult Atlantic salmon, or if there are sufficient returns of "Androscoggin-origin" adult Atlantic salmon to conduct a meaningful evaluation of upstream passage for salmon at Brunswick. As there is no river-specific stock of Atlantic salmon in the Androscoggin, we interpret "Androscoggin-origin" to mean salmon that were either stocked or naturally produced in habitat upstream of the Brunswick Dam in the Androscoggin River. Given the low returns and current stocking practices, it is unlikely that such a study will be triggered during the eight year term of the SPP. However, it is possible that stocking practices could change and therefore, in anticipation of higher numbers of returning salmon, we will assess the effect that the proposed study would have on the species. The study is 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. Although BWPH has not proposed a sample size, we assume that no more than 50 adult salmon would be tagged and handled as part of this study.

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 Brunswick Dam because of incompatibility with salinity.

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 Brunswick Project. Given the small number of Atlantic salmon being tagged (no more than 50 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 to Atlantic salmon

The issuance of amended licenses to BWPH to operate the Lewiston Falls and Brunswick Projects will prolong all of the effects associated with the dams in the action area, as described in the environmental baseline (section 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 a plan to provide spill during the smolt migration, and to more effectively monitor the upstream fishway at the Brunswick Project will improve the baseline condition of the action area, but passage inefficiencies will continue to adversely affect Atlantic salmon.

As described previously, we anticipate that few salmon will occur in the Androscoggin River until either stocking or natural production increases. It is highly unlikely that either will occur during the five year term of the SPP at the Lewiston Falls Project, and the eight year term at the

Brunswick Project. We expect that no more than a few salmon will be passed upstream at the Brunswick Dam annually (no more than 48 over the term of the SPP), and that in some years no salmon will be passed. It is possible that in some years salmon will spawn in the Androscoggin and produce a small number of smolts. However, we anticipate that during this SPP period there will be few, if any, smolts out migrating in the Androscoggin River annually. The small number of smolts will be exposed to mortality of approximately 11% (7% direct mortality + 4% hydrosystem delayed mortality). Out-migrating kelts will be exposed to mortality as well as the turbine racks do not fully exclude them from becoming entrained. Given the analysis conducted by FPL Energy (2013), we expect that no more than 15% of adults passing downstream will be killed due to effects of the Brunswick Project.

The monitoring studies will lead to the injury and handling of up to 50 adult salmon. 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

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.

The critical habitat designation for the GOM DPS is for habitats that support successful Atlantic salmon spawning/rearing, and migration. The critical habitat does not include any unoccupied habitat. In order to determine if the proposed action may affect critical habitat, we consider whether it would impact the habitat in a way that would affect its ability to support spawning, rearing, and migration. Specifically, we consider the effects of the project on the physical features of the proposed critical habitat. As defined in section 2, the action area of the proposed action includes the mainstem of the Androscoggin River downstream of the Lewiston Falls Project. Although the Lewiston Falls Project itself falls outside of designated critical habitat, its peaking operation affects flows throughout the lower river.

In this analysis, we consider the consequences of the action on critical habitat in the action area. For each PBF that may be affected by the action, we determine the effects to the feature. 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, we do not anticipate that the spawning and rearing PBFs occur within the action area. The exception is SR1, which refers to the need for pools where adults can hold near spawning habitat. Spawning may occur in the Little River and the Little Androscoggin River, which flow into the action area, defined as the mainstem Androscoggin downstream of the Lewiston Falls Project. All of the migratory 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, 2009), 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.

The functioning of the PBFs in the action area is likely affected by the peaking operation of the Lewiston Falls impoundment by up to 4-feet to generate power. BWPH conducted an instream flow study in 2014 and 2015 to demonstrate how the fluctuation influenced velocities, water depth, and wetted width at four transects in the habitat downstream of the Project. All four transects were located within one mile of the project spillway, but still provide an indicator of the scale of the effect that the fluctuation might have throughout the action area. BWPH evaluated two Project discharge conditions, 2,421 cfs and 7,812 cfs. Based on recorded depth information collected at four transects located downstream of the Project dam and Monty Station, the study demonstrated that peaking operations at Lewiston Falls produce a small impact on all the monitored parameters. The difference in wetted width between low flow and generation flow conditions varied between 0.8% and 2.6% of the total river width. Average depth at the monitored transects ranged between 2.3 and 13.8 feet under low flow conditions, and between 4.4 and 16.0 feet at generation flows. Flow velocities ranged between 1.0 and 3.6 ft/s during low flow conditions, and between 2.7 and 4.9 ft/s at generation flows. We anticipate that these effects would be dampened further downstream due to flow contributions from the major tributaries (e.g., Lower Androscoggin, Sabattus River, Little River), as well as by the operation of the three downstream hydro projects.

In section 3.2.1 (Table 4), we have identified the range of depth and velocity conditions that are suitable for the migratory adult Atlantic salmon. No flow or depth restrictions have been identified for Atlantic salmon smolts. Velocities for adult migration should remain less than 4 ft/s to be considered functioning. According to BWPH's flow study, the measured velocities exceed that threshold while generating at transect 1 (0.2 miles downstream of the dam) and at transect 4 (0.75 miles downstream of the dam), but not at transects 2 (0.3 miles downstream) and 3 (0.5 miles downstream) where velocities did not exceed 3 ft/s. When not generating, velocities did not exceed the 4 f/s at any of the four transects. This information suggests that although there may be times and places where the velocities may exceed what is ideal for migrating adult salmon, there are places where they can hold until the velocities are reduced. There is no maximum depth for salmon migration, although adult salmon need a minimum 0.5 feet of depth for safe migration and spawning. The range of depths measured in the flow demonstration did not drop below 2.3 feet under low flow conditions. There is no defined minimum or maximum wetted width of a river for it to function as rearing or migration corridor for salmon. As the width only fluctuated up to 2.6%, we do not anticipate that peaking significantly affects the amount of space for any life stage. Therefore, although the peaking operation at Lewiston Falls leads to both higher and lower velocities, depths, and wetted widths than what would occur under a normal hydrograph, we anticipate that the effect to the functioning of the PBFs will be insignificant.

PBF SR1 and M2

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.

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. The effect of the proposed action on these types of habitat is similar. Pools and in-river habitats within the action area are modified largely due to the presence of the Brunswick impoundment and the regulation of flow through the Lewiston Falls Dam. The regulation of flow through the Lewiston Falls project is an effect of the continued operation of the project consistent with the terms of the amended license and therefore, is an effect of the action we are consulting on. As described above, water quantity in the action area is affected by the peaking operation of the Lewiston Falls 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. This regulation of flow may affect the ability of that habitat to function as holding areas for salmon. We anticipate that the area most affected by the fluctuations in the Lewiston Falls impoundment is the reach of river between Lewiston Falls and the impoundment of the next downstream dam (Worumbo). Due to the management of the Worumbo impoundment, as well as the other flow inputs from the Little Androscoggin and the Sabattus Rivers, we expect much of the effect to be attenuated in the downstream habitat. Although there is limited information on the mainstem habitat in the Androscoggin, information from MDMR's 2011 telemetry study indicated that many of the tagged adults held near the confluence with cold water streams during the summer months (MDMR, 2012). For instance, several salmon spent the entire summer in the Brunswick impoundment near the mouths of tributaries. Individuals were detected in the impoundment every week of the six month study with an average of six tagged salmon (range 4 to14) located there per week. Of all the detections made of the 21 study fish from June to December, 42% were in the Brunswick impoundment. This suggests that those streams provided cool water that can sustain adults during the warm, summer months. As described above, we anticipate that the peaking operation at Lewiston Falls may impact flows throughout the action area. However, we anticipate that the changes to depth, wetted width, and velocity will be relatively minor and will not cause the habitat to cease functioning. Although the depths of the pools (or holding areas) themselves may be reduced during periods of storage, the cool water flowing into the habitat from the tributaries, will not be diminished. Therefore, we anticipate that the effects of a short-term reduction in pool depth is likely to be insignificant.

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

In section 3.2.1 (Table 4), we have identified the range of depth and velocity conditions that are suitable for the migratory adult Atlantic salmon. Velocities for adult migration should remain less than 4 ft/s to be considered functioning. According to BWPH's flow study, the measured velocities exceed that threshold while generating at transect 1 (0.2 miles downstream of the dam) and at transect 4 (0.75 miles downstream of the dam), but not at transects 2 (0.3 miles downstream) and 3 (0.5 miles downstream) where velocities did not exceed 3 ft/s. When not generating, velocities did not exceed the 4 f/s at any of the four transects. This information suggests that although there may be times and places where the velocities may exceed what is ideal for migrating adult salmon, there are places where they can hold until the velocities are reduced. There is no maximum depth for salmon migration, although adult salmon need a minimum 0.5 feet of depth for safe migration and spawning. The range of depths measured in the flow demonstration did not drop below 2.3 feet under low flow conditions. There is no minimum or maximum wetted width of a river for it to function as rearing or migration corridor for salmon. As the width only fluctuated up to 2.6%, we do not anticipate that peaking significantly affects the amount of space for adults. Therefore, although the peaking operation at Lewiston Falls leads to both higher and lower velocities, depths, and wetted widths than what would occur under a normal hydrograph, it does not appear to modify the habitat in such a way that it would limit the functioning of the PBF M1. Therefore, we anticipate that the effects of flow fluctuations will be insignificant.

The Brunswick Project operates as a run-of-river facility, where a continuous discharge from the Project that approximates the instantaneous sum of all the inflow to the reservoir is maintained. Project operations do not typically result in rapidly fluctuating water levels that could lead to stranding of fish.

The Brunswick Project partially obstructs upstream migration of Atlantic salmon. Although a fishway is available, it is not 100% effective. The continued operation of the project, even with the terms of the SPP, delays access to spawning and rearing habitat upriver. The proposed action will involve the continued operation of the upstream fishway. The proposed action (i.e. the incorporation of protection measures into the project license) will not worsen the condition of this feature, and it may lead to an improvement through more consistent operation and monitoring required as part of this action. However, as the project will partially block access to spawning and rearing habitat upriver, it will continue to adversely affect this feature for the duration of the SPP.

M3

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

River herring (alewife and blueback herring) reproduce in lake, pond (alewife), and riverine (blueback herring) habitats throughout the Androscoggin and Little Androscoggin River watersheds below Lewiston Falls. The 36-year (1983-2018) average number of river herring trapped at the Brunswick Project is 55,239 (MDMR 2019). Returns to Brunswick have ranged between 49,923 and 179,040 over the past ten years (not counting 2020 when the fishway was closed for the month of May due to pandemic-related staffing restrictions). Some proportion of the river herring run is stocked in lakes and impoundments between the Brunswick Dam and the Lewiston Falls Dam, including some that are stocked directly into the Brunswick impoundment. The river herring stocked in the Brunswick impoundment can either spawn in the headpond or migrate upriver to the Pejepscot and Worumbo headponds. In their 2018 Fishway Report, MDMR indicates that "A new program focused on the restoration of blueback herring started on the Androscoggin in 2016. For two years blueback herring from Lockwood [lowermost dam on the Kennebec] were transported to the Lower Androscoggin River and stocked in the river below Worumbo. The goal is to restore the run of blueback herring above Brunswick. Blueback herring are regularly observed below the fishway but do not ascend the fishway and pass upstream. There is a significant amount of blueback herring spawning habitat above the Brunswick fishway available for colonization" (MDMR 2019).

All of the habitats where river herring are stocked in the Androscoggin are upriver of the Brunswick Project. Therefore, thousands of herring a year are exposed to the effects of downstream passage at the Brunswick Project during adult outmigration in spring and early summer, and juvenile outmigration in the late summer and fall. As the rack spacing on the powerhouse does not exclude fish, it is expected that a large proportion of out migrating river herring pass through the turbines, and it can be assumed that a proportion of these fish are being injured or killed due to passage at the Brunswick Project. The proposal to provide spill to enhance downstream passage of Atlantic salmon smolts may benefit out migrating adult alewives as well. However, given the timing and duration (during the month of May), we expect beneficial effects to river herring to be limited. The proposed action (i.e., the incorporation of protection measures into the project license) will not worsen the condition of this physical and biological feature compared to baseline conditions, and by providing additional passage opportunities (i.e. additional spill), may provide a slight benefit to river herring. However, as the project will continue to impede river herring migration and kill out migrating adults and juveniles, it will continue to adversely affect this feature for the duration of the SPP.

M4

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

The Brunswick Dam has an ongoing effect as a barrier to smolts emigrating to the marine environment. As described previously, smolts are killed, injured, and delayed at the Brunswick

Project as they make their way to the marine environment. We anticipate that BWPH's proposal to provide spill passage at night during the month of May will reduce the effect that the Project has on out migrating smolts compared to baseline conditions. The proposed action (i.e. the incorporation of protection measures into the project license) will not worsen the condition of this physical and biological feature, and by providing additional passage opportunities (i.e. additional spill), will result in an improvement in migratory habitat and may provide a benefit to Atlantic salmon smolts. However, as the project will partially impede migration and kill out migrating smolts, it will continue to adversely affect this feature for the duration of the SPP.

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, BWPH operates the Lewiston Falls Dam in peaking mode to generate power. This means that at times there is less water being released from the impoundment than there is water flowing in; and at other times there is more water being released than there is flowing in. This could conceptually lead to changes in the migration speed of Atlantic salmon smolts swimming through the part of the action area that lies within critical habitat. However, there is generally sufficient flow in the river in the month of May to allow for smolt migration, regardless of the changes in water velocity. In the flow study conducted by BWPH in 2014 and 2015, BWPH documented that the maximum change in wetted width was 2.6% of the river width, which is likely high for what we would expect downstream of the Little River, where any spawning would likely occur. Therefore, we do not anticipate that fluctuating water levels would lead to stranding of migrating Atlantic salmon smolts 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. 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.

6.5 Effects to Shortnose and Atlantic sturgeon

Prior to dam construction, shortnose and Atlantic sturgeon are thought to have ranged as far as the site of the Brunswick Project on the Androscoggin River (Houston et al. 2007). Therefore, both species currently can access the entirety of their historical mainstem habitat in the River. Both species are present downstream of the Brunswick Project at certain times of year and may be affected by Project operation. Operations could directly affect these species due to 1) potential stranding in the downstream pools during the maintenance and /or replacement of flashboards in the spring, 2) entrapment in fishways, and 3) entrainment in the units when they are shut down and dewatered for annual maintenance. In addition to these effects, the operation of the Brunswick Project may affect suitable spawning habitat, flow fluctuations, and water quality in the River.

In the Androscoggin River, sturgeon spawning has been documented approximately 500 meters downstream of the Brunswick Project, and spawning habitat occurs in the action area which extends 0.2 km downstream of the dam. As discussed in greater detail section 6.6, the habitat in the tailrace is scoured bedrock, which lacks the interstitial spaces needed for egg attachment. This is an effect of the operation of the Brunswick Project, which channels high velocity flow through that portion of the action area. Despite this ongoing effect, there is habitat in the action area downstream of the bridge that likely supports spawning and rearing. The Project operates as a run of river facility, which minimizes the scouring of habitats downstream of the tailrace and limits the likelihood of pulsed discharges that could result in the stranding of adult or early life stage Atlantic and shortnose sturgeon. Based on this, we do not expect that operations of the Brunswick Project will affect the ability of shortnose or Atlantic sturgeon to spawn successfully in the vicinity of the Project or that the operation will affect the successful development of early life stages of shortnose or Atlantic sturgeon that may be present in the action area.

Stranding

Once a year, the impoundment of the Brunswick Project is lowered to a point where the flashboards can safely be replaced, resulting in a short period (a few hours) of receded flows downstream. There is potential during these low flow periods for sturgeon to become stranded in pools. While no sturgeon have been documented in the ledges below the Brunswick Dam, they have access, and could be in the action area at the time of flashboard maintenance (April-June). As described previously, there is a ledge drop at the outlet of the large pool downstream of the Brunswick spillway that likely precludes sturgeon from accessing the ledges near the spillway under most conditions. However, there is still a small chance that an adult could make it into the pool at high tide and become stranded under low flow conditions. It is expected that these falls are impassable to juvenile sturgeon.

Data from the Holyoke Hydroelectric project on the Connecticut River can help in assessing the likely effects of stranding on sturgeon. In general, at this facility, several shortnose sturgeon are removed from pools at the base of the dam each year when spill over the dam ceases. Shortnose sturgeon that have been rescued from these pools have been observed to have significant hemorrhaging along the ventral scutes and damage to their fins. If not rescued, these fish would likely have died from these wounds, stress from increased temperature and decreased dissolved oxygen, or a combination of these factors. Since implementing rescue procedures in 1996, there has been no detected mortality of shortnose sturgeon stranded in pools.

Without the development of a rescue procedure for the Brunswick Project, shortnose and Atlantic sturgeon stranded in the pools at the base of the dams would likely suffer injuries and possibly be killed. There has been an approved plan in place for both species of sturgeon at the Brunswick Project since 2013, and they are proposing to continue its implementation. No sturgeon have been stranded at the project since 2013. The implementation of a Sturgeon Handling and Protection Plan will continue to reduce the likelihood of injury and will eliminate this potential source of mortality in the Androscoggin River. While the capture of shortnose and Atlantic sturgeon in nets and the subsequent transport and handling may stress the fish, this stress is not likely to be long lasting and should have no effect on the survival of the fish. We anticipate that no more than one shortnose sturgeon and one Atlantic sturgeon are likely to be exposed to stress and minor injury when they are stranded at the Brunswick Project during the term of the proposed license amendment (8 years). The implementation of a handling plan and the use of proper handling techniques will minimize the potential for major injury. No mortality is expected to occur due to the short time period fish will be caught in the pools and the implementation of proper handling techniques.

Upstream Passage Facilities

The fishway at the Brunswick fishway will be operational during the time of year when adult shortnose and Atlantic sturgeon are likely to be present downstream (May to July). It is unlikely that individuals of either species would be seeking to migrate above the dams, and it is therefore unlikely that they will be caught in the fishways. No sturgeon have ever been detected in the fishway at the Brunswick Project. Data on the effects of the fish lift at the Holyoke Hydroelectric Project on the Connecticut River suggest that fish lifts that successfully attract other species (i.e., shad, salmon etc.) may do a poor job of attracting sturgeon without being specifically designed to improve attraction and access. As the fishway at the Brunswick Project is not designed to pass sturgeon, and no sturgeon have been detected in the fishway to date, we expect very few, if any shortnose or Atlantic sturgeon to enter the fishway. However, we note that a small number of sturgeon have been documented at other fishways in New England where passage attempts are not anticipated (Milford Dam on the Penobscot River, Cataract Dam on the Saco River, West Springfield Dam on the Westfield River), it is reasonable to expect that no more than one shortnose or Atlantic sturgeon will become entrapped in the fishway and trap at the Brunswick Project during the term of the license amendment. We anticipate that these fish would be exposed to stress and minor injury (scale loss and biological sampling) associated with handling at the trap.

The proposed Sturgeon Handling and Protection Plan includes a condition that requires the licensee to require that all fishway operators are trained in handling sturgeon and that any sturgeon caught in the fishway or trap be removed with long handled nets and returned to the tailrace. This condition would ensure that no shortnose or Atlantic sturgeon are inadvertently passed above the dam, injured, or killed in the process of returning them below the dam.

Unit Maintenance

In May 2010, several sturgeon were attracted into portions of the Brunswick Project Unit #1 when the unit was shut down for annual inspection. Specifically, Unit 1 was shut down on the morning of May 10, 2010 to commence the annual inspection of the unit. This work requires dewatering of the internal components of the unit. To accomplish this work, the headgates upstream of the unit and the tailrace gates downstream of the units were installed and personnel then proceeded to drain the unit, a two day effort. In mid-morning of May 12, 2010, when it was safe to enter, personnel observed five live and two dead sturgeon in the scroll case (between the turbine and head gate). They immediately contacted environmental personnel trained in shortnose sturgeon handling, who arrived on site with a handling plan in the afternoon of May 12, 2010. During the recovery process, the five live sturgeon were rescued from the scroll case and the two dead sturgeon were collected from the wicket gate area. Additionally, twenty seven live sturgeon were found and all were rescued from the sump chamber. On May 13, 2010, the sump chamber was re-inspected and an additional four live sturgeon were recovered. After the last sturgeon was collected from the sump, the pipe leading to the sump was visually inspected then closed to prevent sturgeon from accessing the sump chamber. All 36 live sturgeon were released back into the Androscoggin River, just below the Project in the vicinity of the fishway entrance, and appeared to be in good condition at the time of release.

To prevent any similar occurrences in the future, the licensee immediately consulted with us to discuss measures that would be undertaken during similar maintenance work planned for Units 2 and 3, and to also put in place measures to substantially reduce the potential for such events in the future. The licensee proposed, and we approved, the following procedures for when dewatering of the units becomes necessary:

- For areas inside the turbine cavern/pit that are accessible to maintenance crew, a survey will be conducted to determine the presence of sturgeon. If sturgeon are present the Sturgeon Handling and Protection Plan will be implemented, and
- The licensee will not schedule planned outages or maintenance activities at the Brunswick Project during the sturgeon spawning season.

In addition, the licensee installed a screen over the ten inch station sump pipe that discharges into the Unit #1 tailrace. This modification will prevent sturgeon from entering this pipe and the sump, as occurred during the May 2010 event.

The procedures and modifications implemented at the Brunswick Project since the 2010 incident significantly reduced the probability of sturgeon becoming entrapped during unit dewatering. The draft tubes were last dewatered in 2018 and no sturgeon were detected. However, it is still possible that sturgeon could be entrapped. Therefore, we anticipate that no more than one shortnose sturgeon and one Atlantic sturgeon are anticipated to be captured when units are dewatered. These fish would be exposed to stress and minor injury associated with netting, handling, and biological sampling. Given the implementation of the Sturgeon Handling and Protection Plan we do not anticipate that any of these fish will be exposed to serious injury or killed.

6.6 EFFECTS TO ATLANTIC STURGEON CRITICAL HABITAT

As noted above, the action area extends approximately 700 feet (0.2 km) into the habitat downstream of the Brunswick Dam. The Androscoggin River critical habitat unit extends from the point where the Androscoggin River empties into Merrymeeting Bay to the Brunswick Dam, which was also likely the natural upstream limit for Atlantic sturgeon (i.e., Pejepscot Falls).

The Androscoggin River is entirely freshwater (salinity <0.5ppt); therefore, PBF 2 of Atlantic sturgeon critical habitat, or aquatic habitat with a gradual downstream salinity gradient of 0.5 up to as high as 30 ppt and soft substrate (*e.g.,* sand, mud) between the river mouth and spawning sites for juvenile foraging and physiological development, is not present in the action area. The other three PBFs are found in the action area, and we discuss effects of the proposed action on those PBFs below.

PBF 1

Hard bottom substrate (e.g., rock, cobble, gravel, limestone, boulder, etc.) in low salinity waters (i.e., 0.0–0.5 ppt range) for settlement of fertilized eggs, refuge, growth, and development of early life stages

In considering effects to PBF 1, we consider whether the proposed action will have any effect on areas of hard bottom substrate (e.g., rock, cobble, gravel, limestone, boulder, etc.) in low salinity waters (i.e., 0.0–0.5 ppt range) for settlement of fertilized eggs, refuge, growth, and development of early life stages. Therefore, we consider how the action may affect hard bottom substrate and salinity and how any effects may change the value of this feature in the action area. We also consider whether the action will have effects on access to this feature, temporarily or permanently and consider the effect of the action on the action area's ability to develop the feature over time.

As explained above, the entirety of the Androscoggin River downstream of the Brunswick Dam is tidal freshwater, where salinity levels are consistent with the requirements of PBF 1. The action area is approximately 15 rkm upstream from the typical limit of salt water intrusion, which is the southern end of Merrymeeting Bay, where the Bay meets the lower Kennebec estuary at the Chops (Moore and Reblin 2008). Within the Androscoggin River, PBF 1 occurs where there is hard bottom substrate for settlement of fertilized eggs, refuge, growth, and development of early life stages. From tagging and tracking studies, as well as the collection of shortnose sturgeon eggs and larvae, we know that Atlantic and shortnose sturgeon spawning may occur the action area between rkm 7.7 and 8.4 (i.e., the location of the Brunswick Dam) (Squiers et al. 1993; Wippelhauser 2012; Wippelhauser and Squiers 2015; Wippelhauser et al. 2015; Wippelhauser et al. 2017).

We do not have substrate maps for the action area; however, diving transects reported by Squiers et al. 1993, confirm the presence of hard bottom substrate meeting the criteria for PBF 1 in this reach. Based on the limited data we have, we estimate that the portion of the action area within Atlantic sturgeon critical habitat (between rkm 8.2 and rkm 8.4 (the dam)), has approximately 4.5 acres of habitat meeting the criteria of PBF 1 (Figure 12). As discussed in section 4.4, hard bottom substrate is not available throughout the entirety of this area. Areas directly below the bridge, have less scoured ledge from the tailrace flows, and therefore, likely have more bedrock and boulders that are interspersed with smaller rocks and cobbles. These areas with greater prevalence of interstitial spaces likely maintain the most conservation value for Atlantic sturgeon spawning and rearing of early life stages.

The amount of spawning and rearing habitat available to Atlantic sturgeon in the Androscoggin River is not known to be a limiting factor in their likelihood of spawning and recruitment success in the action area. With that said, the action area encompasses a portion of the known spawning habitat in the Androscoggin River. While we have designated critical habitat in the Merrimack, Piscataqua, and Penobscot Rivers, studies to date have only shown spawning activity to occur in the Androscoggin and Kennebec Rivers. Therefore, the spawning habitat in the action area is of great importance to the recovery and conservation of the GOM DPS of Atlantic sturgeon.

The continued operation of the Lewiston Falls and Brunswick projects will have no effect on salinity in the action area. These actions will also not affect substrate type or result in a reduction in hard bottom habitat. It is possible that in certain operating conditions, flow modifications related to project operations could result in higher velocities that may result in the displacement or movement of gravel and small cobbles. However, given the persistence of sturgeon spawning below the dam throughout its operational life, any effects on substrate are likely limited in time and space and may be within natural variability related to storms and other river conditions. The proposal to modify flows at the Brunswick Project during the month of May to create a safe passage route for migrating salmon smolts will lead to more diffuse flow downstream of the dam during low flow periods. By shutting down turbines to increase flow over the spillway, BWPH will be reducing flow in the tailrace. This should reduce velocities, which should reduce scour and reduce the movement of substrates. Based on the available information, any effects of the continued operation of these projects consistent with the terms of the SPPs will be so small that they cannot be meaningfully measured, detected, or evaluated and are therefore insignificant. As such, any effects on the function and value of PBF 1 are also insignificant.

PBF 3

Water absent physical barriers to passage between the river mouth and spawning sites

In considering effects to PBF 3, we consider whether the proposed action will have any effect on water of appropriate depth and absent physical barriers to passage (e.g., locks, dams, thermal plumes, turbidity, sound, reservoirs, gear, etc.) between the river mouth and spawning sites necessary to support: unimpeded movements of adults to and from spawning sites; seasonal and physiologically dependent movement of juvenile Atlantic sturgeon to appropriate salinity zones within the river estuary, and; staging, resting, or holding of subadults or spawning condition adults. We also consider whether the proposed action will affect water depth or water flow, as if water is too shallow it can be a barrier to sturgeon movements, and an alteration in water velocity could similarly impact the movements of sturgeon in the river, particularly early life stages that are dependent on downstream drift. Therefore, we consider effects of the action on water depth and water flow and whether the action results in barriers to passage that impede the movements of Atlantic sturgeon. We also consider whether the action will have effects on access to this feature, temporarily or permanently and consider the effect of the action on the action area's ability to develop the feature over time.

The Brunswick Dam, which is located at the upstream limit of critical habitat designated for Atlantic sturgeon in the Androscoggin River, has a significant impact on the water depth and flow in the action area. While Pejepscot Falls, which is located at the site of the dam, is thought to have historically been the upstream limit for sturgeon in the Androscoggin, the licensee controls releases of water and has greatly influenced the hydrodynamics of the immediate downstream area. As described above, the Androscoggin River discharges through the Brunswick Dam at several points including, the tailrace on the Brunswick side, the flood gates on the Topsham side, and the mid-channel spillway. Given these various discharge points, velocities downstream of the dam vary depending on the stage of river flow and which release points are flowing. At normal flows, velocities in the tailrace range from approximately 6.0 to 8.0 feet per second. At increased flows, water discharges over the spillway and flood gates causing flow through the pond (normally inaccessible to sturgeon) on the river left side of the channel. Higher flows form a channel of increased flow through deeper sections of the pond, spilling over the bedrock ridge. At normal flows, velocities in the pond range from 2.0 feet per second along the edges of the pond to 10.0 feet per second through the center of the pond. If the project is not spilling any water, all of the flow goes through the powerhouse and the project tailrace, while the flow in the pool at the base of the spillway is stagnant. Although we don't have data indicating what velocities would be under the proposed flow scenario, we can surmise that splitting flow between the powerhouse and the spillway will lead to a reduction in the maximum velocity through the Project. This reduction in velocities should reduce the potential barrier effect caused by higher discharge through the powerhouse, and therefore reduce the project's effect on PBF 3 at select times (nighttime during the month of May) within the action area. Based on the available information, any effects of the continued operation of these projects consistent with the terms of the SPPs on PBF 3 will be so small that they cannot be meaningfully measured, detected, or evaluated and are therefore insignificant. As such, any effects on the function and value of PBF 3 are also insignificant.

PBF 4

Water with the temperature, salinity, and oxygen values that, combined, provide for dissolved oxygen values that support successful reproduction and recruitment and are within the temperature range that supports the habitat function

In considering effects to PBF 4, we consider whether the proposed action will have any effect on water, between the river mouth and spawning sites, especially in the bottom meter of the water column, with the temperature, salinity, and oxygen values that, combined, support: spawning; annual and interannual adult, subadult, larval, and juvenile survival; and larval, juvenile, and subadult growth, development, and recruitment. Therefore, we consider effects of the action on temperature, salinity and dissolved oxygen needs for Atlantic sturgeon spawning and recruitment. These water quality conditions are interactive and both temperature and salinity influence the dissolved oxygen saturation for a particular area. We also consider whether the action will have effects to access to this feature, temporarily or permanently and consider the effect of the action on the action area's ability to develop the feature over time.

As described above for PBF 3, discharges of water through the Brunswick Dam have a large impact on the volume, frequency, and velocity of water entering the upper portion of the action area. PBF 4 is present in the action area. The continued operation of the projects consistent with the terms of the SPP, will not affect temperature, salinity, or dissolved oxygen in the action area. As such, there are no effects on PBF 4.

Summary of Effects of Proposed Activities

The continued operation of the projects consistent with the terms of the SPP will affect critical habitat below the Brunswick Dam. We have determined that effects to PBF 1 and 3 will be so small that they are not able to be meaningfully measured, detected or evaluated and are therefore, insignificant. PBF 4 will not be affected by the proposed action.

7. Cumulative Effects

"Cumulative effects" are 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 (50 C.F.R. §402.02). Future Federal actions that are not part of the proposed action are not considered in this section because they require separate consultation pursuant to section 7 of the ESA. It is important to note that the ESA definition of cumulative effects is not equivalent to the definition of "cumulative impacts" under the National Environmental Policy Act (NEPA).

Impacts to Atlantic salmon, Atlantic sturgeon, and shortnose sturgeon from non-federal activities are not well documented in the Androscoggin River. It is possible that occasional recreational fishing for anadromous fish species may result in the illegal capture of these species. Within the action area, despite strict state and federal regulations, both juvenile and adult Atlantic salmon and adult sturgeon remain vulnerable to injury and mortality due to incidental capture by recreational anglers.

Evidence suggests that Atlantic salmon are also targeted by poachers (NMFS 2005). MDMR reported that one of the Atlantic salmon that was radio tagged during the 2011 telemetry study was poached near the confluence with the Little River, upstream of the Pejepscot Project (MDMR 2012). Commercial fisheries for elvers (juvenile eels) and alewives may also capture Atlantic salmon, Atlantic sturgeon, and shortnose sturgeon as bycatch. No estimate of the numbers of these ESA-listed species 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, Atlantic sturgeon, and shortnose sturgeon are vulnerable to impacts from pollution and are likely to continue to be impacted by water quality impairments in the Androscoggin River and its tributaries.

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

The *Integration and Synthesis* section is the final step in our assessment of the risk posed to species as a result of implementing the proposed actions. In this section, we add the *Effects of the Action* to the *Environmental Baseline* and the *Cumulative Effects*, while also considering effects in context of climate change, to formulate the agency's biological opinion as to whether the proposed action is likely to reduce appreciably the likelihood of both the survival and recovery of any ESA-listed species in the wild by reducing its numbers, reproduction, or distribution. The purpose of this analysis is to determine whether the action, in the context established by the status of the species, environmental baseline, and cumulative effects, is likely to jeopardize the continued existence of the Gulf of Maine DPS of Atlantic salmon, the Gulf of Maine DPS of Atlantic sturgeon, or shortnose sturgeon. We also consider whether the proposed action is likely to result in the destruction or adverse modification of critical habitat designated for the Gulf of Maine DPs of Atlantic salmon and the Gulf of Maine DPS of Atlantic sturgeon.

Below, for the listed species that may be affected by the action, we summarize the status of the species and consider whether the action will result in reductions in reproduction, numbers or distribution of these species and then consider whether any reductions in reproduction, numbers or distribution resulting from the action would reduce appreciably the likelihood of both the survival and recovery of these species, as those terms are defined for purposes of the federal Endangered Species Act. In making those assessments we consider the effects of the action in the context of the Status of the Species, Environmental Baseline, Cumulative Effects, and climate change.

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." Below, for the GOM DPS of Atlantic salmon, shortnose sturgeon and the NYB and GOM DPSs of Atlantic sturgeon, the listed species that may be affected by the proposed action, we summarize the status of the species and consider whether the proposed action will result in reductions in reproduction, numbers or distribution of that species and then considers whether any reductions in reproduction, numbers or distribution resulting from the proposed action would reduce appreciably the likelihood of both the survival and recovery of that species, as those terms are defined for purposes of the Federal Endangered Species Act.

While lethal injuries and/or mortalities are being reduced by adhering to the provisions of the SPP, it is anticipated that some Atlantic salmon will be injured or killed as a result of the continued operations of the hydroelectric projects considered in this Opinion, while additional Atlantic salmon will be captured and harassed. No Atlantic sturgeon or shortnose sturgeon are expected to be injured or killed by the action but a small number of individuals will be captured or collected.

8.1 Shortnose sturgeon

Historically, shortnose sturgeon are believed to have inhabited nearly all major rivers and estuaries along nearly the entire east coast of North America. Today, only 19 populations remain. The shortnose sturgeon residing in the Kennebec and Androscoggin Rivers come from one of these nineteen populations. The present range of shortnose sturgeon is disjunct, with northern populations separated from southern populations by a distance of about 400 kilometers. Population sizes range from under 100 adults in the Cape Fear and Merrimack Rivers to tens of thousands in the St. John and Hudson Rivers. As indicated in Kynard (1996), adult abundance is less than the minimum estimated viable population abundance of 1,000 adults for five of 11 surveyed northern populations and all natural southern populations. The only river systems likely supporting populations close to expected abundance are the St John, Hudson and possibly the Delaware and the Kennebec (Kynard 1996), making the continued success of shortnose sturgeon in these rivers critical to the species as a whole. While no reliable estimate of the size of either the shortnose sturgeon population in the Northeastern US or of the species throughout its range exists, it is clearly below the size that could be supported if the threats to shortnose sturgeon were removed. Based on the number of adults in populations for which estimates are available, there are at least 104,662 adult shortnose sturgeon, including 18,000 in the Saint John River in Canada. The lack of information on the status of some populations, such as that in the Chesapeake Bay, adds uncertainty to any determination on the status of this species as a whole. Based on the best available information, NMFS believes that the status of shortnose sturgeon throughout their range is stable (SNSSRT 2010).

Future operations of the Lewiston Falls Project are not likely to result in any effects to shortnose sturgeon as it is located upstream of what is believed to be the historic range of shortnose sturgeon in the Androscoggin River, and no shortnose sturgeon will be exposed to effects of Project operations. Therefore, this analysis relates solely to effects of the Brunswick Project. The Brunswick Project is located at what is believed to be the upstream extent of the historic range of shortnose sturgeon and, therefore, is not considered a barrier to upstream migration. Shortnose sturgeon are known to utilize habitat downstream of the project, including for spawning. Therefore, it is possible that the operation of the facility could impact shortnose sturgeon and its habitat downriver of the dam.

We have determined that due to the run of river operation (i.e., the lack of peaking or pulsed flows) of the Brunswick Project that spawning and rearing downstream of the project will not be affected. We have determined that the proposed action will affect shortnose sturgeon by resulting in the capture of one adult in the fishway at the Brunswick Project over the eight years remaining in the project's license. Additionally, the stranding of one shortnose sturgeon is expected in pools downstream of the spillways during the replacement or maintenance of flashboards, and one more could be entrapped in the units during dewatering. Over the terms of the existing license, therefore, it is anticipated that three shortnose sturgeon (one trapped in the fishway, one stranded in downstream pools, and one trapped in the dewatered draft tubes) could become trapped at the Brunswick Project. The licensee will adhere to the Sturgeon Handling and Protection Plan to ensure that any shortnose sturgeon captured in the fishways, or in isolated pools, or dewatered draft tubes are removed promptly and returned safely downstream. It is possible that some captured shortnose sturgeon could experience minor injuries, such as abrasions, due to contact with the concrete surface of the fish lift. Shortnose sturgeon captured or stranded will be temporarily delayed from carrying out spawning activities. However, given that regular monitoring will occur during the spawning season the amount of time that any shortnose sturgeon would spend in the fishways, or in an isolated pool, is short and certainly less than 24 hours. As such, it is extremely unlikely that the fish would miss a spawning opportunity. Similarly, it is unlikely that the temporary capture in the fishways, or in the pools or draft tubes, and subsequent removal and placement back downstream would cause an individual shortnose sturgeon to abandon their spawning attempt. Considering this analysis, the capture of three shortnose sturgeon is not likely to result in any injury or mortality or affect the fitness of any individuals, or cause any reduction in the number of eggs spawned or in the successful development of those eggs and larvae.

The proposed action is not likely to reduce reproduction of shortnose sturgeon in the action area because: (1) there will be no reduction in the number of spawning adults; (2) there will be no reduction in fitness of spawning adults; (3) there is not anticipated to be any reduction in the number of eggs spawned or the fitness of any eggs or larvae.

The action is also not likely to reduce the numbers of shortnose sturgeon in the action area as there will be no mortality of any individuals and no reason shortnose sturgeon would abandon the action area during the spawning season. Although sturgeon may not be able to access areas close to the powerhouse under baseline conditions due to high velocities associated with turbine discharge, the affected area is relatively small (proximal to the powerhouse itself), and the barrier effect varies based on river flow. The proposed action may lead to a minor reduction in this effect by shifting flow away from the tailrace under low flow conditions at night in the month of May. The distribution of shortnose sturgeon within the action area will not be affected by the action.

Based on the information provided above, the proposed action will not appreciably reduce the likelihood of survival for shortnose sturgeon in the wild (i.e., it will not decrease the likelihood that the species will continue to persist into the future with sufficient resilience to allow for the potential recovery from endangerment). The action will not affect shortnose sturgeon 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 which would prevent shortnose sturgeon from completing their entire life cycle, including reproduction, sustenance, and shelter. This is the case because: (1) the action will not result in the mortality of any shortnose sturgeon (2) as the action will not result in the mortality of any individuals, the action is not likely to have an effect on the levels of genetic heterogeneity in the population; (3) the temporary adverse effects to individuals captured in the fish lifts will not affect the reproductive output of any individual or the species as a whole; (4) the action will not affect the distribution of shortnose sturgeon in the action area or beyond the action area (i.e., throughout its range); (5) the action will not affect the reproductive fitness of any individual spawning adult or result in any reductions in the number of eggs spawned or the successful development of any eggs or larvae; (6) the operations of the project will not affect the ability of shortnose sturgeon to successfully spawn or for eggs and larvae to successfully develop and, (7) the action will have no effect on the ability of shortnose sturgeon to shelter or forage.

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 shortnose sturgeon will survive in the wild, which includes consideration of recovery potential. Here, we consider whether the action will appreciably reduce the likelihood of recovery from the perspective of ESA section 4. As noted above, recovery is defined as the improvement in status such that listing under Section 4(a) as "in danger of extinction throughout all or a significant portion of its range" (endangered) or "likely to become an endangered species within the foreseeable future throughout all or a significant portion of its range…" (threatened) is no longer appropriate. Thus, we have considered whether the proposed action will appreciably reduce the likelihood that shortnose sturgeon can rebuild to a point where they are no longer in danger of extinction through all or a significant part of its range.

A Recovery Plan for shortnose sturgeon was published in 1998 pursuant to Section 4(f) of the ESA. The Recovery Plan outlines the steps necessary for recovery and indicates that each population may be a candidate for downlisting (i.e., to threatened) when it reaches a minimum population size that is large enough to prevent extinction and will make the loss of genetic diversity unlikely. However, the plan states that the minimum population size for each population has not yet been determined. The Recovery Outline contains three major tasks, (1) establish delisting criteria; (2) protect shortnose sturgeon populations and habitats; and, (3) rehabilitate habitats and population segments. We know that in general, to recover, a listed species must have a sustained positive trend of increasing population over time. To allow that to happen for sturgeon, individuals must have access to enough habitat in suitable condition for foraging, resting and spawning. Conditions must be suitable for the successful development of early life stages. Mortality rates must be low enough to allow for recruitment to all age classes so that successful spawning can continue over time and over generations. There must be enough suitable habitat for spawning, foraging, resting, and migrations of all individuals. Habitat connectivity must also be maintained so that individuals can migrate between important habitats without delays that impact their fitness. Here, we consider whether the operation of the dam will affect the Androscoggin River population of shortnose sturgeon in a way that would affect the species' likelihood of recovery.

The proposed action is not expected to modify, curtail or destroy the range of the species since it will not result in any reductions in the number of shortnose sturgeon in the action area and since it will not affect the overall distribution of shortnose sturgeon other than to cause temporary changes in movements throughout the action area. The proposed action will not limit the amount of suitable habitat for foraging, resting, spawning, migration, or for the development of early life stages. As the Brunswick Dam is the historical limit of sturgeon in the Androscoggin River, habitat connectivity will not be affected and individuals will can continue to migrate between habitats downstream of the dam. The proposed action will not lead to any mortality of shortnose sturgeon, and therefore will allow for recruitment to to all age classes so spawning can continue over time. The effects of the proposed action will not hasten the extinction timeline or otherwise increase the danger of extinction; further, the action will not prevent the species from growing in a way that leads to recovery and the action will not change the rate at which recovery can occur. Therefore, the proposed action will not appreciably reduce the likelihood that shortnose sturgeon can be brought to the point at which they are no longer listed as endangered or threatened.

Despite the threats faced by individual shortnose sturgeon inside and outside of the action area, the proposed action will not increase the vulnerability of individual shortnose sturgeon to these additional threats and exposure to ongoing threats will not increase susceptibility to effects related to the proposed action. While we are not able to predict with precision how climate change will impact shortnose sturgeon in the action area or how the species will adapt to climate change-related environmental impacts, no additional effects related to climate change to shortnose sturgeon in the action area are anticipated over the life of the proposed action (i.e., through the license period of the individual projects). We have considered the effects of the proposed action in light of cumulative effects explained above, including climate change, and have concluded that even in light of the ongoing impacts of these activities and conditions, the conclusions reached above do not change.

8.2 Gulf of Maine DPS of Atlantic sturgeon

While Atlantic sturgeon occur in several rivers in the Gulf of Maine, recent spawning has only been documented in the Kennebec River and Androscoggin River. Future operations of the Lewiston Falls Project is not likely to result in any effects to Atlantic sturgeon as it is located upstream of what is believed to be the historic range of Atlantic sturgeon in the Androscoggin River, and no Atlantic sturgeon will be exposed to effects of project operations. Therefore, the proposed amendment of the Lewiston Falls license will have no effect on the Gulf of Maine DPS of Atlantic salmon. Effects of the Lewiston Falls project will not be considered further here.

As explained in the “Effects of the Action” section, the operation of fishways at the Brunswick Project and the lowering of water levels during flashboard maintenance is expected to directly affect very few adult Atlantic sturgeon. We anticipate that one Atlantic sturgeon will become stranded at the project through the term of the license amendment. Likewise, we anticipate that one Atlantic sturgeon will become trapped in the fishways, and one during the dewatering of the draft tubes, over the same timeframe. As explained above, we expect all adult Atlantic sturgeon in the action area to originate from the Gulf of Maine DPS.

The Brunswick Project is located at the presumed upstream extent of the historic range of Atlantic sturgeon and, therefore, is not considered a barrier to upstream migration. Atlantic sturgeon use habitat downstream of the project, potentially for spawning. Therefore, it is possible that the operation of the facility could impact Atlantic sturgeon and its habitat downriver of the dam.

The licensee will adhere to the Sturgeon Handling and Protection Plan to ensure that any Atlantic sturgeon captured in the fishways, or in isolated pools, are removed promptly and returned safely downstream. It is possible that some captured Atlantic sturgeon could experience minor injuries, such as abrasions, due to contact with the concrete surface of the fish lift. Atlantic sturgeon captured in the fishways will be temporarily delayed from carrying out spawning activities. However, given that regular monitoring will occur during the spawning season the amount of time that any Atlantic sturgeon would spend in the fishways, or in an isolated pool, is short and certainly less than 24 hours. As such, it is extremely unlikely that the fish would miss a spawning opportunity. Similarly, it is unlikely that the temporary capture in the fishways, or in the pools, and subsequent removal and placement back downstream would cause an individual Atlantic sturgeon to abandon their spawning attempt. Considering this analysis, the capture of three Atlantic sturgeon, is not likely to result in any injury or mortality or affect the fitness of any individuals, or cause any reduction in the number of eggs spawned or in the successful development of those eggs and larvae.

The proposed action is not likely to reduce reproduction of the GOM DPS of Atlantic sturgeon in the action area because: (1) there will be no reduction in the number of spawning adults; (2) there will be no reduction in fitness of spawning adults; and (3) there is not anticipated to be any reduction in the number of eggs spawned or the fitness of any eggs or larvae.

The action is also not likely to reduce the numbers of Atlantic sturgeon in the action area as there will be no mortality of any individuals and no reason Atlantic sturgeon would abandon the action area during the spawning season. The distribution of the GOM DPS of Atlantic sturgeon within the action area will not be affected by the action, as they will have access to the entirety of its historic range.

Based on the information provided above, the proposed action will not appreciably reduce the likelihood of survival for the GOM DPS of Atlantic sturgeon in the wild (i.e., it will not decrease the likelihood that the species will continue to persist into the future with sufficient resilience to allow for the potential recovery from endangerment). The action will not affect Atlantic sturgeon 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 sturgeon from completing their entire life cycle, including reproduction, sustenance, and shelter. This is the case because: (1) the action will not result in the mortality of any shortnose sturgeon (2) as the action will not result in the mortality of any individuals, the action is not likely to have an effect on the levels of genetic heterogeneity in the population; (3) the temporary adverse effects to individuals captured in the fish lifts will not affect the reproductive output of any individual or the species as a whole; (4) the action will not affect the distribution of Atlantic sturgeon in the action area or beyond the action area (i.e., throughout its range); (5) the action will not affect the reproductive fitness of any individual spawning adult or result in any reductions in the number of eggs spawned or the successful development of any eggs or larvae; (6) the operations of the project will not affect the ability of Atlantic sturgeon to successfully spawn or for eggs and larvae to successfully develop and, (7) the action will have no effect on the ability of Atlantic sturgeon to shelter or forage.

In rare instances, an action that does not appreciably reduce the likelihood of a species' survival might appreciably reduce its likelihood of recovery. As explained above, we have determined that the proposed action will not appreciably reduce the likelihood that the Gulf of Maine DPS of Atlantic sturgeon will survive in the wild, which includes consideration of recovery potential. Here, we consider whether the action will appreciably reduce the likelihood of recovery from the perspective of ESA Section 4. As noted above, recovery is defined as the improvement in status such that listing under Section 4(a) as "in danger of extinction throughout all or a significant portion of its range" (endangered) or "likely to become an endangered species within the foreseeable future throughout all or a significant portion of its range…" (threatened) is no longer appropriate. Thus, we have considered whether the proposed action will appreciably reduce the likelihood that Gulf of Maine DPS Atlantic sturgeon can rebuild to a point where the Gulf of Maine DPS of Atlantic sturgeon is no longer likely to become an endangered species within the foreseeable future throughout all or a significant portion of its range.

No Recovery Plan for the Gulf of Maine DPS has been published. The Recovery Plan will outline the steps necessary for recovery and the demographic criteria which once attained would allow the species to be delisted. In January 2018, we published a Recovery Outline for the five DPSs of Atlantic sturgeon (NMFS 2018[17]). This outline is meant to serve as an interim guidance document to direct recovery efforts, including recovery planning, until a full recovery plan is developed and approved. The outline provides a preliminary strategy for recovery of the species. We know that in general, to recover, a listed species must have a sustained positive trend of increasing population over time. To allow that to happen for sturgeon, individuals must have access to enough habitat in suitable condition for foraging, resting and spawning. Conditions must be suitable for the successful development of early life stages. Mortality rates must be low enough to allow for recruitment to all age classes so that successful spawning can continue over time and over generations. There must be enough suitable habitat for spawning, foraging, resting and migrations of all individuals. For Gulf of Maine DPS Atlantic sturgeon, habitat conditions must be suitable both in the natal river and in other rivers and estuaries where foraging by subadults and adults will occur and in the ocean where subadults and adults migrate, overwinter and forage. Habitat connectivity must also be maintained so that individuals can migrate between important habitats without delays that impact their fitness. As described in the vision statement in the Recovery Outline, subpopulations of all five Atlantic sturgeon DPSs must be present across the historical range. These subpopulations must be of sufficient size and genetic diversity to support successful reproduction and recovery from mortality events. The recruitment of juveniles to the sub-adult and adult life stages must also increase and that increased recruitment must be maintained over many years. Recovery of these DPSs will require conservation of the riverine and marine habitats used for spawning, development, foraging, and growth by abating threats to ensure a high probability of survival into the future. Here, we consider whether this proposed action will affect the Gulf of Maine DPS likelihood of recovery.

This action will not change the status or trend of the Gulf of Maine DPS. The proposed action will not affect the distribution of Atlantic sturgeon across the historical range. The proposed action will not result in any mortality or reproductive output. Therefore, it will not affect abundance in a way that would impair resiliency or genetic diversity. The proposed action will

[17] Available online at: https://media.fisheries.noaa.gov/dam-migration/ats_recovery_outline.pdf; last accessed Sept. 17, 2021

have only insignificant effects on habitat and will not impact habitat in a way that makes additional growth of the population less likely, that is, it will not reduce the habitat's carrying capacity. The proposed action will not result in any loss of habitat. For these reasons, the action will not reduce the likelihood that the Gulf of Maine DPS can recover. Therefore, the proposed action will not appreciably reduce the likelihood that the Gulf of Maine DPS of Atlantic sturgeon can be brought to the point at which they are no longer listed as threatened. Based on the analysis presented herein, the proposed action, is not likely to appreciably reduce the survival and recovery of this species.

8.2.1 ANDROSCOGGIN RIVER CRITICAL HABITAT UNIT (GULF OF MAINE DPS)

We consider the impacts of the proposed actions on the Androscoggin River Critical Habitat Unit and whether the proposed actions are likely to result in the destruction or adverse modification of critical habitat designated for the Gulf of Maine DPS. 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 essential 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.

As explained in section 6.6, we have determined that all effects of the continued operation of the Brunswick Project on PBFs 1 and 3 are insignificant; and that there will be no effect to PBF 4. PBF 2 does not occur in the action area. Based on this, all effects to the Androscoggin River unit will be insignificant or extremely unlikely to occur. Therefore, the continued operation of the Brunswick Project pursuant to the proposed license amendment is not likely to adversely affect critical habitat designated for the Gulf of Maine DPS of Atlantic sturgeon.

8.3 ATLANTIC SALMON

GOM DPS Atlantic salmon currently exhibit critically low spawner abundance, poor marine survival, and are confronted with a variety of additional threats. The abundance of GOM DPS Atlantic salmon has been low and either stable or declining over the past several decades. The proportion of fish that are of natural origin is extremely low. 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.

We recognize that the operation of the Brunswick Project for an eight year period pursuant to the amended license that incorporates the proposed SPP will lead to an improvement in passage for Atlantic salmon as compared to current operations. However, the Project will continue to affect the abundance, reproduction and distribution of salmon in the Androscoggin River by halting or delaying upstream migrating prespawn adults, as well as by killing, injuring, and delaying out migrating smolts and kelts. While FERC will require that the licensee implement several measures to reduce adverse impacts of project operation, all Atlantic salmon in the Androscoggin River watersheds will be adversely affected by continued operation of the Brunswick Project.

We recognize that the operation of the Lewiston Falls Project for a five year period pursuant to the amended license that incorporates the proposed SPP will not change passage conditions at the Project in any way. Despite blocking access to abundant high quality habitat, BWPH has not proposed any measures to ameliorate the fish passage blockage caused by the Project. Therefore, the project will continue to affect the abundance, reproduction and distribution of salmon in the Androscoggin River by halting upstream migrating prespawn adults. As the barrier created by the project will preclude the production of juvenile salmon upstream of the dam, the project will not affect any individual juvenile or post-spawn salmon. The only measure proposed by the BWPH is to monitor for salmon stranding in the ledges downstream of the dam. This measure has been in place since 2013, and the proposal merely continues it. Despite being the continuation of an existing measure, FERC proposes to once again amend the license in order to incorporate the measure through the expiration of the existing license. Therefore, the Project will continue to adversely affect adult salmon that are stranded at the Project, but the continuation of monitoring will minimize the probability of significant injury or mortality.

As the terms of the amendments being proposed differ (Brunswick expires in 2029; Lewiston Falls expires in 2026) there will be a three year period (2026 to 2029) where only one of the two amendments will be implemented. We anticipate that a separate Biological Opinion will be developed to consider the effects of the Lewiston Falls Project beyond the expiration of the proposed license amendment we have considered here. That Opinion will consider the effects of the issuance of a new 30-50 year license at the Lewiston Falls Project. Therefore, the below analysis considers the effects of the two proposed amendments in two separate phases. Phase 1, which will cover the period from 2021 to the expiration of the Lewiston Falls license in 2026, includes the effects of the two amendments individually and combined on the survival and recovery of Atlantic salmon. Phase 2, which will cover the period between the expiration of the Lewiston Falls license in 2026 to the expiration of the Brunswick Project in 2029, only includes the effects of the Brunswick Project on survival and recovery. In the second phase, we assume that the effects of Lewiston Falls will persist at existing levels as part of the environmental baseline. Although operation and passage conditions at the Lewiston Falls Project could change as a result of the ongoing relicensing process, we have no information at this time to indicate that conditions between 2026 and 2029 will differ from what has been considered above.

Summary of Upstream Passage Effects

Atlantic salmon use the upstream fishway at the Brunswick Project. However, even when operated pursuant to the amended 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 at the Brunswick Dam will be at least 77% effective during the SPP period. Adult salmon that are not passed at the Brunswick Dam 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 associated with locating and successfully passing the fishways. As explained in the effects of the action section of this Opinion, we estimate mortality rate for Atlantic salmon that fail to pass the Brunswick Dam is 2%, which equates to no more than 0.5% (2% of the 23% that fail to pass) of the salmon that approach the project. Given the small proportion, as well as the small number of salmon we anticipate to pass the Brunswick Project, we anticipate that this will not equate to the mortality of any adult salmon over the term of the action. Therefore, we anticipate that during the term of the SPP no more than 48 salmon will pass the project, 14 will be delayed and harassed, and 0 will be killed. We also anticipate that one salmon each could be harassed at the Brunswick and Lewiston Falls Projects due to stranding in the pools downstream of the dams.

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 Brunswick fishway will take longer than 48 hours to do so, which we consider long enough to be a significant disruption of migration. Although we anticipate that 50% of adults will be harassed due to migratory delay, we expect that there are some features of the Androscoggin 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 upstream migrating adults do not have very far to migrate to access spawning habitat in the Androscoggin River, the overall energy needs for upstream migrants is significantly less. Additionally, the presence of cool water refuge both downstream in Merrymeeting Bay, as well as in the Brunswick headpond, reduces the probability that salmon will be stranded in warm water when temperatures are high.

As described in section 4.5.2.1, the Lewiston Falls Project blocks 100% of salmon from passing further upstream into the Androscoggin River. The delay and potential stranding of salmon downstream of the Lewiston Falls Project can lead to adverse effects to individual pre-spawn salmon that are attracted to the significant amount of flow that comes through the project powerhouse and spillways. These salmon are significantly affected by the stress associated with searching for a way past the dam. As explained in the effects of the action section of this Opinion, we estimate mortality rate for Atlantic salmon that fail to pass the Lewiston Falls Dam is 1%, which equates to no more than 1.0% (1% of the 100% that fail to pass) of the salmon that approach the project. Given the small proportion, as well as the very small number of salmon we anticipate to approach the Lewiston Falls Project, we anticipate that this will not equate to the mortality of any adult salmon over the term of the action. As described previously, we would not anticipate that 20% of the salmon that pass the Brunswick Dam pass the Worumbo Dam and therefore be able to approach the Lewiston Falls Dam. Therefore, we anticipate that over the 5-year term of the SPP, no more than six salmon will be delayed and harassed, and 0 will be killed due to the passage blockage at the Lewiston Falls Project.

Summary of Downstream Passage Effects

No salmon are stocked or naturally produced in the habitat above the Lewiston Falls Project, therefore, there are no salmon passing downstream through the project. Atlantic salmon smolts migrate downstream to the estuary past the Brunswick Dam in the spring in years following successful upstream spawning events or stocking and when smolts have survived passage through the other upstream projects (i.e., Worumbo and Pejepscot). We expect an improvement (from 87.1% to 93%) in survival at the Brunswick Dam associated with BWPH's proposal to provide spill and shutdown turbines during low flow years. Given the survival estimated for other dams in the River (i.e., as described in section 3.4.1: Worumbo 92%, Pejepscot 93.5%), we anticipate that this improvement in survival will lead to a 5% (80%-75%) increase in the number of smolts surviving the direct effects of passage through all three mainstem dams in the River.

Dams can result in unnatural delays and sublethal injuries to out migrating 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 Androscoggin River, we assume a similar proportion of smolts will be subject to delayed mortality in the estuary due to their passage experience at the Brunswick Project. 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 Androscoggin River to 4%. This conceptually reduce the delayed mortality from 18% (6% per dam for three dams) to 16%. We anticipate that this level of mortality will continue to occur for the duration of the SPP. Therefore, we anticipate that smolt mortality associated with the Brunswick project will not exceed 11% (7% direct mortality + 4% hydrosystem delayed mortality) annually.

Atlantic salmon kelts migrate downstream 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). We do not have information regarding migratory delay of kelts in the Androscoggin River, although we expect it may occur particularly in low flow years. They are known to migrate 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). We anticipate some proportion of kelts will be entrained in the turbines as the rack spacing is not narrow enough to exclude them. We anticipate that some proportion of these fish will be injured during passage, which may lead to a reduction in fitness and potentially to mortality. 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. Based on an analysis by FPL Energy (2013) we assume that kelt survival at the Brunswick Project is approximately 85%. Given the survival estimated for other dams in the River (i.e., as described in section 3.4.1: Worumbo 90%, Pejepscot 85%), we anticipate that cumulative survival of kelts is approximately 65%. The proposed action is not anticipated to lead to an increase in the amount of kelt mortality at the project, or in the Androscoggin River.

8.3.1 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 actions 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 Merrymeeting Bay SHRU over the 8 year life of the amended license.

8.3.2 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 Actions" section of this Opinion will affect the Androscoggin River population of Atlantic salmon, how the effects to the Androscoggin River population will affect the Merrymeeting Bay SHRU, and then finally, how the effects to the Merrymeeting Bay 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 Merrymeeting Bay 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 Merrymeeting Bay SHRU is a measure of both the reproduction and numbers of the species. We consider the ability of prespawn Atlantic salmon to access high quality spawning and rearing habitat in all the rivers of the Merrymeeting Bay SHRUs as a measure of distribution. Below, we analyze whether the proposed action (FERC issuance of license amendments) will reduce the reproduction, numbers, or distribution of the Atlantic salmon in the action area and the Merrymeeting Bay SHRU to a point that appreciably reduces the species likelihood of survival in the wild.

The Lewiston Falls Project completely blocks access for Atlantic salmon to the upper Androscoggin River, which contains over 95% of the modelled rearing habitat for Atlantic salmon in the River (Wright et al. 2008). However, by itself, the dam only blocks access to a three miles of impounded riverine habitat downstream of the next upstream dam (i.e. Deer Rips Dam). Regardless, the existing distribution of salmon in the action area is substantially limited by the lack of passage at the dam. In addition to posing a barrier to passage, the presence of the dam leads to migratory delay of prespawn adults seeking a route past the dam, as well as stress and minor injury to salmon that might become stranded in the pools downstream of the dam. The proposed action includes a rescue plan for Atlantic salmon to minimize the effect of stranding, which will significantly reduce the potential for major injury, or mortality.

Unlike the Lewiston Falls Project, the Brunswick Project passes Atlantic salmon upstream and downstream in most years. A basic model can predict the effect that the proposed changes at the Brunswick Project will have on the number of returning Atlantic salmon to the Androscoggin River during this phase given the lack of stocking in combination with poor marine and freshwater survival. As indicated above, an average of two salmon per year have passed the Brunswick Project over the last nine years. Based on information from NOAA's Northeast Fisheries Science Center[18], 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 (0.13%; USASAC 2020), 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 0.14 adults to return to the Androscoggin River to spawn. Adding the mortality rates for smolts that have been attributed to the Brunswick and Pejepscot Projects (as the documented spawning habitat is above both dams), including hydrosystem delayed mortality, and reduces the estimated number of returns to 0.11 adults under baseline conditions, and 0.12 under the SPP conditions. 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 Brunswick Project. While we do not expect it to occur over the SPP 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 Brunswick Project would become more apparent and the reduction in numbers would be clear. Using this simple model, we can conclude that the proposed measures would increase the number of returning adults by as much as 9% ((0.12-0.11)/0.11) compared to current conditions.

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, our priority in the Androscoggin River is to abate the imminent threats in the system, namely the threats posed by the hydroelectric dams.

Under existing conditions and stocking effort (no stocking), the Androscoggin River contributes minimally to the production of Atlantic salmon in the Merrymeeting Bay SHRU. Over the last decade, the number of prespawn Atlantic salmon returning to all rivers in the Merrymeeting Bay

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

SHRU ranged between 18 and 127 annually; with an average return of 55 individuals (derived from data in USASAC 2020). The Androscoggin River has contributed 11% of these returns (5% if you remove the high return year of 2011 from the dataset) throughout this timeframe. Therefore, we anticipate that although effects to salmon will continue to occur at the Brunswick Project, the consequences of the reduction in reproduction and numbers resulting from the loss of individual salmon in the Androscoggin River during the SPP period (i.e., 2021-2029) will be negligible; that is, they will be so small that they will not be detectable at the level of the Merrymeeting Bay SHRU or the DPS as a whole.

Our analysis indicates that operation of the project consistent with the proposed amendment (i.e., inclusive of the proposed fish passage measures achieving the performance standards) would lead to approximately a 9% increase in returns over what we would expect under existing conditions. As indicated, this increase would be negligible at current stocking levels, however, with more production and stocking occurring in the River, numerically more salmon would be affected by the passage improvements at the project. Therefore, the proposed action has the potential to increase the number and reproduction of prespawn salmon in the Androscoggin River, the Merrymeeting Bay SHRU, and thus the GOM DPS, compared to the numbers and reproduction that could occur absent the proposed action (i.e., if the terms of the SPP were not implemented). This is an appropriate conclusion as the environmental baseline for this consultation is not a dam-free scenario, but one that includes the ongoing effects of the dams. Thus, the Brunswick Project would continue to affect every salmon that passes up and downstream of the dam if the action were not implemented. Our analysis indicates that the incorporation of the proposed protection measures will lead to a reduction of those effects.

Compared to current conditions, the proposed action will not significantly increase the distribution of the species in the Androscoggin River, as we don't anticipate that the operation the fishways in compliance with the revised O&M plan will make the upstream habitat fully accessible as defined by the 2019 recovery plan. However, we do expect that this habitat will be available to salmon during the term of the license amendment. Additionally, we expect that some Atlantic salmon straying from the Kennebec River will be able to access suitable spawning habitat in the Androscoggin under these conditions.

In summary, the proposed actions improve passage conditions in the Androscoggin River and will not result in a reduction of the numbers, reproduction, and distribution of Atlantic salmon in the action area, the Androscoggin River, the Merrymeeting Bay 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 amendment is issued), the proposed action would increase the potential numbers and reproductive potential of Atlantic salmon in the Androscoggin 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 Brunswick Project consistent with the terms of the proposed license amendment, 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: (1) the action is expected to improve passage conditions at the Brunswick Project, which would result in an increase in numbers and reproductive output of Atlantic salmon in the Androscoggin River if there was a sustained stocking program or increased natural production occurring in the River. Increased numbers would result in a corresponding increase in the population trend of Atlantic salmon in the Androscoggin River that will positively impact the population trend of the Merrymeeting Bay SHRU and the DPS as a whole; and (2) the loss of individual Atlantic salmon due to the Project is not expected to impact the genetic heterogeneity of the Merrymeeting Bay SHRU or the species as a whole because there is no river specific stock of Atlantic salmon in the Androscoggin River.

The Lewiston Falls Project will continue to limit access of Atlantic salmon to the upper Androscoggin River during the proposed five year license amendment. The habitat being blocked by the dam, however, contains only 27 modelled rearing habitat units, and no mapped spawning habitat. There is abundant modelled rearing habitat further upstream in the Androscoggin River, but passage would have to be provided at two additional dams (i.e., Deer Rips and Gulf Island dams) that will not undergo relicensing for another 25 years. Therefore, the conservation value of the habitat above Lewiston Falls is currently limited. The proposed action to be implemented over the next five years will allow for the rescue of salmon stranded in the ledges downstream of the dam. Based on the analysis provided above, the injury of one prespawn adult Atlantic salmon as a result of the operation of the Lewiston Falls Project consistent with the terms of the proposed license amendment, 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). As only one salmon is expected to be affected, and as we anticipate that the salmon will not be affected to such a degree that it would not be able to spawn in downstream habitat, we do not expect that the proposed action at the Project will lead to any reduction of reproduction in the GOM DPS. Additionally, we do not anticipate that the injury of one salmon would impact the genetic heterogeneity of the Merrymeeting Bay SHRU or the species as a whole because there is no river specific stock of Atlantic salmon in the Androscoggin River.

8.3.3 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 rare 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 SPP and the amended licenses that Atlantic salmon produced in conservation hatcheries will continue to be stocked in all three habitat units, including the Merrymeeting Bay 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 11, 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.

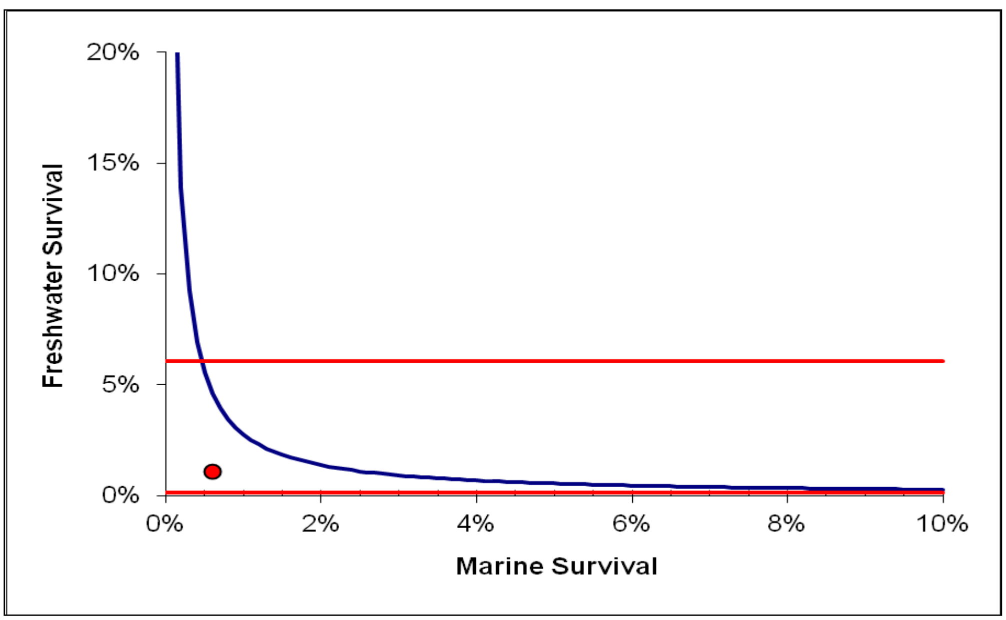


Figure 11. NMFS (2010) conceptual model depicting marine and freshwater survival relative to recovery of the GOM DPS of Atlantic salmon (Note: The dot represents current conditions, the curved line represents recovery, and the straight lines are the historic maximum and minimum freshwater survival).

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

Androscoggin River, which reduces the number of smolts and adults surviving to reproduce in the Androscoggin River and in the Merrymeeting Bay SHRU. We anticipate that these effects will be reduced with the implementation of the proposed action at the Brunswick Project. As indicated above, given the assumed survival and passage rates and the anticipated marine survival rate, we expect that the proposed action will lead to a 9% increase in returns when compared to the existing survival rates at the project. Given low freshwater production and poor marine survival, this improvement will likely not result in a measurable increase in returns to the Androscoggin River, the Merrymeeting Bay SHRU, or the GOM DPS. However, we anticipate that the proposed measures will improve the condition of the environmental baseline (a condition that includes the ongoing effects of the dams as described in section 4.5.2) of the action area, and will allow for conditions that are more conducive to supporting a recovered population. Therefore, we do not anticipate that the proposed action will appreciably reduce the potential for recovery.

We anticipate that the proposed action will lead to an increase in access of habitat (and thus the distribution) of Atlantic salmon in the Merrymeeting Bay SHRU. Presently, approximately 12,423 units (41% of the habitat recovery criteria) are currently fully accessible in the Merrymeeting Bay SHRU (CMS, 2021). The proposed passage operational measures will improve access to upstream habitat, although it will not make the upstream habitat fully accessible to Atlantic salmon fully accessible. The Project currently hinders access to almost all of the habitat in the Androscoggin River, which contains 12% of the rearing habitat (and 5% of the high quality habitat) in designated critical habitat in the Merrymeeting Bay SHRU (Table 6; based on modelling by Wright et al. 2008).

Although the Brunswick and Lewiston Falls Projects will continue to adversely affect juvenile and adult Atlantic salmon in the Androscoggin River, they will not affect salmon outside of the Androscoggin River; that is, salmon in the rest of the habitat within the Merrymeeting Bay SHRU. The SHRU contains three rivers (i.e., Sheepscot, Kennebec, Androscoggin) that support small runs of Atlantic salmon. While the proposed action will adversely affect Atlantic salmon in the Androscoggin River (which hosts the smallest run of the three), it does not affect the salmon in the Kennebec and Sheepscot rivers. Therefore, the potential for the proposed action to appreciably diminish recovery of the SHRU and DPS is limited.

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 dam and the operation of the Brunswick Project will result in a reduction in the number of Atlantic salmon in the Androscoggin River compared to the number that could occur if there was no dam related mortality. While Atlantic salmon mortality caused by the Brunswick Project will continue to reduce the numbers and reproduction of Atlantic salmon in the Androscoggin River, we expect that the proposed operational improvements will lead to a reduction in mortality and passage inefficiency. This reduction is unlikely to lead to an increase in the number of returning Atlantic salmon over the eight year term of the action given the low freshwater and marine survival, as well as the lack of a sustained stocking effort in the Androscoggin River watershed. However, the proposed action will not worsen conditions, and should actually make the conditions in the action area more conducive to supporting a salmon run, should the baseline conditions change. Given this, and the relatively small proportion of salmon in the Merrymeeting Bay SHRU that return to the Androscoggin River (12%), we do not anticipate that the action will appreciably reduce the likelihood of recovery.

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 remainder of the existing licenses). 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.

8.3.4 ADVERSE MODIFICATION ANALYSIS

We consider the impacts of the proposed action on critical habitat designated in the Merrymeeting Bay 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 Merrymeeting Bay SHRU. Presently, approximately 12,423 units (41% of the recovery criteria) are currently considered fully accessible in the Merrymeeting Bay 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 Androscoggin River contains 2,886 modelled habitat units suitable for salmon rearing, of which 97% (i.e., 2,806 units) are above the Brunswick Dam. However, only 156 units occur between the Brunswick Dam and the Pejepscot Project, the next upstream barrier to passage, which comprises only 5% of the total amount of critical habitat in the Androscoggin River. Although BWPH has proposed measures that will improve passage at the Project, we cannot conclude with any certainty that the fishway is highly effective (i.e., approximately 95-100%) at passing Atlantic salmon, and it is unlikely that sufficient adult salmon will be available to conduct a study to verify it regardless. Therefore, we do not anticipate highly effective passage will occur during the SPP period, and as such the upstream habitat will not contribute towards achieving the recovery criteria (>30,000 habitat units of accessible spawning and rearing habitat in the Merrymeeting Bay SHRU).

As explained in Section 6.4, we have determined that the action is likely to adversely affect PBFs SR 1 and M 1-6. 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) and migratory habitat (M 1-6) in the project area within the context of the conservation value of critical habitat in the Merrymeeting Bay 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.

The PBFs affected by the proposed action are critical to the functioning of the Androscoggin River as migratory corridor for Atlantic salmon moving to spawning and rearing habitat in the tributaries upstream of the Brunswick Project. We identified that the effects to the PBFs are primarily associated with the water level fluctuations associated with dam operation at Lewiston Falls, as well as passage inefficiencies at the Brunswick Project. We anticipate that the effects of the action will allow for the functioning of migration habitat in the action area, although they will continue to adversely affect the relevant PBFs. Although the action will lead to improved passage, we do not anticipate that the upstream habitat will become fully accessible during the eight-year SPP period. However, there is abundant accessible habitat in the other Merrymeeting Bay Rivers (i.e., the Kennebec and the Sheepscot), most of it vacant or under-utilized by salmon, where salmon are currently stocked. Although possible that the habitat in the Androscoggin may 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 Merrymeeting Bay Rivers that currently host salmon runs, we do not anticipate a time in the next eight years where the impediments to passage in the Androscoggin River will be the limiting factor in the recovery of Atlantic salmon to the Merrymeeting Bay SHRU. The other major rivers in the Merrymeeting Bay SHRU have abundant available habitat; and one of them (the Sheepscot River) hosts a locally adapted salmon stock and has benefited from a concerted decades-old restoration effort. Although the Kennebec does not have a local stock, there is a significant stocking program, an active restoration effort, and a trap and truck operation to allow naturally reared salmon to access the abundant high quality habitat in the Sandy River. Conversely, the Androscoggin River lacks a stocking program, contains a small amount of habitat, and has a small run comprised of individuals straying from other rivers. Once the effects of the project have been evaluated and minimized adequately, we anticipate that the restoration of the Androscoggin River will become a priority. However, as indicated, we do not anticipate that will happen during the eight year duration of the SPP.

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 Merrymeeting Bay 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, the GOM DPS of Atlantic sturgeon, shortnose sturgeon, 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 actions may adversely affect but is not likely to jeopardize the continued existence of the GOM DPS of Atlantic salmon, shortnose sturgeon, or the GOM DPS of Atlantic sturgeon. Furthermore, the proposed actions are not likely to destroy or adversely modify critical habitat designated for the GOM DPS of Atlantic salmon or the GOM 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."*[19] 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 BWPH 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 BWPH 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.

10.1.1 ATLANTIC SALMON

Smolts

We anticipate that direct mortality of smolts associated with passage at the Brunswick Project will not exceed 7% (Table 18). In addition to direct mortality, it is anticipated that 4% of smolts that survive passage at Brunswick could die in the estuary due to migratory delay and sublethal effects of dam passage (i.e., hydrosystem delayed mortality). Therefore, this ITS exempts the death of up to 11% of smolts migrating in the action area annually. during the eight year term of

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

the SPP. In addition to mortality, we anticipate that the proposed action will lead to the sublethal injury of 3.5% of smolts, and the harassment of 2.7% of smolts due to migratory delay.

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., 4%) to have been exceeded if smolts monitored during downstream passage studies exceed what we expect for migratory delay (i.e., 2.7%) or sublethal injury rates (i.e., 3.5%). Although no studies have been proposed, we anticipate that studies will be conducted over the eight year duration of the SPP at the upstream Pejepscot Project, and that BWHP will monitor delay and mortality at the Brunswick Project concurrently.

We do not anticipate or exempt any take of smolts at the Lewiston Falls Project as no salmon are produced or stocked upstream of the dam.

Kelts

The best available information indicates that 85% of kelts survive passage at the Brunswick Project under existing and proposed conditions. Therefore, this ITS exempts the death or injury of up to 15% of kelts migrating in the action area annually.

We do not anticipate or exempt any take of kelts at the Lewiston Falls Project as no adult salmon are passed upstream of the dam.

Prespawn Adults

We conservatively estimate that the Brunswick fishway will pass a minimum of 77% of motivated prespawn salmon. These fish will be exposed to stress and minor injury (scale loss and biological sampling) associated with handling at the trap. Up to 23% of pre-spawn Atlantic salmon in the action area could be prevented from passing upstream during each of the eight years remaining in the project's license (i.e., the term of the SPP). These fish will be harassed due to migratory delay and potential spawning failure. Given these rates and a maximum of six salmon expected annually, we anticipate that no more than 48 Atlantic salmon will pass the project over the term of the SPP, and an additional 14 will fail to pass and will be harassed. Additionally, we anticipate that 50% of salmon that successfully pass the Brunswick Project (in addition to the 23% that fail to pass), and 100% that attempt to pass the Lewiston Falls Project, will be delayed by more than 48 hours and will be harassed due to the potential energetic effects of being hindered in their migration.

We anticipate that one adult salmon could become stranded in the ledges downstream of the Lewiston Falls Project; and one additional adult could become stranded in the large pool downstream of the spillway at the Brunswick Project. Any stranded fish could potentially be injured due to abrasions caused with contact with ledges, and could be severely stressed due to the effects of stranding, handling, and transport.

Table 18. Exempted take of Atlantic salmon associated with the Lewiston Falls (5-year) and Brunswick (8-year) proposed license amendments.

Project	Term	Lifestage	Source	Type	Amount
Lewiston Falls	2021-2026	Adult	Stranding/Handling	Minor Injury	1 fish total
			Delay/Straying	Harassment	100% annually
Brunswick	2021-2029	Adult	Trapping/Handling	Minor Injury	77% annually
			Delay/Straying	Harassment	23% annually
			Stranding/Handling	Minor Injury	1 fish total
			Migratory Delay	Harassment	50%* annually
		Smolt	Passage	Mortality	7% annually
			Delayed Mortality	Mortality	4% annually
			Sublethal Injury	Injury	3.5% annually
			Migratory Delay	Harassment	2.7% annually
		Kelt	Passage	Mortality	15% annually

*50% of the fish that successfully pass the project.

Fish Passage Monitoring

To study the effects of dam passage on upstream adults, up to 50 adults will be surgically implanted with radio tags during the studies. Although no mortality is expected, all study fish will be harassed and injured due to handling and tagging during the study. This ITS exempts the take (harassment and injury) of the 50 adults that will be handled during the dam passage studies.

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.

10.1.2 SHORTNOSE AND ATLANTIC STURGEON

We anticipate that the proposed action will lead to the capture or stranding of up to three shortnose sturgeon. These sturgeon could become stranded in the pools downstream of the dam, trapped in dewatered draft tubes, or captured in the fish trap during the eight year term of the proposed license amendment at the Brunswick Project. Therefore, capture, handling, and biological sampling could lead to the minor injury of three shortnose sturgeon at the Brunswick Project as a result of the proposed action.

Similarly, we anticipate that the proposed action will lead to the capture or stranding of up to three Atlantic sturgeon. These sturgeon could become stranded in the pool downstream of the dam, trapped in dewatered draft tubes, or captured in the fish trap during the eight year term of the proposed license amendment at the Brunswick Project. Therefore, capture, handling, and biological sampling could lead to the minor injury of three Atlantic sturgeon at the Brunswick Project as a result of the proposed action.

We do anticipate that any take of sturgeon will occur at the Lewiston Falls Project over the five year term of the proposed license amendment. This ITS exempts the non-lethal take of three adult shortnose sturgeon and three GOM DPS adult Atlantic sturgeon

10.2 Reasonable and Prudent Measures

The following reasonable and prudent measures are necessary and appropriate to minimize the impact of the amount or extent of incidental take (50 CFR 402.02) and monitor that take incidental take of Atlantic salmon, shortnose sturgeon, and Atlantic sturgeon. These reasonable and prudent measures and terms and conditions are in addition to the measures contained in the December 31, 2019 SPP and BA, as well as the Brunswick Fishway Operations and Maintenance Plan filed on April 12, 2021, that the licensee has committed to implement and FERC is proposing to incorporate into the project licenses. As those measures will become requirements of the amended licenses, we do not repeat them here as they are considered to be part of the proposed action.

1. FERC must ensure, through enforceable conditions of the amended licenses, that the proposed fish passage measures are implemented and monitored in a manner that is adequately protective of listed species.
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, the FERC must comply (or must ensure that BWPH complies) with the following terms and conditions.

To implement reasonable and prudent measure #1, FERC must require BWPH to do the following:

1. To adequately monitor take, prepare in consultation with NMFS a plan to measure the survival of downstream migrating Atlantic salmon smolts at the Brunswick Project if and when similar studies are conducted at the Pejepscot and/or Worumbo Projects upstream.
    a. Coordinate with the licensees of the Pejepscot and Worumbo Projects to ensure that passage at the Brunswick Project is evaluated if and when salmon studies are conducted at those upstream projects.
    b. Require BWPH to measure the survival of downstream migrating Atlantic salmon smolts at the Brunswick Project using a scientifically acceptable methodology if/when studies are being conducted at upstream projects. BWPH must incorporate the Brunswick Project into these studies by installing telemetry receivers as necessary at the Project. The study must:

    i. Measure the survival of downstream migrating smolts approaching within 200 meters of the dam downstream to the point where delayed effects of passage can be quantified.
    ii. Use a Cormack-Jolly-Seber (CJS) model, or other acceptable approach, to determine if the survival estimate and associated error bounds are within the scope of published telemetry work for salmon in the region.
    iii. BWPH must consult with us concerning the application of appropriate statistical methodology and must provide an electronic copy of model(s) and data to us.
  c. 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.

2. Prepare in consultation with NMFS a plan to evaluate adult Atlantic salmon upstream and downstream passage at the Brunswick Dam, as well as delay at the Lewiston Falls Project.
  a. Conduct an upstream passage study at the Brunswick Project when either 1) more than 40 adult Atlantic salmon return per year in two consecutive years, or 2) sufficient stocking occurs upstream of the project such that NMFS determines it is likely to produce at least 40 returning adult Atlantic salmon. The study should be conducted in the year that sufficient adults are anticipated.
    i. As a component of their upstream passage studies, BWPH must document the amount of migratory delay that occurs at the Brunswick Project.
    ii. As a component of their upstream passage studies, BWPH must document the amount of migratory delay that occurs at the Lewiston Falls Dam.
    iii. As a component of this study, BWPH must monitor the survival of downstream migrating kelts approaching within 200 meters of the dam downstream to the point where delayed effects of passage can be quantified. To make the best use of fish, this study must coincide with the proposed upstream passage study.
    iv. 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.
    v. BWPH must consult with NMFS concerning the application of appropriate statistical methodology and must provide an electronic copy of model(s) and data to NMFS.
    vi. 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.
  b. At the Brunswick Project, BWPH must install, operate, and maintain a PIT tag receiver near the entrance of the fishway to monitor movements of salmon and sturgeon in the project area annually throughout the term of the amended license. Provide all PIT tag data to NMFS annually by December 31.
  c. BWPH must insert a PIT tag into all ESA-listed Atlantic salmon that are trapped and handled at the Brunswick fishway.

3. Require that BWPH operate the upstream and downstream fishways at the Brunswick Project to ensure that passage of Atlantic salmon is safe, timely, and effective.
    a. BWPH must take immediate action, regardless of whether the fishway is being observed in–person or remotely, to pass Atlantic salmon when they are observed in the fishway, regardless of the co-occurrence of an invasive species. If an invasive species is observed with an Atlantic salmon in the fishway, BWPH should attempt to pass the salmon upstream while preventing the passage of the invasive species.
    b. BWPH staff must be onsite if the v-gate near the viewing window of the Brunswick fishway is being operated to ensure that salmon are not injured or killed by the closing of the gate. This gate must not be controlled remotely.
    c. Position cameras to ensure that there are no blind spots where Atlantic salmon could hold without being observed when operating remotely.
    d. Consult annually with NMFS regarding the appropriate timing for the initiation of the implementation of downstream spill measures.
    e. Remove any debris that could affect the ability of fish to pass either the downstream or upstream fish passages immediately upon inspection.
    f. Replace entrance gate actuator and upstream fishway handrail within one day of tailrace flows subsiding to safe levels after high water event during the fish passage season.
    g. Annual maintenance requiring the shutdown of upstream fish ways should be conducted during the first two weeks of August. The fishway should not be inoperable for any longer than it takes to make the necessary repairs.
    h. Consult with NMFS regarding the timing of the replacement of flashboards.

4. Require that BWPH actively monitor for the stranding of listed fish downstream of the Brunswick Dam and Lewiston Falls Dam.
    a. Develop, in consultation with NMFS, an appropriate schedule for regularly surveying the pool downstream of the Brunswick dam for both stranded salmon and shortnose and Atlantic sturgeon.
    b. Implement the Atlantic salmon Rescue and Handling Plan at the Lewiston Falls Project from May 1 to November 15 after significant spill events when salmon could be in the project area.

5. Require that BWPH update the sturgeon handling plan to incorporate the following conditions:
    a. BWPH must record the weight, length, and condition of all sturgeon that are handled. Sturgeon must also be scanned for PIT tags. Genetic samples must be taken from all captured Atlantics sturgeon (alive or dead) to allow for identification of the DPS of origin of captured individuals and tracking of the amount of incidental take. This must be done in accordance with the Procedures for Obtaining Sturgeon Fin Clips (https://media.fisheries.noaa.gov/dam-migration/sturgeon_genetics_sampling_revised_june_2019.pdf). All fin clips and the accompanying metadata form must be held and submitted to the Atlantic Coast Sturgeon Tissue Research Repository on a quarterly basis. The Sturgeon Genetic Sample Submission Form is available for download at: https://www.fisheries.noaa.gov/new-england-mid-atlantic/consultations/section-7-

take-reporting-programmatics-greater-atlantic). Captured sturgeon, regardless of the presence or scale of injury, must be safely returned to the Androscoggin River downstream of the project.

b. Dead sturgeon must be placed on ice or be refrigerated if possible. NMFS must be contacted immediately for further instructions.

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

1. Inspect the upstream and downstream fish passage facilities at the Brunswick 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 amended license.
3. Submit as-built drawings to NMFS for the current configuration of the upstream and downstream fishways.
4. Allow NMFS staff to inspect the upstream and downstream fishways at reasonable times, including but not limited to annual engineering inspection.
5. Review and update Fishway Operations and Maintenance Plan a minimum of every 3 years in cooperation with NMFS. The plan must be updated as soon as possible to ensure it is consistent with the terms and conditions of this Opinion, as well as with the State of Maine's most recent version of their *Atlantic Salmon Trap Operating and Fish-Handling Protocols* (except where it may conflict with the terms and conditions included with this Incidental Take Statement).
6. In the event of a serious injury or mortality of any ESA listed species, allow NMFS access to investigate the source of the mortality and work in cooperation with NMFS to correct the source of serious injury/mortality.
7. Submit annual reports at the end of each calendar year summarizing the results of proposed action and any takes of listed sturgeon or Atlantic salmon to NMFS by December 31.
8. Contact NMFS within 24 hours of any interactions with Atlantic salmon, shortnose sturgeon, or Atlantic sturgeon, including non-lethal and lethal takes (Matt Buhyoff: by email (Matt.Buhyoff@noaa.gov) or phone (207) 866-4238 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.
9. 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.

FERC staff have reviewed the RPMs and Terms and Conditions outlined above and have not raised any objections to their incorporation into the ITS. 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 BWPH will be required to implement the measures and monitor their success. These terms and conditions also describe the protocol BWPH must follow to adequately minimize effects to individual salmon and sturgeon that use the Brunswick fishway or are stranded downstream of the dams. Term and Conditions #1 and #2 require that BWPH measure their adherence to proposed action in a way that is statistically sound and appropriate; as well as adequately monitor the effects of the action. Term and Conditions #3 and #4 make minor modifications to the action that will allow for more effective protection for listed salmon and sturgeon. Among other requirements, term and condition #2 requires that BWPH PIT tag every adult salmon that is handled at the Brunswick fishway, and install a PIT tag receiver at the fishway entrance. This is necessary to monitor the effects of the proposed action and will provide information regarding the use of the fishway by sturgeon and salmon that have been tagged in other rivers, as well as the fate of salmon that fall back over the dam after being handled and released into the headpond. Term and Condition #5 requires that the sturgeon handling plan be updated to incorporate the most recent guidance regarding the handling of living, injured, and dead sturgeon at the Brunswick Project. These procedures represent only a minor change to the proposed action as implementing them 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 BWPH 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. 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 unavoidable effects of their actions by requiring the licensee to carry out activities that improve the environmental baseline in the Androscoggin River. This could involve the removal of other barriers to fish migration in the watershed, or the construction of fishways.

   Brookfield Renewable Energy Group (BREG) conducted a habitat assessment of the Little River as described in their interim Species Protection Plan at the upstream Pejepscot Project (Accession # 20161222-5480). The BA states that:

   > *This survey would…provide additional and updated information on potential barrier removals, culvert replacements, and suspected point and non-point source pollution sources [in the Little River]. This data would be valuable in selecting and prioritizing habitat improvement opportunities in the Little River and is consistent with the recovery actions described in the updated SHRU Recovery Workplan-2016 (UFSWS and NOAA-Fisheries 2016b).*

   Information from this assessment should be used to identify and resolve passage issues in the Little River, which contains the majority of the accessible salmon spawning and rearing habitat in the lower Androscoggin, and is the only tributary that is currently stocked with salmon. The restoration of access to the entirety of the Little River is an achievable task over the eight year term of the SPP that would partially offset the adverse effects associated with the operation of the Brunswick and Lewiston Falls Projects over that timeframe. Although restoring access would not completely offset the effects of the projects, it would increase the potential productivity of the habitat in the lower Androscoggin River, which could lead to increased numbers of salmon. FERC and the licensee should work closely with the state and federal fisheries agencies to identify suitable projects in the Little River, or other suitable tributary, which can contribute to the recovery of Atlantic salmon and address the effects of degradation of designated critical habitat.

12. Reinitiation Notice

This concludes formal consultation concerning FERC's proposal to amend the licenses of the Brunswick and Lewiston Falls Projects for eight and five years, respectively. 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 BWPH not carry out the non-discretionary RPMs or associated Terms and Conditions contained within this Opinion.

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