NATIONAL MARINE FISHERIES SERVICE
ENDANGERED SPECIES ACT
BIOLOGICAL OPINION

Agency: Federal Energy Regulatory Commission (FERC)

Activity Considered: Proposed amendment of the license for the Benton Falls (FERC No. 5073) Hydro Project GARFO-2022-03605

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

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Approved by: Jennifer Anderson

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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 (P-5073; issued in 1984) for the Benton Falls Project 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, 2034. The Benton Falls Project is an existing hydroelectric project located on the Sebasticook River in Maine. The project is the first dam on the Sebasticook River, a tributary to the Kennebec River; there are no mainstem dams downstream of the confluence on the Kennebec River.

In a letter dated June 19, 2014, FERC designated Benton Falls Associates, LLC (BFA or Licensee) as their non-federal representative to conduct informal ESA consultation with us. In a January 24, 2022, letter to FERC, BFA requested that FERC amend the licenses of the Benton Falls Project to incorporate the provisions of a SPP for Atlantic salmon, Atlantic sturgeon, and shortnose sturgeon. On February 1, 2022, 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 amendment. As the license amendment would only be in effect until the current license expires, this Opinion only considers the effects of the project on listed species for that period. The current license expires on February 28, 2034. Issuance of any new license for the period beyond the expiration of the existing license is a separate Federal action that will require a new section 7 consultation. Therefore, the take exemption included in the Incidental Take Statement included with this Opinion is only in effect for the period in which the facility 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 to any new license that may be issued in the future. It is our expectation that upon receipt of this Opinion, FERC will issue a license amendment that incorporates the measures contained in the SPP and any additional measures included as Terms and Conditions in this Opinion.

This Opinion is based on information provided in FERC's February 1, 2022 Biological Assessment and SPP. A complete administrative record of this consultation will be maintained at our Maine Field Office in Orono, Maine. Formal consultation was initiated on May 22, 2023.

1.1 Consultation History

June 19, 2014 – FERC designated BFA to act as its non-federal representative in conducting informal consultation under section 7 of the ESA regarding federally listed species at the Benton Falls Project.

January 24, 2022 – BFA submitted a draft Biological Assessment and Species Protection Plan to FERC.

February 1, 2022 – FERC requested formal section 7 consultation for the Species Protection Plan at the Benton Falls Project.

May 22, 2023 – NMFS and BFA met to discuss a suitable schedule for the initiation of formal section 7 consultation.

May 25, 2023 – NMFS initiated section 7 consultation for the Benton Falls Species Protection Plan.

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.

At the time the project's existing license was issued in 1984, the only ESA listed species under NMFS jurisdiction that occurred in the Kennebec River watershed was shortnose sturgeon. However, upstream movement of shortnose sturgeon was blocked by the Edwards Dam on the mainstem Kennebec River. The removal of the Edwards Dam in 1999 allowed shortnose sturgeon to access their historic habitat in the mainstem; their range now extends to the Lockwood Dam. Since the removal of the Edwards Dam, the Gulf of Maine DPS of Atlantic salmon and the Gulf of Maine DPS of Atlantic sturgeon were listed under the ESA. The removal of the Fort Halifax Dam in 2008 allowed shortnose and Atlantic sturgeon access to the Sebasticook River up to the Benton Falls project, which is considered the likely historic limit of sturgeon in the river. As the Benton Falls Project was last licensed when there were no ESA listed species under our jurisdiction in the project area, NMFS did not carry out an ESA consultation at that time.

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 the existing FERC license 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 dam, as it is already licensed to operate. It is, therefore, necessary to draw a distinction in our analysis between certain ongoing effects of the dam that are part of the environmental baseline versus effects of the proposed action. 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" (50 C.F.R. § 402.02). For instance, some effects of the dam are associated with the lawful existence of the physical structures in the river. As we understand that FERC does not have discretionary authority to decommission or remove a dam outside of a relicensing proceeding, some effects (e.g., the effects of the physical presence of the dam including the existing impoundment, sediment loading, and water quality)[1] must be considered as part of the environmental baseline. Therefore, only the effects associated with the operation of the facilities consistent with the terms of the proposed license amendments, are effects of the proposed action.

On July 5, 2022, the U.S. District Court for the Northern District of California issued an order vacating the 2019 regulations that were revised or added to 50 CFR part 402 in 2019 ("2019 Regulations," see 84 FR 44976, August 27, 2019) without making a finding on the merits. On September 21, 2022, the U.S. Court of Appeals for the Ninth Circuit granted a temporary stay of the district court's July 5 order. On November 14, 2022, the Northern District of California issued an order granting the government's request for voluntary remand without vacating the 2019 regulations. The District Court issued a slightly amended order two days later on November 16, 2022. As a result, the 2019 regulations remain in effect, and we are applying the 2019 regulations here. For purposes of this consultation and in an abundance of caution, we considered whether the substantive analysis and conclusions articulated in the biological opinion and incidental take statement would be any different under the pre-2019 regulations. We have determined that our analysis and conclusions would not be any different.

2. Project Description and Proposed Action

As noted above, this consultation is considering the effects of FERC's proposal to amend 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.

license for the Benton Falls hydropower project, pursuant to authorities under the Federal Power Act, to incorporate provisions of a species protection plan.

2.1 Project Description

The Benton Falls Hydroelectric facility is located at the site of a former hydroelectric project on the Sebasticook River, in the town of Benton, Kennebec County, Maine. Construction on the project was completed in 1987. The Benton Falls Project has a total installed capacity of 4.468 MW. The project is located in a steeply sloped river valley and results in the additional flooding of 27 acres of land to form the 83-acre project reservoir. The facility is operated as a run-of-river plant in accordance with its FERC license requirement.

The Project works consist of:

- A 500-foot-long dam with a west abutment, an L-shaped power house, a fishway bay, a 72-foot-long gated concrete section, a 50-foot-long concrete gravity spillway, 3-foot-high flashboards on the spillway section, a 175-foot-long non-overflow earth dike;
- An 83-acre reservoir with a usable storage capacity of 200 acre-feet at the ogee crest;
- A normal water surface elevation of 85 feet msl. The difference in elevation between nominal headwater and tail water levels is approximately 28 feet. ;
- A powerhouse constructed integrally with the dam, consisting of two turbine generators. Unit #1 is a Dominion Bridge Sultzer double regulated Kaplan turbine with a 2,800 mm diameter runner and a design hydraulic capacity of 1,765 cubic feet per second (cfs) with a generator nameplate of 3,580 kW. Unit #2 is an Escher Wyss double regulated Kaplan turbine with a 1,200 mm diameter runner and a design hydraulic capacity of 350 cfs with a generator nameplate capacity of 750 kW;
- A 150-foot-long tailrace channel;
- A substation;
- A 170 foot long, 12 kV transmission line; and
- Appurtenant facilities.

The powerhouse contains two turbine generators with a total rated hydraulic capacity of 2115 cfs under a gross head of 29.5 feet. The project utilizes all of the available head and about 79% of the available streamflow.

2.1.1 Upstream Passage

The Project's upstream fish passage facilities consist of a fish lift/elevator designed to pass American shad, Alewife and Atlantic salmon and an upstream eel ramp to pass American eels. Construction of the permanent fish lift facility at the Project commenced in July 2005 and the facility became operational May 1, 2006 for the 2006 migration season.

The fish lift contains a 600-gallon hopper that operates on a minimum cycle time of approximately seven minutes. The fish passage system is designed to pass an annual population of 50,408 American shad, 767,267 alewives, and 260 Atlantic salmon.

The fish passage system consists of an automatically adjusted entrance gate, a horizontally moving crowder system, a separation screen, a single hopper, an adjustable exit flume trip gate system, an elevated exit flume to the impoundment equipped with a viewing window, fish counter and blockage screens, a downstream migrant bypass pipe to the tailrace, attraction flow piping, and a video monitoring system.

A total attraction flow of up to 60 cfs can be provided at the entrance gate with 30 cfs through the exit flume and 30 cfs through gravity flow piping from the impoundment. The fish lift has an operational passage range up to 4,500 cfs. This maximum flow occurs approximately 5% of the time in the month of May, <2% of the time in June, and almost never thereafter.

A dedicated automated programmable logic controller controls the fish lift. The controller is located in the Project's powerhouse building, but also can be operated remotely. The fish lift begins operating on May 1 and stops on July 1 (or when water temperature exceeds 24ºC). During this time, lifts are made as often as necessary to accommodate upstream migrants (predominantly alewives), sometimes as often as every 15 minutes. From July 1 to November 1, if temperatures are under 24ºC, fish lifts are typically made at least hourly.

2.1.2 Downstream Passage

The downstream fish passage facility is designed to pass all species and consists of a surface bypass system (two 3-foot wide intakes leading to a bypass pipe that discharges to the project tailrace) and turbine screening to exclude eels. Flow from the transition basin leads fish back to the river downstream of the project powerhouse through a 24-inch pipe with a total capacity of 30 cfs. This pipe discharges fish into the tailrace area of the project's smaller turbine. This system is used to provide downstream passage during the fall migration season. Consistent with the terms of the existing license, the downstream bypass is operated from June 15 to November 30.

In 2005, the Licensee installed a hinged eel screen on the trash racks of Unit #1 to facilitate downstream passage of eels. Unit #1 has trash racks that have two different clear space openings. The top 7 feet of the racks have 0.5" bars with 3" opening. The 3" opening is then split with a 0.25" bar resulting in a 1.375" clear space opening. From the bottom of the 7 feet to the bottom of the racks is a second section with 3" clear space opening. This unit has a hinged overlay that is installed by September 1 and is raised on December 1. The overlay is made of grating bars that allow a clear spacing of 1". On August 29, 2009, a new trash rack with 1" clear space opening was installed on Unit #2 so it could also be run during downstream eel migration.

A Lowrance sonar system was installed in the head pond in 2007 to improve the downstream monitoring process for eel and alewife. The system was originally placed near the downstream passage entrance to see if there was a method of observing eel using the passage. Although the Lowrance was not useful for observing eel, it has been useful in observing schools of downstream alewife. When large pools of alewives are observed the top opening sluice gate can be used to move the school downstream.

2.1.3 Project Operation

The project is operated in a run-of-river mode in accordance with the existing FERC license. The headpond is typically operated with minimal impoundment fluctuation, and is generally maintained near the top of the flashboards. The Project currently provides upstream fish passage. The Licensee's upstream fish passage facilities consist of a fish lift/elevator designed to pass American shad, Alewife and Atlantic salmon and an upstream eel ramp to pass American eels. The Licensee operates the upstream fish lift according to the following schedule:

- May 1 to June 1 – Fish lifts made as often as necessary to provide upstream passage of alewife without undue delay. This may require additional operational changes that increase the fish lift cycle to sufficiently move a large number of fish (over 2 million), such as suspending the use of the V-trap crowder or the hopper separation gate;
- June 1 to July 1 – Fish lifts made hourly and operated according to specifications (full attraction flow and operation of the V-trap crowder and hopper separation gate);
- July 1 to Water Temperature Exceeds 24°C – Fish lifts made hourly and operated according to specifications. Fewer lifts or operational changes may be required based on the results of camera monitoring at the fishway entrance;
- Water Temperature below 24°C (late summer or early fall) to November 1 – Fish lifts made hourly and operated according to specifications. Fewer lifts or operational changes may be considered based on the results of camera monitoring at the fishway entrance.

2.1.4 Project Maintenance

Regular facility maintenance is performed to ensure safe operations throughout the year, including fish passage facility maintenance. Routine maintenance activities include inspections and raking of the trash racks upstream of the powerhouse in the event that frazil ice or debris has built-up (and reduced incoming flows or reduced the optimal performance of the passage facilities). Occasional maintenance outages occur due to frazil ice build-up, lightning, wicket gate problems, speed increaser failures, and miscellaneous equipment failures.

The trash racks are maintained with a manually operated hydraulic rake, and the debris is cleared as soon as river conditions allow safe access. Debris is removed when needed by the operators utilizing the trash rake, day or night. Raking effectively minimizes any impacts that the debris has on operations and energy production. Then the accumulation of grass is a problem, the operators have occasionally "burped" the units to dislodge the grass from the trash racks.

2.2 Proposed Action

2.2.1 Atlantic salmon Species Protection Plan

BFA's proposed license amendment would require them to continue to implement their existing protective measures for Atlantic salmon as described in sections 2.1.1 – 2.1.3 above, which includes:

- Operation of the current upstream and downstream fish passage facilities in coordination with the Maine Department of Marine Resources (MDMR) to provide adequate passage and protection of anadromous and catadromous fish species;
- Operation of the project in a run-of-river mode while providing seasonally variable

bypass and instream flows suitable for the protection of fishery habitat;

- Conduct fishway maintenance activities that include debris management to ensure downstream bypass weir operates to enhance fish passage;
- Fishway pumps are routinely inspected and repaired on an as-needed basis;
- Benton Falls publishes an annual fish passage and proposed operating plan and consults with NMFS, US Fish and Wildlife Service, Maine Department of Inland Fisheries and Wildlife (MDIFW), and MDMR during preparation of the report. This report is filed with FERC by March 31 for the previous year's fish passage activities. It includes passage numbers for Atlantic salmon;
- BFA will contact NMFS within 24 hours of any interactions with Atlantic salmon, including non-lethal and lethal takes (Matt Buhyoff: by email Matt.Buhyoff@noaa.gov or phone (207) 866-4238) and to: nmfs.gar.incidental-take@noaa.gov; and
- In the event of any lethal takes, any dead specimens or body parts will be photographed, measured, and preserved (refrigerate or freeze) until disposal procedures are discussed with NMFS.

In addition, BFA's proposed license amendment includes the following new measures to further reduce effects to listed Atlantic salmon:

- If any Atlantic salmon are encountered in the project fishway, the following operational changes will be made:
  - Hourly operation of the lift shall be changed to an increased frequency of 20 minutes cycle. This increased lift frequency will be maintained for a period of one month from the last Atlantic salmon encounter or until river water temperature reaches 24°C, whichever comes first. Additionally, increased lift frequency may be discontinued sooner as a result of consultation with NMFS and other relevant agency staff.
- If 40 Atlantic salmon are observed passing upstream in two consecutive years, site-specific salmon adult upstream and kelt passage studies (telemetry) will be performed. After the first year of 40 Atlantic salmon passing upstream at the project, BFA will begin planning studies in consultation with NMFS and other relevant agency staff.
- If at least two salmon are passed upstream of the Benton Dam in a given passage season, FERC's BA indicates that BFA shall implement the following operational changes to protect downstream migrating salmon:
  - For smolts:
    - Operate the downstream fish bypass during the smolt migration period two years after the passage of any two or more salmon in a given passage season.[2]
    - BFA will consult with NMFS to develop and implement a mutually acceptable schedule for installing the 1" clear bar hinged overlay screen to reduce entrainment of downstream migrating smolts. It is expected that this would occur during the smolt migration window (April 15-June 15)

[2] BFA proposes to operate the bypass between April 1 and December 31 beginning two years after the passage of two or more salmon to protect salmon smolts. However, we expect that the smolt run would be limited to the period between April 15 and June 15.

two years following the passage of two or more salmon.
    - BFA will consult with NMFS to develop and implement a mutually acceptable site-specific study plan to assess the effects of the project on downstream migrating smolts.
- For kelts:
    - BFA will consult with NMFS to develop and implement a mutually acceptable schedule for installing the 1-inch clear bar hinged overlay screen to prevent entrainment of kelts. Kelts are known to leave the river between October and December in the year they spawn, or they may overwinter in the river and leave the following spring (April-June). It is expected that the overlay screen would be installed following this schedule in years where two or more adults pass the project. Alternatively, BFA may opt to replace intake trash racks with a 2.5-inch clear space rack, which would also be considered protective for downstream migrating kelts.

Although not included in their SPP or BA, BFA has agreed to coordinate with NMFS to develop a plan to reduce the potential effects of stranding on Atlantic salmon and other fish species (Mineau, M., BFA, personal communication, email on 8/28/2023).

2.2.2 Sturgeon Handling and Protection Plan

BFA has proposed 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 fishway. Procedures for handling fish and documenting these interactions are outlined below.

- If a sturgeon is observed inside the hopper or entering the hopper before it is lifted, the operator will suspend lift operation and will wait until it exits the hopper before restarting operation.
- If a sturgeon is observed in the flume of the fishway, the Licensee shall immediately contact MDMR to remove the fish from the flume with a long handled net outfitted with non-abrasive knotless mesh. The sturgeon will then be released into the river downstream of the dam. The net will be kept onsite at the BFA project. The flume has a screen at the exit, which has 1" clear space bars which would prevent sturgeon from exiting the flume and passing upstream.
- If any injured sturgeon are found in the fishway, the Licensee shall report immediately to NMFS and MDMR. Injured fish must be photographed if possible. If the fish is badly injured, the fish should be retained by the Licensee, if possible, until notified by NMFS with instructions for potential rehabilitation.
- If any dead sturgeon are found in the fishway, the Licensee must report immediately to NMFS. Specimens should be stored in a refrigerator or freezer by the Licensee until they can be obtained by NMFS for analysis.

As indicated above, although not included in the proposed amendment, BFA has agreed to coordinate with NMFS to develop a plan to reduce the potential effects of stranding on sturgeon and other fish species (Mineau, M., BFA, personal communication, email on 8/28/2023).

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 Benton Falls Project under the terms of the amended license affects a portion of the Sebasticook River. In addition to the immediate footprint of the Project, the action area encompasses the impounded habitat upriver of the dam, as well as the area downriver of the project affected by project flow modifications. Therefore, the action area of the Project encompasses the impoundment (which extends approximately 2 miles upstream), to a point approximately 5 miles downstream of the dam where the Sebasticook River flows into the Kennebec River (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 project.

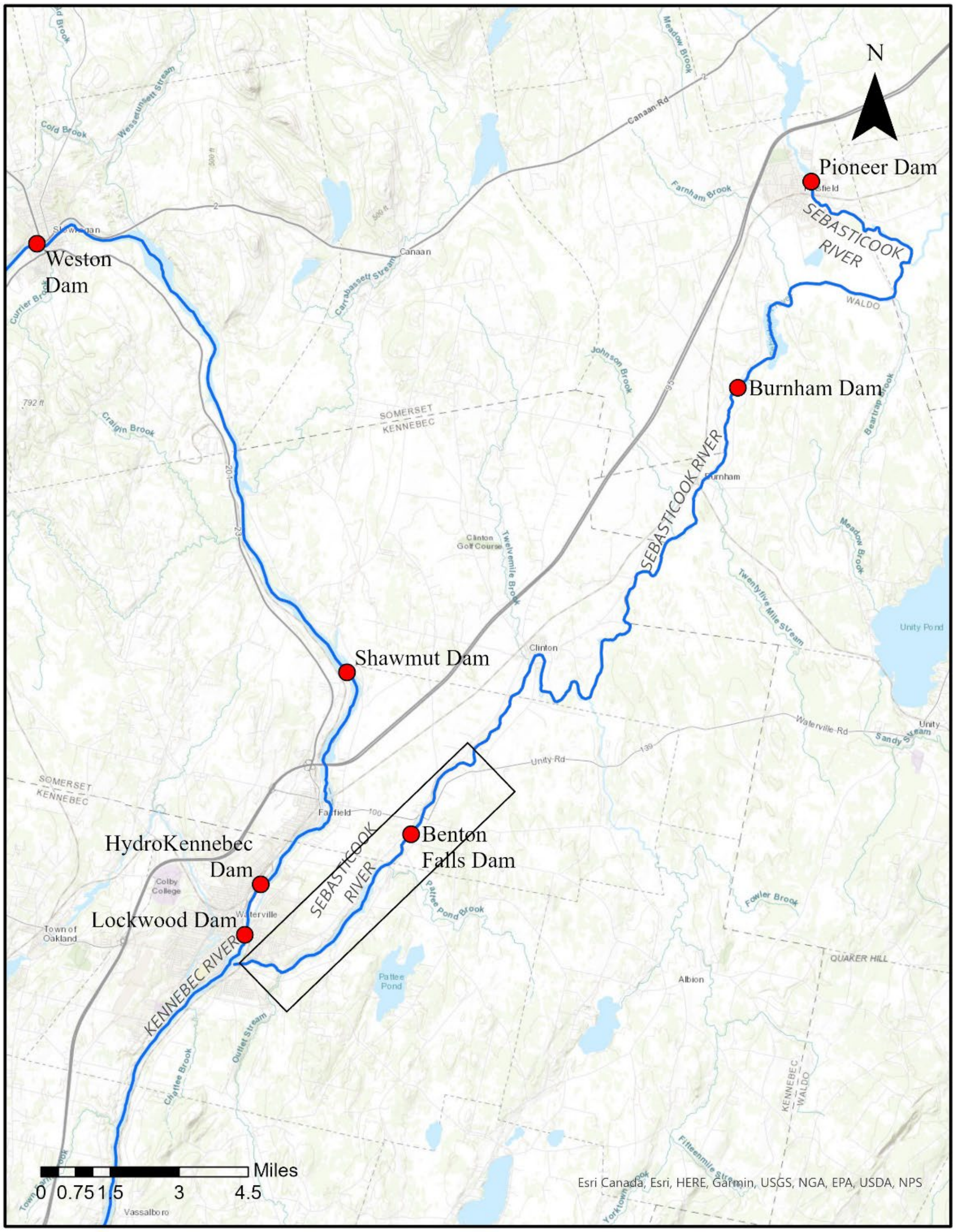

Figure 1. The action area for the proposed action includes the footprint of the Benton Falls Project, as well as the habitat impounded by the dam and the reach of river downstream to the confluence with the Kennebec where any flow modifications could be detected.

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 under our jurisdiction (Table 1). Critical habitat has been designated for the GOM DPS of Atlantic salmon and the GOM DPS of Atlantic sturgeon in the Kennebec River, but neither designation extends into the Sebasticook River where the action area occurs.

Table 1. ESA-listed species 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[3]
Shortnose Sturgeon	*Acipenser brevirostrum*	Range-wide	32 FR 4001	NMFS 1998

3.1 Atlantic salmon (Gulf of Maine DPS)

The Gulf of Maine (GOM) DPS of anadromous Atlantic salmon was initially listed by USFWS and NMFS (collectively, the Services) as an endangered species on November 17, 2000 (65 FR 69459) (Figure 2). 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.

[3] 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).

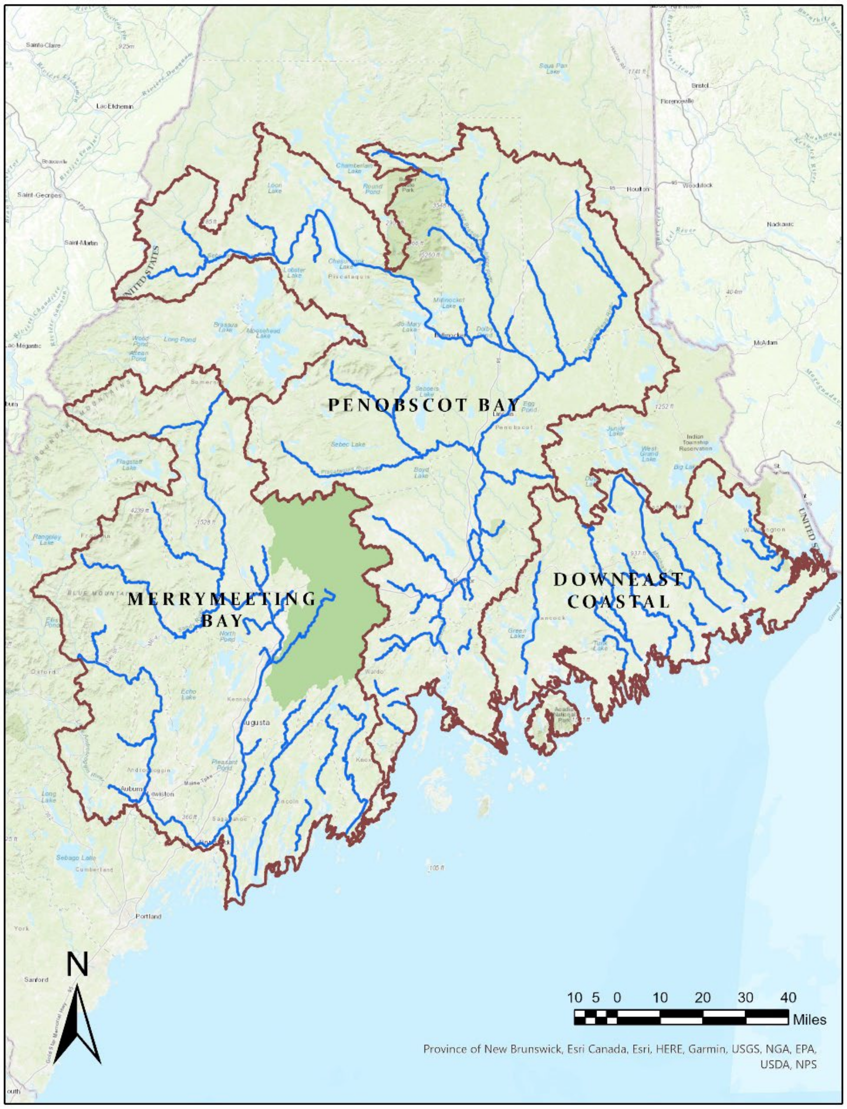

Figure 2. The GOM DPS of Atlantic salmon with the three recovery units identified. The Sebasticook River watershed, which flows into the Kennebec, is shown in green.

3.1.1 Survival and Recovery of the GOM DPS

The USFWS and NMFS issued a recovery plan ("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 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.

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.

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[4] 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, the delisting criteria are:

- 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.

In 2020, NMFS and USFWS completed a 5-year review that evaluated whether any of these reclassification criteria had been achieved. The review concluded that the demographic risks to Atlantic salmon are still high, that the number of naturally reared or wild adults is still less than 100 per SHRU, and that the primary threats have not been sufficiently abated. As such, the review indicated that none of the above criteria had been achieved; and therefore did not recommend any change to the classification of the GOM DPS of Atlantic salmon (NMFS &

[4] One habitat unit equals 100 square meters.

USFWS, 2020).

3.1.2 Atlantic salmon Life History

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

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; however, individuals may enter at any time between early spring and late summer (Baum, E., 1997). 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). The female salmon creates an egg pit (i.e., redd) by digging into the substrate with her tail and then deposits eggs while male salmon release sperm to fertilize the eggs. After spawning, the female continues digging upstream of the last deposition site, burying the fertilized eggs with clean gravel. Females produce a total of 1,500 to 1,800 eggs per kilogram of body weight, yielding an average of 7,500 eggs per two sea-winter (SW) female (an adult female that has spent two winters at sea before returning to spawn) (Baum & Meister, 1971).

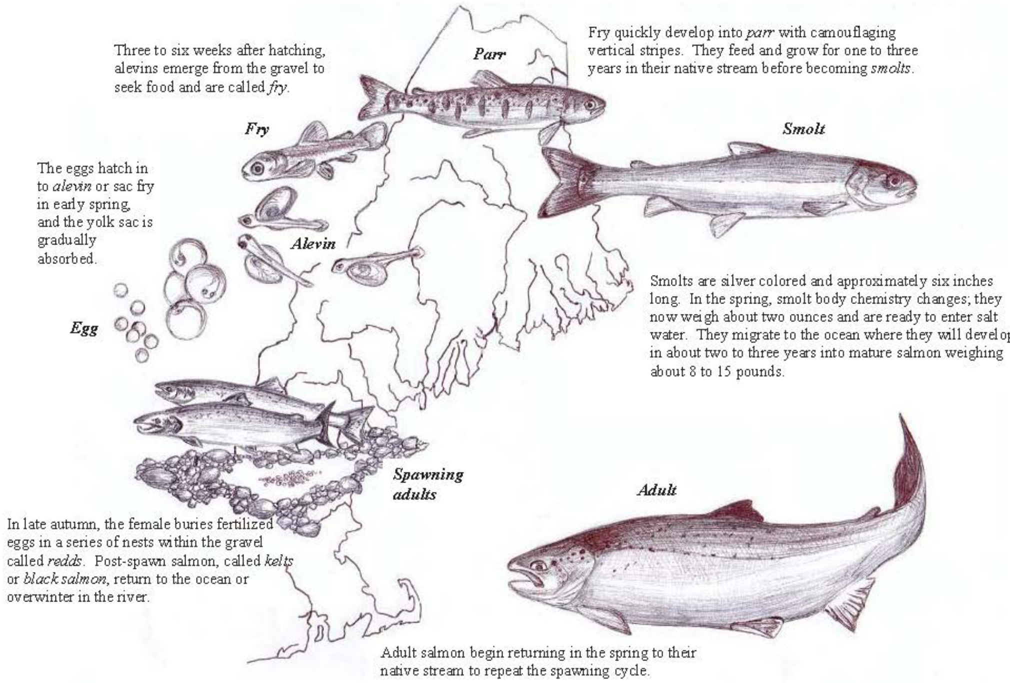

Figure 3. Life cycle of the Atlantic salmon (diagrams courtesy of Katrina Mueller).

Postspawn Adult Salmon (Kelts)

Atlantic salmon are iteroparous, meaning they are able to spawn more than once. Repeat spawners may comprise a significant proportion of a self-sustaining Atlantic salmon population, with estimates reaching upwards of 60% for some populations (Lawrence et al., 2016). Repeat spawners provide considerable benefits to Atlantic salmon populations as repeat spawning females are considerably larger than first time spawners. Larger fish have greater fecundity and larger egg size, resulting in increased fitness of their progeny (Beacham & Murray, 1993; Fleming, 1996). Repeat spawners also increase genetic diversity because they add additional year classes to the spawning population (Niemelä et al., 2006; Saunders & Schom, 1985). Consequently, a salmon population with a higher proportion of repeat spawners is widely considered to be more resilient and better able to compensate for the many threats posed through their life-cycle (Babin et al., 2021; Baktoft et al., 2020; Lawrence et al., 2016; Maynard et al., 2018; Schindler et al., 2010). In years when marine survival is particularly low, a higher proportion of repeat-spawners can partially offset the overall reduction in returns given their higher fecundity. As such, it has been estimated that a high proportion of repeat spawners may reduce the probability of population decline by 27% or greater (Lawrence et al., 2016). Lawrence et al. (2016) has estimated that a salmon population in a river with four dams is 16% less likely to face decline if it has kelt stage as part of its life history[5].

It is thought that only a small proportion of adult salmon that survive spawning will migrate back to the ocean in the fall, whereas the majority (>80%) overwinter in the river and then out-migrate in the subsequent spring (Maynard et al., 2018; Babin et al., 2021). Though initial survival after

[5] Assuming a 90% per dam passage survival probability.

spawning may be upwards of 80 percent for first time spawners (Maynard et al., 2018), in-river mortality among overwintering postspawn adults can be quite high (~50% or greater), particularly in males (up to 100%) (Babin et al., 2021; Maynard et al., 2018). This mortality is a result of depleted energy reserves after a lengthy migration when salmon are not feeding. Although this is a natural part of salmon life-history, the presence of dams can significantly increase postspawn mortality due to the additional depletion of reserves associated with substantial migratory delay at multiple dams during their spawning run (Baktoft et al., 2020; Rubenstein et al., 2022).

Since 1970, repeat spawners have represented just over 1% (on average) of the US adult returns (Maynard et al., 2018). The low proportion is likely due to a number of factors such as poor marine survival, and the presence of dams on all major river systems. Dams lead to energy depletion in prespawn adults, which can lead to increased prespawn and postspawn mortality (Rubenstein, 2021). The Kennebec River, which hosts four mainstem dams downstream of the Sandy River, only had a single repeat spawning adult documented between 2011 and 2020 (USASAC, 2021), which constitutes less than 0.5% of the run over that time period.
Out-migrating postspawn salmon are subjected to similar challenges as out-migrating smolts when it comes to passing dams. Postspawn adults may experience both direct mortality (e.g., turbine strikes) and indirect mortality as a result of injury or delay (Baktoft et al., 2020). As with prespawn adults, postspawn adults are exposed to delay at dams as they migrate back out to the ocean. Delay of kelts at hydro-dams has been shown to reduce their remaining energy reserves by as much as 4 to 5 percent, which may lead to reduced postspawn survival (Baktoft et al., 2020). Babin et al. (2021) found that kelt movement slowed in dam reservoirs as kelts either entered searching mode or underwent multiple reversals, resulting in lower migration success. Jonnson et al. (1997) found that even minor additional energy expenditures by kelts resulted in considerable reduction in postspawn survival (Jonsson et al., 1997).

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, referred to as alevin or 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). 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., 1998). Late migrants lose physiological smolt characteristics due to high water temperatures during spring migration. Most smolts migrate rapidly if unimpeded (Hyvärinen et al., 2006; Lacroix & McCurdy, 1996; Lacroix & Knox, 2005; Lacroix et al., 2004).

Predation

Smallmouth bass and chain pickerel are each significant predators of juvenile 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 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 also feed upon fry and parr (van den Ende, 1993). Chain pickerel feed actively in temperatures below 10°C (van den Ende, 1993). Smolts were, by far, the most common item in the diet of chain pickerel observed by Barr (Barr, 1962) and van den Ende (1993). However, van den Ende (1993) concluded that "daily consumption was consistently lower for chain pickerel than that of smallmouth bass" apparently due to the much lower abundance of chain pickerel.

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

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 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., 2021). 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 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 & Friedland, 1993; Ritter, 1997).

Adults

Some salmon may remain at sea for one or two years before they are ready to return to the rivers to spawn. 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).

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 lifespan of Atlantic salmon ranges from two to eight years (Fay et al., 2006).

3.1.3 Status and Trends of the GOM DPS of Atlantic salmon

The historic distribution and abundance of Atlantic salmon in Maine has been described extensively (Baum, E. T., 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 (Saunders et al., 2006).

Today, the spatial distribution of the GOM DPS of Atlantic salmon is limited directly by dams that obstruct passage and indirectly by 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. Indirectly, the spatial distribution of the GOM DPS of Atlantic salmon is also limited by low abundance (i.e., lack of potential donor or source populations) as well as the species' strong and inherent homing tendencies (Pess et al., 2014).

The reproduction 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 United States dating back to 1967 exists (Figure 4; USASAC, 2023). 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, 1867) estimated that as many as 216,000 adult salmon may have returned to the Kennebec 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, 2023).

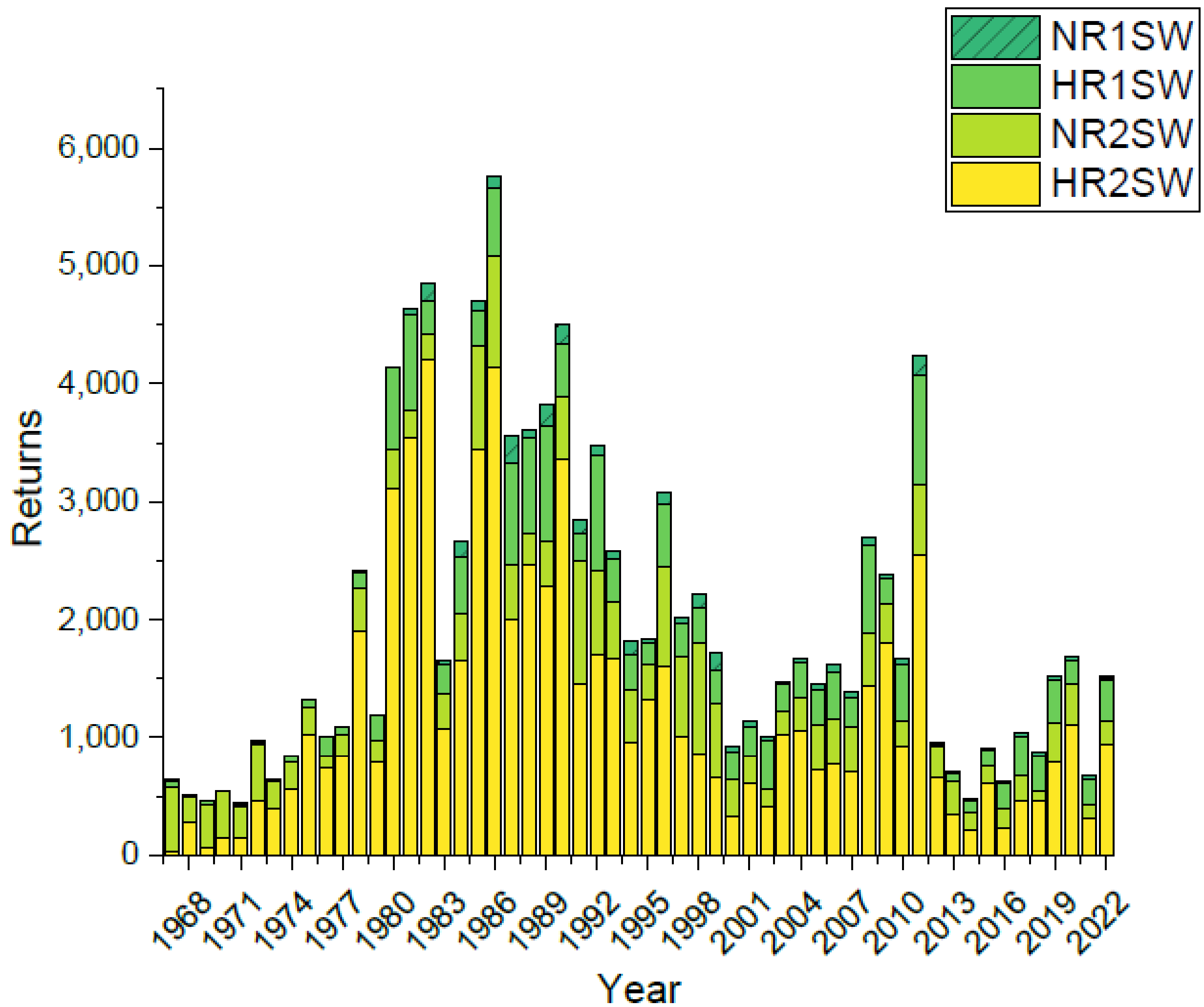

Figure 4. Origin and sea age (age 1 and 2 only) Atlantic salmon returning to USA rivers, 1967 to 2022 (NR1SW = Naturally Reared One Sea Winter; HR1SW = Hatchery Reared One Sea Winter; NR2SW = Naturally Reared Two Sea Winter; HR2SW = Hatchery Reared Two Sea Winter) (USASAC, 2023).

After a period of population growth between the 1970s and the early 1980s, adult returns of salmon in the GOM DPS have been declining since the early 1990s, stabilizing at very low levels during the 2000s. The population growth observed in the 1970s is likely attributable to favorable marine survival and increases in hatchery capacity, particularly from the USFWS Green Lake National Fish Hatchery (GLNFH) (constructed in 1974). Marine survival remained relatively high throughout the 1980s, and salmon populations in the GOM DPS remained relatively stable until the early 1990s. In the early 1990s, marine survival rates decreased, leading to the declining trend in adult abundance that persists today.

The pattern of low marine survival is not unique to the GOM DPS of Atlantic salmon. Chaput et al. (2005) first raised the potential for a "regime shift" in marine survival for Atlantic salmon throughout North America resulting in decreased productivity and abundance. The effects of this regime shift appear to be particularly acute at the southern edge of the range with many researchers implicating the effects of climate change as a key driver in the ongoing reductions in marine survival of Atlantic salmon (Mills et al., 2013). Marine survival, growth, and maturation are affected in complex ways by warming conditions in the ocean (Friedland, 1998; Friedland & Todd, 2012) and a warming ocean is generally problematic for Atlantic salmon (Friedland & Todd, 2012) except in the northernmost portions of the range (Jonsson & Jonsson, 2009). Reductions in energy content of prey resources in the marine environment may also be linked to recent changes in climate and reduced marine survival (Renkawitz et al., 2015), but considerable uncertainty remains. While the reasons for the decline in marine survival of Atlantic salmon are not well understood at this time, a growing consensus has emerged: abundant healthy wild smolts should be free to emigrate from rivers to the ocean if populations are to sustain the contemporary challenges imposed by the marine environment (Thorstad et al., 2021).

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 contributes approximately 20% of Atlantic salmon returns to the GOM DPS (CMS, 2022). The term "naturally reared" includes fish originating from both natural spawning and from stocked hatchery eggs and fry (USASAC, 2012). Adults that result from the stocking of eggs and fry are included as naturally reared because hatchery eggs and fry are not marked, and therefore cannot be visually distinguished from fish produced through natural spawning. While the Penobscot hosts the largest run in the GOM DPS by far (10-year average of 83% of the total returns), only 22% of that run consists of naturally reared fish (CMS, 2022). This compares to 53% and 78% of the run in the Downeast Coastal and Merrymeeting Bay SHRUs, respectively. The run in the Kennebec River, which occurs in the Merrymeeting Bay SHRU, consists of 94% naturally reared returns (as a result of egg planting in the Sandy River). The distinction between hatchery and naturally reared adult salmon is critical in understanding the potential for the achievement of the recovery criteria as laid out in the Final Recovery Plan (USFWS & NMFS 2019). Only naturally reared and wild salmon are considered when determining achievement of the downlisting and delisting criteria. Hatchery returns do not count towards the criteria themselves; however, if they return and successfully spawn in the wild their progeny would be counted toward the criteria. Therefore, in the context of reaching downlisting and delisting goals, a more meaningful metric than the total adult returns to the GOM DPS is the abundance of naturally reared or wild returns (Figure 5).

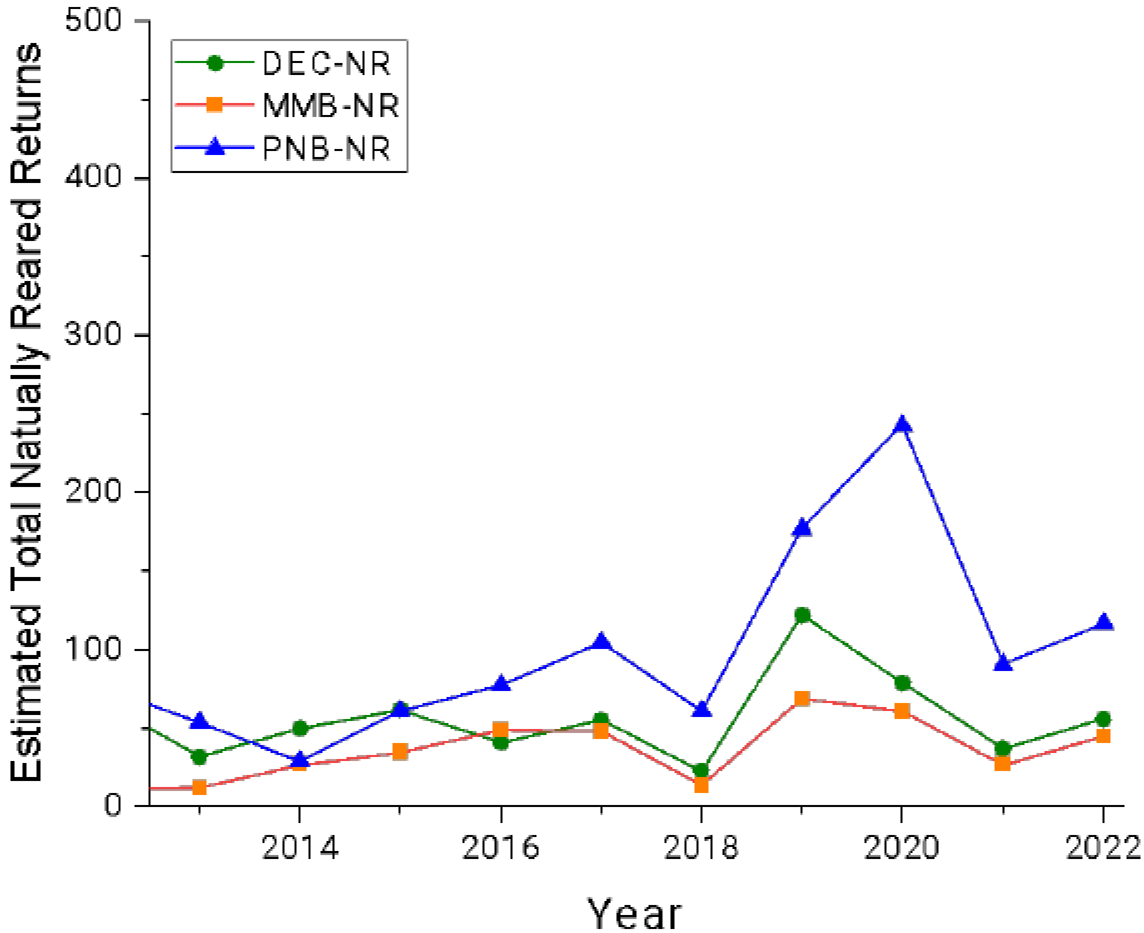

Figure 5. Time series of the last decade of naturally reared adult returns to the Merrymeeting Bay (Orange), Penobscot Bay (Blue), and Downeast (Green) SHRUs. The downlisting target of 500 natural spawners is maximum axis value (USASAC, 2023).

Although the *proportion* of naturally reared salmon is significantly higher in the Downeast and Merrymeeting Bay SHRUs, the more extensive stocking effort in the Penobscot SHRU leads to a higher number of naturally reared adults compared to the other SHRUs. Of the naturally reared or wild adults returning to the GOM DPS, on average 51%, 30%, and 19% return to the Penobscot Bay, Downeast, and Merrymeeting Bay SHRUs, respectively. It should be emphasized that this distribution is dependent on current stocking effort (lifestage and abundance), and by itself should not be construed to mean that any one SHRU is inherently more important or suitable in regards to its contribution to recovery.

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 little sign of growth. The most recent five year review for the species concluded that:

> The demographic risks to Atlantic salmon remain high. The three SHRUs have 10-year average abundance of less than 100 natural spawners per SHRU. Of the eight locally adapted populations that remain in the GOM DPS, seven are supported by conservation hatcheries that act to buffer extinction risk. The eighth, the Ducktrap River, is at very high risk of extirpation. With naturally reared populations being very low, the geometric mean population growth rates have been, as can be expected, highly variable. Given the high degree of variability in the population growth rates and the very low population abundances of naturally reared fish, we will need to continue to monitor population trajectories very carefully. (NMFS and USFWS, 2020)

The spatial distribution of the GOM DPS has been severely reduced relative to historical distribution patterns due to the construction of dams. 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. Although the hatchery program is critical, it alone cannot recover the species. Recovery of the GOM DPS must be accomplished through increases in naturally reared salmon, which will only occur if the ongoing threats to the species (as defined in the 2019 Recovery Plan) are abated. This can be accomplished by improving connectivity at dams and road stream crossings, and through projects that improve freshwater habitat productivity.

3.1.5 Factors Affecting Atlantic salmon

Atlantic salmon face a number of threats to their survival, which are fully described in the Recovery Plan (USFWS & NMFS, 2019) with additional information provided in the 2020 5-Year Review. As described in the listing rule and the Recovery Plan, 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.

These conclusions were reaffirmed in the 2020 5-Year Review (NMFS and USFWS, 2020).

Many actions 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. As noted in the 2020 5-Year Review, while progress has been made to reduce or better understand many of those threats, each of these threats continues to contribute to the endangerment of the species (NMFS & USFWS, 2020).

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.

3.1.6 Status and Trends of Atlantic salmon 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 SHRU. The Sebasticook River is a major tributary to the Kennebec River, which contains most of the accessible salmon habitat in the Merrymeeting Bay SHRU, and hosts a small run of mostly naturally reared Atlantic salmon. The Sebasticook itself is not stocked, and has little, if any, natural production. However, given its proximity to the Kennebec, salmon migrating through the Kennebec occasionally stray into the Sebasticook, where they may make use of available spawning and rearing habitat.

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 increased (Figure 6). Over the last 10 years, the total number of prespawn Atlantic salmon returning to the three rivers where counts are made in the Merrymeeting Bay SHRU (Kennebec, Androscoggin, Sheepscot) ranged between 18 and 87 annually; with an average return of 46 individuals (derived from data in USASAC (2022) and CMS (2022)). Of the prespawn adult salmon that return to the Merrymeeting Bay SHRU to spawn, approximately 63% (10 year average) return to the Kennebec River; 5% return to the Androscoggin River, and 32% return to the Sheepscot River. On the Kennebec River, salmon are counted at the Lockwood Project, which is located just upstream of where the Sebasticook flows into the mainstem. In years when salmon are trapped at the Benton Falls Dam on the Sebasticook, those fish are added to the total observed at Lockwood to estimate the number of fish returning to the Kennebec watershed as a whole. Over the last decade (2013-2022), salmon were only passed at Benton Falls in 2013 (1 salmon) and 2022 (5 salmon).[6] During that same time period, the Kennebec River had an average return of

[6] MDMR. 2022. Historical Trap Counts. https://www.maine.gov/dmr/sites/maine.gov.dmr/files/inline-files/Trap%20Count%20Archive%202022.pdf Preliminary data indicates that an additional three salmon were

37 salmon a year.

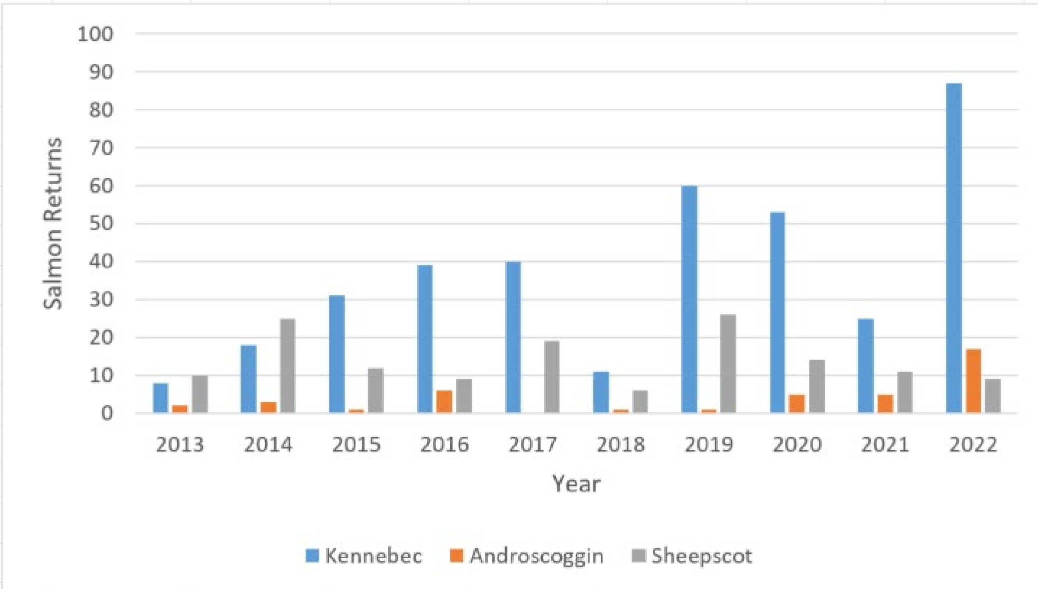

Figure 6. Adult Atlantic salmon returns to the rivers in the Merrymeeting Bay SHRU between 2013 and 2022 (derived from data in USASAC (2023)).

Although relatively small, the Sheepscot River hosts one of the eight remaining river-specific stocks of Atlantic salmon. These are the only remaining locally adapted populations of wild Atlantic salmon in the GOM DPS. The river specific stocks for the Androscoggin and Kennebec were extirpated largely due to habitat loss and the construction of dams. Both rivers are now stocked largely with salmon from the Penobscot population. The Sheepscot stock is the only river-specific population remaining 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 elsewhere in the SHRU. Between 2010 and 2020, the only smolts that were stocked in the SHRU were tagged study fish that Brookfield put in the river to test the efficiency of their downstream fishways. In 2020, MDMR began implementing a multi-year plan to stock smolts in the mainstem Kennebec River with the stocking of almost 90,000 smolts in 2020, and 100,000 in both 2021 and 2022 (USASAC, 2023). No salmon have been stocked in the Sebasticook River over the last decade.

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

passed in 2023 (as of July 27. 2023): https://www.maine.gov/dmr/fisheries/sea-run-fisheries/programs-and-projects/trap-count-statistics habitat units in each SHRU was estimated using a GIS-based salmon habitat model (Wright et al., 2008). Using this model, we estimate that approximately one-third of habitat units within the Merrymeeting Bay SHRU are within the designated critical habitat for Atlantic salmon. Approximately 90,000 of those habitat units occur within critical habitat in the Kennebec River; this constitutes roughly three-quarters of the critical habitat in the SHRU. The remaining 32,000 habitat units within critical habitat are divided between the other four rivers within the SHRU (Figure 7). In addition to abundance, the model also identifies the proportion of each modeled reach that is expected to be suitable for juvenile rearing. The Maine Stream Habitat Viewer[7] categorized these proportions into three classes with the first, second, and third classes predicted to contain >50%, 27-50%, and <26% rearing habitat, respectively. As areas that contain a higher proportion of rearing habitat are more likely to produce juvenile salmon, class 1 habitats are expected to be the most suitable for rearing and class 3 habitats expected to be least suitable[8]. Using the model and the established classification, we describe how the suitability and abundance of rearing habitat compares between the five rivers in the SHRU (Figure 7). Of the over 55,000 class 1 habitat units in the critical habitat within the Merrymeeting Bay SHRU, 78% occur within the Kennebec River, with the remaining 22% divided among the other four rivers.

The Sebasticook River does not occur within designated critical habitat (and therefore is not included in the above estimate of habitat in the SHRU), but it does contain modeled rearing habitat (Wright et al. 2008). The Sebasticook contains nearly 25,000 modeled units, of which approximately 10,000 occur in the West Branch, which is inaccessible due to impassable dams. Of the 15,000 accessible units, approximately 50% are class 1, 15% are class 2, and 35% are class 3.

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[7] Maine Stream Habitat Viewer. Atlantic salmon Modeled Rearing Habitat. Layer maintained by US Fish and Wildlife Service Gulf of Maine Coastal Program. https://webapps2.cgis-solutions.com/MaineStreamViewer/

[8] In the context of the Wright et al. (2008) model, what we refer to as suitability is actually a measure of habitat abundance or density within a stream reach, rather than a measure of quality. A segment of river modeled as class 1 would be expected to have a higher proportion of productive habitat than one modeled as class 3. However, this does not suggest that a unit of habitat in a class 1 reach would necessarily produce more salmon parr than a unit of habitat in a class 3 reach (i.e., quality).

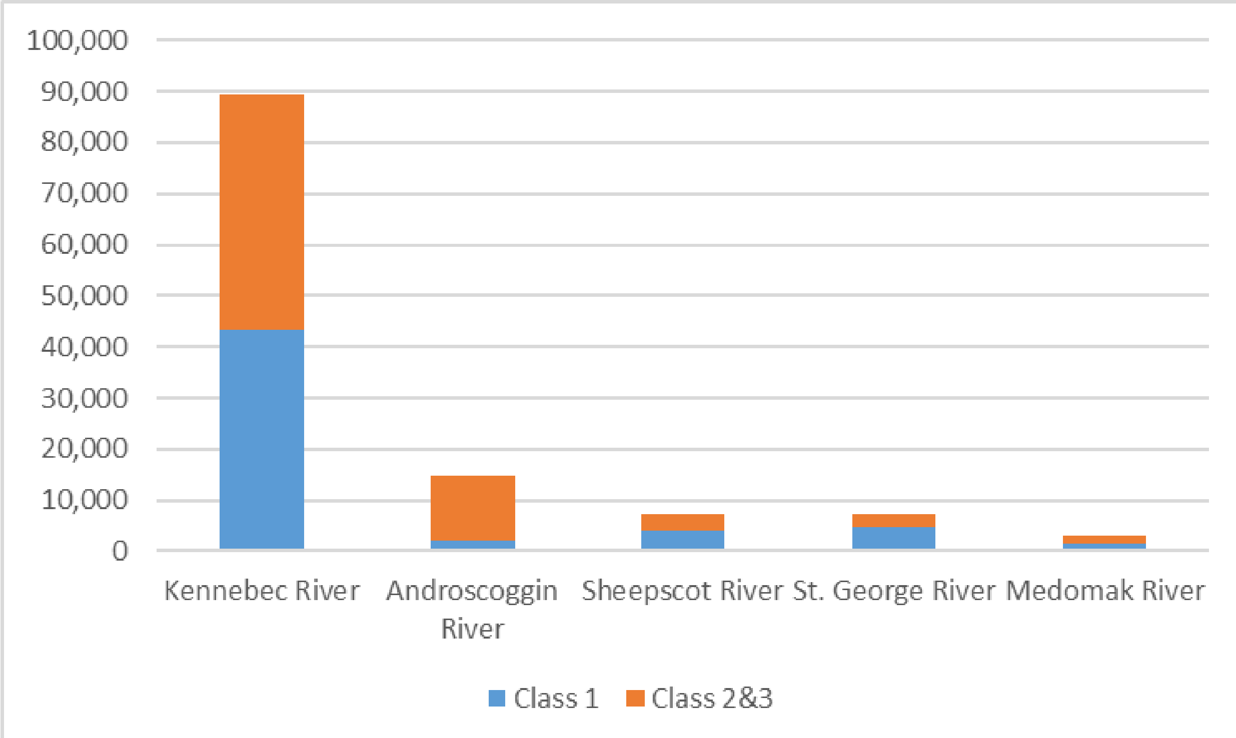

Figure 7. The abundance and suitability of modeled rearing habitat units in designated critical habitat within the Merrymeeting Bay SHRU for Atlantic salmon (based on Wright et al. (2008)).

Dams significantly affect Atlantic salmon in the Merrymeeting Bay SHRU through habitat alteration, fish passage delays, and entrainment and impingement of juveniles and kelts. 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 Sebasticook River has several mainstem dams, including three (Benton Falls, Burnham, and Sebasticook Lake Dam) that have fishways.

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). Accessible habitat, in the context of the recovery criteria, is habitat within the designated critical habitat that the majority (generally >95%) of Atlantic salmon can freely swim to safely with minimal human intervention. As such, habitat above dams that have inadequate passage effectiveness is not considered accessible. Similarly, habitat that is only accessible because salmon are trapped at a dam and transported to the habitat upstream through extensive human intervention is not considered accessible. Therefore, the estimate of accessible habitat does not include habitat above the Lockwood dam (because salmon can only access upstream habitat when transported by humans) or the first Androscoggin or Sebasticook dams (where fishway effectiveness has not been evaluated). Most of the accessible high quality (i.e., class 1) rearing habitat in the SHRU is located in the Sheepscot River (3,985 units), St. George River (4,617 units) and the Kennebec River downstream of the Lockwood Dam (5,337 units). This is a relatively small amount when compared to the 39,389 units located upstream of Lockwood on the Kennebec; 30,000 of which occur in the Sandy River tributary. There is also mapped accessible spawning habitat in the lower Kennebec, St. George, and Sheepscot[9] that provides opportunity for spawning and rearing for adults that do not pass successfully upstream of the Lockwood Dam.

Summary

Adult returns for the Merrymeeting Bay recovery unit remain well below the biological criteria established for each SHRU in the 2019 Recovery Plan (USFWS & NMFS, 2019). The 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. Similarly, the Plan indicates that an escapement of 500 naturally reared adults returning to two of the three SHRUs would be required to downlist the species from endangered to threatened. The abundance of Atlantic salmon in the SHRU remains low. The 10-year (2012-2021) average number of naturally-reared or wild adults returning to the Merrymeeting Bay SHRU is 36 (CMS, 2022). This constitutes 7.2% of the total needed for downlisting (reclassification to threatened), and 1.8% 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.

In 2020, NMFS and USFWS completed a 5-year review that evaluated whether the reclassification criteria had been achieved for the GOM DPS of Atlantic salmon (NMFS & USFWS, 2020). The review concluded that the demographic risks to Atlantic salmon are still high, that the number of naturally reared or wild adults is still less than 100 per SHRU, and that the primary threats have not been sufficiently abated. 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. In freshwater, the primary threat to the species and to the functioning of critical habitat is the lack of abundant accessible spawning and rearing habitat, which is attributable to ineffective fish passage at dams, and at road-stream crossings.

3.2 Shortnose Sturgeon

Shortnose sturgeon could occur in the portion of the action area below the Benton Falls Dam, although they have never been observed there. 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).

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

3.2.1 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 2.

Table 2. Shortnose sturgeon general life history for the species throughout its range.

Stage	Size (mm)	Duration	Behaviors/Habitat Used
Egg	3-4	13 days postspawn	stationary on bottom; Cobble and rock, fresh, fast flowing water (0.4-0.8 m/s)
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 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 al., 1984) and then spawn every 3-5 years (Dadswell, 1979; Dadswell et 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 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 et al, 2012; Kynard et al, 2016). 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 & 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 (Secor and Niklitschek 2001).

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, 1985a, Dadswell et al., 1984; Buckley and Kynard, 1985b; 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).

3.2.1.1 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 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.

3.2.2 Status of Shortnose Sturgeon

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).

3.2.2.1 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[10]. 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.

3.2.3 Summary of Status of Northeast Rivers

[10] 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.

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.

3.2.3.1 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 are presumed to 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 detected in the Penobscot River 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)).

3.2.3.2 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 and 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 (Wippelhauser and Squiers 2015, Wippelhauser et al., 2015). In both rivers, there are hydroelectric facilities located at the base of natural falls thought to be the natural upstream limit of the species. As such, these dams (Lockwood Dam on the Kennebec and Brunswick Dam on the Androscoggin) are not considered to limit the movements of sturgeon in these rivers. The Sheepscot River is used for foraging during the summer months.
Altenritter et al. (2017) found that a large proportion of female shortnose sturgeon tagged in the Penobscot River migrated to the Kennebec River during probable spawning windows. They also found that shortnose sturgeon in the Penobscot River were larger and had a higher condition factor than shortnose sturgeon in the Kennebec River. Based on this, they speculated that "increased abundance and resource limitation in the Kennebec River may be constraining growth and promoting migration to the Penobscot River by individuals with sufficient initial size and condition." These individuals then return to spawn in the Kennebec River at larger size that could potentially result in increased reproductive potential compared to nonmigratory females. Thus, migrants could experience an adaptive reproductive advantage relative to nonmigratory

individuals. Further, Altenritter et al. (2017) noted that although migrants to the Penobscot River may be a small proportion of the Kennebec River population, they could disproportionately contribute to regional recruitment and facilitate population resilience to disturbance.

3.2.3.3 Merrimack River

The historic range in the Merrimack extended to Amoskeag Falls (Manchester, NH, river kilometer 116; Piotrowski (2002)); currently shortnose sturgeon cannot move past the Essex Dam in Lawrence, MA (river kilometer 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 (Altenritter et al., 2017, Wippelhauser et al., 2017). 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). In the fall of 2014, a shortnose sturgeon tagged in the Connecticut River in 2001 was captured in the Merrimack River. To date, genetic analysis has not been completed and we do not yet know the river of origin of this fish.

3.2.3.4 Connecticut River

The Holyoke Dam divides the Connecticut River shortnose population; upstream and downstream fishway improvements were implemented for the 2016 fish passage season. Passage between 1975 and 1999 was an average of four fish per year and no shortnose sturgeon passed upstream of the dam between 2000 and 2015. From 2016 - 2020, 287 shortnose sturgeon have passed upstream of the dam, at an average rate of 57 per year. The number of sturgeon passing downstream of the Dam is less well known due to difficulties in monitoring downstream passage. However, the 2016 fishway improvements have been shown to significantly reduce the potential for serious injury or mortality. 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 long-term 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; river kilometer 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, until recently successful spawning (i.e., capture of viable eggs and larvae) has only been documented upstream of the Holyoke Dam. Abundance of prespawning adults was estimated each spring between 1994 and 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.

3.2.3.5 Hudson River

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.

3.2.3.6 Delaware River-Chesapeake Bay Metapopulation

Shortnose sturgeon range from Delaware Bay up to at least Scudders Falls (river kilometer 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.

In Chesapeake Bay, shortnose sturgeon have most often been found in Maryland waters of the mainstem bay and tidal tributaries such as the Susquehanna, Potomac, and Rappahannock Rivers (Kynard et al., 2016; SSSRT, 2010). Spells (1998), Skjeveland et al. (2000), and Welsh et al. (2002) all reported one capture each of adult shortnose sturgeon in the Rappahannock River. Recent documented use of Virginia waters of Chesapeake Bay is currently limited to two individual shortnose sturgeon: one captured in 2016 (Balazik, 2017) and a second sturgeon (a confirmed gravid female) caught in 2018 in the James River (Balazik, pers. comm. 2018). Spawning has not been documented in any tributary to the Bay although suitable spawning habitat and two prespawn 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.

3.2.3.7 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 from 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.

3.2.4 Factors Affecting Shortnose Sturgeon

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 5.0). More information on threats experienced in the action area is presented in the Environmental Baseline section of this Opinion.

3.2.4.1 Survival and Recovery

The 1998 Recovery Plan (NMFS, 1998) 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.

3.2.4.2 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.

3.3 Atlantic sturgeon

Atlantic sturgeon could occur in the portion of the action area below the Benton Falls Dam, although they have never been observed in the Sebasticook. 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 8). 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. 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. Critical habitat for all five DPSs was designated in 2017 (82 FR 39160); the designation for the Gulf of Maine DPS includes the Kennebec River critical habitat unit as described further below.

3.3.1 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 8). 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.

There is currently no mixed stock analysis[11] for the action area specifically; however, genetic analyses and telemetry studies indicate that within the Gulf of Maine nearly all Atlantic sturgeon originate from the Gulf of Maine DPS and that within the action area we would only expect Atlantic sturgeon originating from the Gulf of Maine DPS. Wippelhauser et al. (2017) tagged Atlantic sturgeon in four Gulf of Maine rivers and tracked their movements between 2006 and 2014; they found that only 7% of the Atlantic sturgeon tagged in the four study rivers moved outside of the Gulf of Maine during the study period. Kazyak et al. (2021) examined genetic results of captured Atlantic sturgeon in three geographic regions (North of Cape Cod, Mid-Atlantic, and south of Cape Hatteras) to determine stock compositions in each of the three areas. They report that all individuals from the north region were from the Gulf of Maine DPS (87.8%) or Canadian River (12.2%). The authors state there was no indication that Atlantic sturgeon from other stocks were present in the samples from the north region, nor did they detect any differences in stock composition between individuals collected in riverine/estuarine habitats and offshore. Wirgin et al. (2012) determined that stocks in the Bay of Fundy were primarily from the St. John River (>60%) and the Kennebec River (34-36%). Together, these studies support the conclusion that Atlantic sturgeon in the Gulf of Maine are likely to originate from Canadian rivers or the Gulf of Maine DPS.

The only Atlantic sturgeon we expect to occur in the action area are adults, eggs, and larvae. In the Kennebec River, non-spawning Atlantic sturgeon spend the majority of their time downstream of rkm 45 (Wippelhauser et al., 2017), which is downstream of the action area.

[11] A mixed stock analysis uses genetic studies to estimate the proportional contributions of individuals from different stocks in a particular geographic area or population.

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.

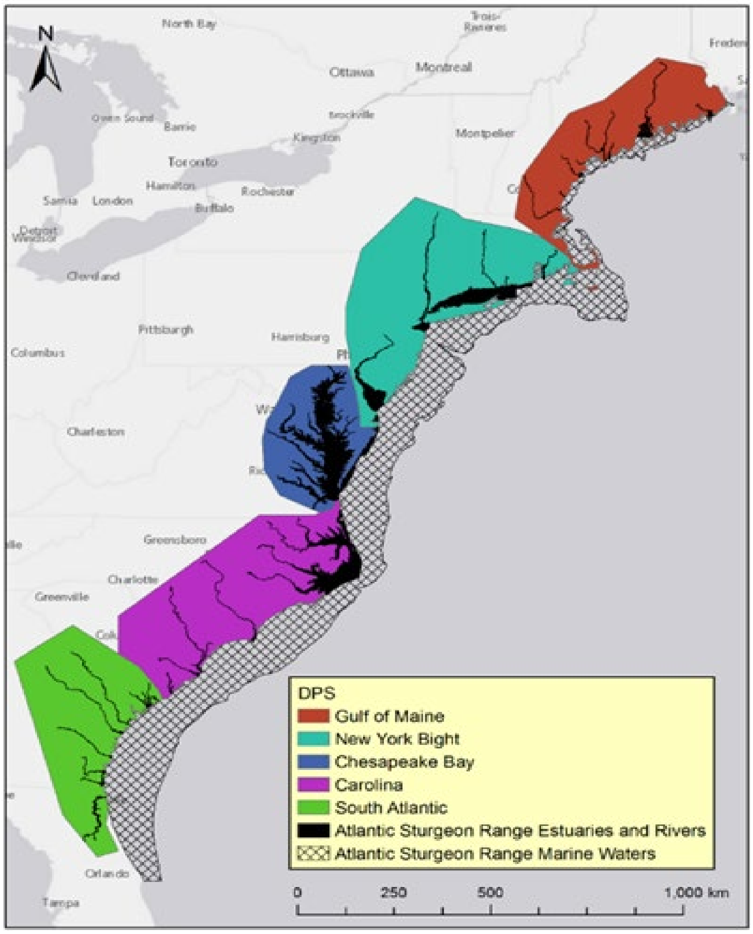

Figure 8. U.S. range of Atlantic sturgeon DPSs

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), as well as the 5-Year Reviews for the Gulf of Maine, New York Bight, and Chesapeake Bay DPSs (NMFS, 2022a, b, c) were used to summarize the life history, population dynamics, and status of the species.

3.3.2 Atlantic Sturgeon Life History

Atlantic sturgeon size at sexual maturity varies with latitude with individuals reaching maturity in the Saint Lawrence River at 22 to 34 years (Scott and Crossman, 1973). Atlantic sturgeon spawn in freshwater but spend most of their adult life in the marine environment. Spawning adults generally migrate upriver in May through July in Canadian systems (Bain, 1997; Caron et al., 2002; Murawski and Pacheco, 1977; Smith, 1985; Smith and Clugston, 1997). Atlantic sturgeon spawning is believed to occur in flowing water between the salt front and fall line of large rivers at depths of three to 27 meters (Bain et al., 2000; Borodin, 1925; Crance, 1987; Leland, 1968; Scott and Crossman, 1973). Atlantic sturgeon likely do not spawn every year; spawning intervals range from one to five years for males (Caron et al., 2002; Collins et al., 2000; Smith, 1985) and two to five years for females (Stevenson and Secor, 2000; Van Eenennaam et al., 1996; Vladykov and Greeley, 1963).

The life stages of Atlantic sturgeon can be divided up into six general categories as described in Table 3 below.

Table 3. Descriptions of Atlantic sturgeon life history stages. The size ranges are only guidelines for the life stages, which are more dependent on behavior (e.g., if a sturgeon is measured to be <760 mm total length, but is reported to have traveled in offshore marine waters, it is most likely a subadult and not a juvenile). See https://media.fisheries.noaa.gov/dam-migration/ans_life_stage_behavior_descriptions_20191029_508.pdf for more information.

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)	~6 mm - 14 mm (Bath *et al.* 1981, pp. 714-715)	8-12 days post hatch (ASSRT 2007, p.4)	Negative photo-taxis; nourished by yolk sac
Post yolk-sac larvae (PYSL)	~14 mm - 37 mm (Bath *et al.* 1981, p.. 714-715)	12-40 days post hatch	Free swimming; feeding; silt/sand bottom, deep channel; fresh water
Young of Year (YOY)	0.3 grams <410 mm total length	From 40 days to 1 year	Fish that are >3 months and <1 year old; capable of capturing and consuming live food
Juveniles	>410 mm and <760 mm total length	1 year to time at which first coastal migration is made	Fish that are at least 1 year old, are not sexually mature, and do not make coastal migrations.
Subadults	>760 mm and <1,500 mm total length	From first coastal migration to sexual maturity	Fish that are not sexually mature, but make coastal migrations
Adults	>1,500 mm total length	Post-maturation	Fish that are sexually mature

Sturgeon eggs are highly adhesive and are deposited on the bottom substrate, usually on hard surfaces (Gilbert, 1989; Smith and Clugston, 1997) between the salt front and fall line of large rivers (Bain et al., 2000; Borodin, 1925; Crance, 1987; Scott and Crossman 1973). Following spawning in northern rivers, males may remain in the river or lower estuary until the fall; females typically exit the rivers within four to six weeks (Savoy and Pacileo, 2003). Hatching occurs approximately 94 to 140 hours after egg deposition at temperatures of 20 and 18 degrees Celsius, respectively (Theodore et al., 1980).

Hatchlings (called free embryos) have a yolk sac that provides nourishment (endogenous feeding) during the first stage of larval development. Hatchlings are assumed to undertake a demersal existence, seek cover in the bottom substrate and yolk sac larvae (i.e., free embryos less than 4 weeks old, with total lengths (TL) less than 30 mm; Van Eenennaam et al., 1996) are assumed to inhabit the same riverine or estuarine areas where they were spawned (Kynard and Horgan 2002; Bain et al. 2000). The free embryo exhaust the yolk sac and become (post yolk sac) larvae after about eight days (Kynard and Horgan, 2002). Post yolk sac larvae drift downstream where they eventually settle, become demersal, and start foraging in freshwater reaches above the salt front (Kynard and Horgan, 2002).

Studies suggest that age-0 (i.e., young-of-year), age-1, and age-2 juvenile Atlantic sturgeon occur in low salinity waters of the natal estuary (Hilton et al., 2016) while older fish are more salt tolerant and occur in higher salinity waters as well as low salinity waters (Hilton et al., 2016; Collins et al., 2000). Atlantic sturgeon remain in the natal estuary for months to years before emigrating to open ocean as subadults (ASSRT, 2007; Dadswell, 2006; Dovel and Berggren, 1983; Hilton et al., 2016). Juvenile Atlantic sturgeon feed on aquatic insects, insect larvae, and other benthic invertebrates (ASSRT, 2007; Guilbard et al., 2007; Bigelow and Schroeder, 1953).

Upon reaching the subadult phase, individuals move to coastal and estuarine habitats (Dovel and Berggren, 1983; Murawski and Pacheco, 1977; Smith, 1985; Stevenson, 1997). Tagging and genetic data indicate that subadult and adult Atlantic sturgeon travel widely once they emigrate from rivers. Despite extensive mixing in coastal waters, Atlantic sturgeon exhibit high fidelity to their natal rivers (Grunwald et al., 2008; King et al., 2001; Waldman et al., 2002). Because of high natal river fidelity, it appears that most rivers support independent populations (Grunwald et al., 2008; King et al., 2001; Waldman and Wirgin, 1998; Wirgin et al., 2002; Wirgin et al., 2000). Atlantic sturgeon feed primarily on polychaetes, isopods, American sand lances and amphipods in the marine environment, while in fresh water they feed on oligochaetes, gammarids, mollusks, insects, and chironomids (Guilbard et al., 2007; Johnson et al., 1997; Moser and Ross, 1995; Novak et al., 2017; Savoy, 2007).

Based on fishery-independent, fishery dependent, tracking, and tagging data, Atlantic sturgeon appear to primarily occur inshore of the 50 meter depth contour (Stein et al., 2004a; Stein et al., 2004b; Laney et al., 2007; Dunton et al., 2010; Erickson et al., 2011; Dunton et al., 2015; Waldman et al., 2013; O'Leary et al., 2014; Wirgin et al., 2015a; Wirgin et al., 2015b). However, they are not restricted to these depths and excursions into deeper (e.g., 75 m) continental shelf waters have been documented (Timoshkin, 1968; Collins and Smith, 1997; Colette, 2002; Stein et al., 2004a; Dunton et al., 2010; Erickson et al., 2011). Data from fishery-independent surveys and tagging and tracking studies also indicate that some Atlantic sturgeon may undertake seasonal movements along the coast (Erickson et al., 2011; Dunton et al., 2010;

Wippelhauser et al., 2012; Oliver et al., 2013; Post, 2014; Hilton et al., 2016). 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 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 20 meters (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 25 meters (Bain et al., 2000; Stein et al., 2004a; Laney et al., 2007; Dunton et al., 2010; Erickson et al., 2011; Oliver et al., 2013; Waldman et al., 2013; O'Leary et al., 2014; Wippelhauser et al., 2012; Wippelhauser et al., 2015; Savoy and Pacileo, 2003). 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 refuge, wintering sites, or marine foraging areas (Stein et al., 2004a; Dunton et al., 2010; Erickson et al., 2011).

Water temperature plays a primary role in triggering the timing of spawning migrations (Hilton et al., 2016). Spawning migrations generally occur during February-March in southern systems, April-May in Mid-Atlantic systems, and May-July in Canadian systems (Hilton et al., 2016). Male sturgeon begin upstream spawning migrations when waters reach approximately 6° C (43° F) (Hilton et al., 2016), and remain on the spawning grounds throughout the spawning season (Bain, 1997). Females begin spawning migrations when temperatures are closer to 12° C to 13° C (54° to 55° F) (Dovel and Berggren, 1983; Smith, 1985), make rapid spawning migrations upstream, and quickly depart following spawning (Bain, 1997). Females may leave the estuary and travel to other coastal estuaries until outmigration to marine waters in the fall (Smith et al., 1982; Dovel and Berggren, 1983; Smith, 1985; Bain, 1997; Bain et al., 2000; Greene et al., 2009; Balazik et al., 2012; Breece et al., 2013; NMFS, 2017; Hatin et al., 2002). Following spawning, males move downriver to the lower estuary and remain there until outmigration in the fall (Smith et al., 1982; Dovel and Berggren, 1983; Smith, 1985; Bain, 1997; Bain et al., 2000; Hatin et al., 2002; Greene et al., 2009; Balazik et al., 2012; Breece et al., 2013; Ingram et al., 2019).

3.3.2.1 Population Dynamics

A population estimate was derived from the NEAMAP trawl surveys.[12] For this 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) 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

[12] 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.

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 Table 16 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 4). 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; however, those segments of the Atlantic sturgeon populations are at minimal risk from the proposed actions since they are rare within the action area. 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 4. Calculated Atlantic sturgeon 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)
Gulf of Maine	7,455	1,864	5,591
New York Bight	34,566	8,642	25,925
Chesapeake Bay	8,811	2,203	6,608
Carolina	1,356	339	1,017
South Atlantic	14,911	3,728	11,183
Canada	678	170	509
Total	67,776		

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.

3.3.3 Status of Atlantic Sturgeon

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 expected to be 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 10 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. A first-of-its-kind climate vulnerability assessment, conducted on 82 fish and invertebrate species in the Northeast U.S. Shelf, concluded that Atlantic sturgeon from all five DPSs were among the most vulnerable species to global climate change (Hare et al., 2016).

The ASMFC completed an Atlantic sturgeon benchmark stock assessment in 2017 that considered the status of each DPS individually, as well as all five DPSs collectively as a single unit (ASMFC, 2017). The assessment concluded all five DPSs of Atlantic sturgeon, as well as each individual DPS remain depleted relative to historic abundance. The assessment also concluded that the population of all five DPSs together appears to be recovering slowly since implementation of a complete moratorium on directed fishing and retention in 1998. However, there were only two individual DPSs, the New York Bight DPS, and Carolina DPS, for which there was a relatively high probability that abundance of the DPS has increased since the implementation of the 1998 fishing moratorium. There was considerable uncertainty expressed in the stock assessment and in its peer review report. For example, new information suggests that these conclusions about the New York Bight DPS primarily reflect the status and trend of only the DPS's Hudson River spawning population. In addition, there was a relatively high probability that mortality for animals of the Gulf of Maine DPS and the Carolina DPS exceeded the mortality threshold used for the assessment. Yet, the stock assessment notes that it was not clear if: (1) the percent probability for the trend in abundance for the Gulf of Maine DPS is a reflection of the actual trend in abundance or of the underlying data quality for the DPS; and (2) the percent probability that the Gulf of Maine DPS exceeds the mortality threshold actually reflects lower survival or was due to increased tagging model uncertainty owing to low sample sizes and potential emigration. Therefore, while Atlantic sturgeon populations may be showing signs of slow recovery since the 1998 and 1999 moratoriums when all five DPSs are considered collectively, these trends are not necessarily reflected with individual DPSs and there is considerable uncertainty related to population trends (ASMFC, 2017).

3.3.3.1 Gulf of Maine DPS of Atlantic Sturgeon

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 habitat is available and accessible in the Penobscot, Androscoggin, Kennebec, Merrimack, and Piscataqua (inclusive of the Cocheco and Salmon Falls rivers) rivers. As described more fully in section 3.3.4, 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 the Androscoggin River (NMFS, 2018).

Bigelow and Schroeder (1953) surmised that Atlantic sturgeon likely spawned in Gulf of Maine Rivers in May-July. More recent captures of Atlantic sturgeon in spawning condition within the Kennebec River suggest that spawning more likely occurs in June-July (ASMFC, 1998; NMFS and USFWS, 1998; Wippelhauser et al., 2017). Evidence for the timing and location of Atlantic sturgeon spawning in the Kennebec River includes: (1) the capture of five adult male Atlantic sturgeon in spawning condition (*i.e.*, expressing milt) in July 1994 below the (former) Edwards Dam; (2) capture of 31 adult Atlantic sturgeon from June 15, 1980, through July 26, 1980, in a small commercial fishery directed at Atlantic sturgeon from the South Gardiner area (above Merrymeeting Bay) that included at least four ripe males and one ripe female captured on July 26, 1980; (3) capture of nine adults during a gillnet survey conducted from 1977-1981, the majority of which were captured in July in the area from Merrymeeting Bay and upriver as far as Gardiner, ME (ASMFC, 2007; NMFS and U.S. FWS, 1998); and (4) the capture of three Atlantic sturgeon larvae between rkm 72 and rkm 75 in July 2011 (Wippelhauser et al., 2017). The low salinity values for waters above Merrymeeting Bay are consistent with values found in rivers where successful Atlantic sturgeon spawning is known to occur.

At this time, there is no evidence of recent spawning in the remaining rivers in the Gulf of Maine DPS. 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; Wippelhauser et al. 2017).

Several threats play a role in shaping the current status of Gulf of Maine DPS Atlantic sturgeon. Historical records provide evidence of commercial fisheries for Atlantic sturgeon in the Kennebec and Androscoggin Rivers dating back to the 17th century (Squiers and Smith, 1979). In 1849, 160 tons of sturgeon was caught in the Kennebec River by local fishermen (Squiers and Smith, 1979). Following the 1880s, the sturgeon fishery was almost non-existent due to a collapse of the sturgeon stocks. All directed Atlantic sturgeon fishing as well as retention of Atlantic sturgeon bycatch has been prohibited since 1998. Nevertheless, mortalities associated with bycatch in fisheries occurring in state and federal waters still occurs. In the marine range, Gulf of Maine DPS Atlantic sturgeon are incidentally captured in federal and state-managed fisheries, reducing survivorship of subadult and adult Atlantic sturgeon (ASMFC, 2007; Stein et al., 2004a). Subadults and adults are killed as a result of bycatch in fisheries authorized under Northeast Fishery Management Plans (FMPs). At this time, we are not able to quantify the impacts from this and other threats or estimate the number of individuals killed as a result of anthropogenic threats. Habitat disturbance and direct mortality from anthropogenic sources are the primary concerns.

Riverine habitat may be impacted by dredging and other in-water activities, disturbing spawning habitat, and also altering the benthic forage base. Many rivers in the Gulf of Maine DPS have navigation channels that are maintained by dredging. Dredging outside of Federal channels and in-water construction occurs throughout the Gulf of Maine DPS. While some dredging projects operate with observers present to document fish mortalities, many do not. To date, we have not received any reports of Atlantic sturgeon killed during dredging projects in the Gulf of Maine region; however, as noted above, not all projects are monitored for interactions with fish. At this time, we do not have any information to quantify the number of Atlantic sturgeon killed or disturbed during dredging or in-water construction projects. We are also not able to quantify any effects to habitat.

Connectivity is disrupted by the presence of dams on some rivers in the Gulf of Maine region, including the Penobscot and Merrimack Rivers. While there are also dams on the Kennebec, Androscoggin, and Saco Rivers, these dams are near the site of natural falls and likely represent the maximum upstream extent of sturgeon occurrence even if the dams were not present. Because no Atlantic sturgeon are known to occur upstream of any hydroelectric projects in the Gulf of Maine region, passage over hydroelectric dams or through hydroelectric turbines is not a source of injury or mortality in this area. While not expected to be killed or injured during passage at the dam, the extent that Atlantic sturgeon are affected by the existence of dams and their operations in the Gulf of Maine region is currently unknown. The tracking of spawning condition Atlantic sturgeon downstream of the Brunswick Dam in the Androscoggin River suggests however, that Atlantic sturgeon spawning may be occurring in the vicinity of at least that project and therefore, may be affected by project operations. Until it was breached in July 2013, the range of Atlantic sturgeon in the Penobscot River was limited by the presence of the Veazie Dam. Since the removal of the Veazie Dam and the Great Works Dam, sturgeon can now travel as far upstream as the Milford Dam. Atlantic sturgeon primarily occur within the mesohaline reach of the river, particularly in areas with high densities of sturgeon prey which means that the Penobscot River is likely an important foraging area for Atlantic sturgeon belonging to the Gulf of Maine DPS (Altenritter et al., 2017). There is no current evidence that spawning is occurring in the Penobscot River. Acoustic tag detections suggest that the adults that forage in the Penobscot River travel to the Kennebec River to spawn (Altenritter et al., 2017). The Essex Dam on the Merrimack River blocks access to approximately 58 percent of historically accessible habitat in this river. Atlantic sturgeon occur in the Merrimack River but spawning has not been documented. Like the Penobscot, it is unknown how the Essex Dam affects the likelihood of spawning occurring in this river.

Gulf of Maine DPS Atlantic sturgeon may also be affected by degraded water quality. In general, water quality has improved in the Gulf of Maine over the past decades (EPA, 2008; Lichter et al., 2006). Many rivers in Maine, including the Kennebec River, were heavily polluted in the past from industrial discharges from pulp and paper mills. While water quality has improved and most discharges are limited through regulations, many pollutants persist in the benthic environment. This can be particularly problematic if pollutants are present on spawning and nursery grounds, as developing eggs and larvae are particularly susceptible to exposure to contaminants.

The threat of vessel strike appears to be less for Atlantic sturgeon belonging to the Gulf of Maine DPS compared to the New York Bight or Chesapeake Bay DPSs based on the number of Atlantic sturgeon vessel struck carcasses that are found in Gulf of Maine Rivers, and given the differences in vessel activity in the respective natal rivers. Nevertheless, some strikes do occur within the Gulf of Maine and sturgeon belonging to the Gulf of Maine can also be struck in other areas of their range including higher salinity waters of the Hudson River Estuary, Delaware River Estuary, and Chesapeake Bay.

We described in the listing rule that potential changes in water quality as a result of global climate change (temperature, salinity, dissolved oxygen, contaminants, etc.) in rivers and coastal waters inhabited by Atlantic sturgeon will likely affect riverine populations, and we expected these effects to be more severe for southern portions of the U.S. range. However, new information shows that the Gulf of Maine is one of the fastest warming areas of the world as a result of global climate change (Brickman et al., 2021; Pershing et al., 2015). Markin and Secor (2020) further demonstrate the effects of temperature on the growth rate of juvenile Atlantic sturgeon, and informs how global climate change may impact growth and survival of Atlantic sturgeon across their range. Their study showed that all juvenile Atlantic sturgeon had increased growth rate with increased water temperature regardless of their genetic origins. However, based on modeling and water temperature data from 2008 to 2013, they also determined that there is an optimal water temperature range, above and below which juveniles experience a slower growth rate, and they further considered how changes in growth rate related to warming water temperatures associated with global climate change might affect juvenile survival given the season (e.g., spring or fall) in which spawning currently occurs.

There are no abundance estimates for the Gulf of Maine DPS or for the Kennebec River spawning population. Wippelhauser and Squiers (2015) reviewed the results of studies conducted in the Kennebec River System from 1977-2001. In total, 371 Atlantic sturgeon were captured, but the abundance of adult Atlantic sturgeon in the Kennebec spawning population could not be estimated because too few tagged fish were recaptured (i.e., 9 of 249 sturgeon).

Another method for assessing the number of spawning adults is through determinations of effective population size, which measures how many adults contributed to producing the next generation based on genetic determinations of parentage from the offspring. Effective population size is always less than the total abundance of a population because it is only a measure of parentage, and it is expected to be less than the total number of adults in a population because not all adults successfully reproduce. Measures of effective population size are also used to inform whether a population is at risk for loss of genetic diversity and inbreeding. The effective population size of the Gulf of Maine DPS was assessed in two studies based on sampling of adult Atlantic sturgeon captured in the Kennebec River in multiple years. The studies yielded very similar results which were an effective population size of: 63.4 (95% CI=47.3-91.1) (ASMFC, 2017) and 67 (95% CI=52.0–89.1) (Waldman et al., 2019).

3.3.3.2 Summary of the Gulf of Maine DPS of Atlantic Sturgeon

Spawning for the Gulf of Maine DPS is known to occur in the Kennebec River and may occur in the Androscoggin. Spawning may be occurring in other rivers, such as the Penobscot, but has not been confirmed. In the Stock Assessment, the Commission concluded that the abundance of the Gulf of Maine DPS is "depleted" relative to historical levels and there is a 51 percent probability that abundance of the Gulf of Maine DPS has increased since implementation of the 1998 fishing moratorium (ASMFC, 2017). The Commission also noted that the Gulf of Maine is particularly data poor among all five DPSs. Atlantic sturgeon continue to be present in the Kennebec River; in addition, they are captured in directed research projects in the Penobscot River, and are observed in rivers where they were unknown to occur or had not been observed to occur for many years (e.g., the Saco, Presumpscot, and Charles rivers). The Saco River supports a large aggregation of Atlantic sturgeon that forage on sand lance in Saco Bay and within the first few kilometers (km) of the Saco River, primarily from May through October. Detections of acoustically-tagged sturgeon indicate that both adult and subadult Atlantic sturgeon use the area for foraging and come back to the area year after year (Little, 2013; Novak et al., 2017). Some sturgeon also overwinter in Saco Bay (Hylton et al., 2018; Little, 2013) which suggests that the river provides important wintering habitat as well, particularly for subadults. However, none of the new information indicates recolonization of the Saco River for spawning. It remains questionable whether sturgeon larvae could survive in the Saco River even if spawning were to occur because of the presence of the Cataract Dam at rkm 10 of the river (Little, 2013) which limits access to the freshwater reach. Some sturgeon that spawn in the Kennebec have subsequently been detected foraging in the Saco River and Bay (Novak et al., 2017; Wippelhauser et al., 2017).

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). 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 Gulf of Maine DPS are not commonly taken as bycatch in areas south of Chatham, Massachusetts, with only 8 percent (e.g., 7 of 84 fish) of interactions observed in the New York 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., 2012). Thus, a significant number of the GOM DPS fish appear to migrate north into Canadian waters where they may be subjected to a variety of threats including bycatch. Dadswell et al. (2016) describes characteristics of the seasonal aggregation of sturgeon in the Bay of Fundy. Dadswell et al. does not identify the natal origin of each of the 1,453 Atlantic sturgeon captured and sampled for their study. However, based on Wirgin et al. (2012) and Stewart et al. (2017), NMFS considers the results of Dadswell et al. as representative of the movement of the Gulf of Maine DPS of Atlantic sturgeon. Dadswell et al. determined subadult and adult Atlantic sturgeon occur seasonally (approximately May to September) in the Bay of Fundy for foraging, and many return in consecutive years. Fork length (FL) of the 1,453 sampled sturgeon ranged from 45.8 to 267 cm, but the majority (72.5 percent) were less than 150 cm FL. The age of the sturgeon (i.e., 4 to 54 years old) is also indicative of the two different life stages. Detailed seasonal movements of sturgeon to and from the Bay of Fundy are described in Beardsall et al. (2016).

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; Brown and Murphy, 2010; ASMFC, 2007; Kahnle et al., 2007). We have 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.

In 2018, we announced the initiation of a 5-year review for the Gulf of Maine DPS. We reviewed and considered new information for the Gulf of Maine DPS that has become available since this DPS was listed as threatened in February 2012. We completed the 5-year review for the Gulf of Maine DPS in February 2022. Based on the best scientific and commercial data available at the time of the review, we concluded that no change to the listing status is warranted.

3.3.3.3 Atlantic Sturgeon 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.

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 Benton Falls Project. The consequences to listed species or designated critical habitat from ongoing agency activities or existing agency facilities that are not within the agency's discretion to modify are part of the environmental baseline; 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 Sebasticook River from the upper extent of the project impoundment downstream to its confluence with the Kennebec River. Past impacts of the operation of the Benton Falls Project is considered in the Environmental Baseline. State, Federal, and private actions in other areas of the Sebasticook 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 in the Action Area

A summary of the status of the species range wide and designated critical habitat in its entirety was provided above. This section will focus on the status of Atlantic salmon in the action area. The Sebasticook River is a major tributary to the Kennebec River, which supports a naturally reared run of Atlantic salmon and a stocking program. However, the Sebasticook River is not within designated critical habitat for the GOM DPS, and is not currently managed for Atlantic salmon.

According to the Benton Comprehensive Plan[13] (2008), although the existing Benton Falls dam wasn't completed until 1987, there has been a dam at the site since the 1700s, which has significantly affected sea-run fish, particularly alewives and American shad:

> Alewives and Shad were the predominant fish caught, but salmon were caught in smaller quantities due to less than adequate spawning grounds in the Sebasticook River. In 1817, fishing privileges were auctioned off so that sections of the river were sold to individuals. Dams, which provided the power to the mills, conflicted with fishing. The first dam, erected at the upper falls in Benton Falls was built before the Revolutionary War. It provided a gap for fish to continue upstream/downstream through the dam. In 1809, a second dam was built at the lower falls, with no fish way. It so hindered the fishing that six years later the selectmen had it removed. The construction of the dam in Augusta, with no provisions for the passage of fish, doomed the future of fishing in town.

As described in section 3, the Kennebec River contains abundant high quality spawning and rearing habitat for Atlantic salmon, mostly in the Sandy River. The Sebasticook River, however, is generally believed to have lower quality habitat. As indicated above, even prior to dam construction, few salmon were caught in the Sebasticook, likely due to a lack of suitable spawning habitat. The *Biological valuation of Atlantic salmon habitat within the Gulf of Maine Distinct Population Segment* (NMFS, 2009) classifies the Sebasticook drainage as low quality (score of 1), which means that it is expected to be roughly a third as suitable as fully functional habitat. There are no records of salmon being stocked in the Sebasticook, and there is minimal natural production as very few salmon return to the watershed. However, Atlantic salmon returning to habitat where they were stocked or naturally reared in the upper Kennebec River do occasionally enter the Sebasticook and are trapped at the Benton Falls fishway. As such, we assume that both juvenile and adult salmon could be present in the action area.

Until 1999, passage of sea-run fish into the Sebasticook was significantly hindered by the presence of two additional dams; the Edwards Dam on the mainstem Kennebec, and the Fort Halifax Dam on the Sebasticook near its confluence with the Kennebec. Those two dams were removed in 1999 and 2008, respectively, which has allowed for the restoration of a large alewife run, and access to the river for both American shad and Atlantic salmon (Table 5). Since the removal of the Fort Halifax Dam, salmon were passed at the Benton Falls Project in 4 of 15 passage seasons. Since the construction of the fishway in 2008, only 13 Atlantic salmon have passed into the Sebasticook, for an average of less than one salmon a year (MDMR, 2022; USASAC, 2010, 2011, 2012, 2023). As stocking does not occur in the Sebasticook, it is expected that all of these fish were strays from the Kennebec. The relative increase in returns to the Sebasticook in 2022 and 2023 is likely attributable to smolt stocking that occurred in the mainstem Kennebec in the vicinity of the confluence.

Table 5. Sea run fish returns to the Sebasticook River as documented at the Benton Falls fish lift

[13] https://www.maine.gov/local/towninfo.php?t=36&p=1025

since its construction in 2008.

	Atlantic Salmon	American Shad	River Herring
2009	4	UNK	UNK
2010	0	UNK	UNK
2011	0	UNK	UNK
2012	0	163	1,703,820
2013	1	113	2,272,492
2014	0	26	2,378,906
2015	0	47	2,158,769
2016	0	18	3,128,753
2017	0	65	3,547,091
2018	0	26	5,579,901
2019	0	114	3,287,702
2020	0	10	2,847,171
2021	0	7	3,552,813
2022	5	9	2,803,248
2023*	3	2	4,154,124
Average	1	50	3,117,899

*2023 data is preliminary and is reported on the Maine DMR website (https://www.maine.gov/dmr/fisheries/sea-run-fisheries/programs-and-projects/trap-count-statistics). Documented as of July 27, 2023.

Given the limited number of fish, it is unknown where, or if, the adult salmon that passed Benton Falls may have spawned. However, it is possible that they located suitable spawning habitat and made use of it. Maine DMR conducted spawning and rearing habitat surveys between 1983 and 2020 throughout much of the Kennebec River basin, including within the Sebasticook watershed between the Benton Falls and Pioneer Dams (Figure 9).[14] Although none was mapped in the action area, spawning habitat was documented in the mainstem approximately 6-km upstream of the Benton Falls Dam (1,632 units); in Twentyfive Mile Stream approximately 16-km upstream of the dam (717 units); and downstream of the Pioneer Dam (4,906 units) approximately 26-km upstream. We don't expect most of the surveyed habitat to function fully as it occurs in the warm mainstem, but given the field mapping it is probable that the habitat could support the production of some number of smolts. Similarly, the field surveys documented habitat throughout this section of the Sebasticook that would likely support the rearing of juvenile salmon; although no rearing habitat was documented in the action area. As indicated above, a model developed by USFWS and NMFS, has identified approximately 25,000 habitat units in the Sebasticook River (Wright et al., 2008). The model indicates that there are approximately 2,000 habitat units of mainstem rearing habitat in the action area, and that additional habitat likely occurs in the tributaries the mainstem.

[14] Maine Department of Marine Resources. 2017. Atlantic salmon Habitat (ASHAB). Updated March 17, 2021. Accessed through Maine Office of GIS Data Catalog: https://maine.hub.arcgis.com/datasets/1cd03b001cec43e1b33b87f7af3063e8/explore?location=45.232742%2C-69.119381%2C7.38

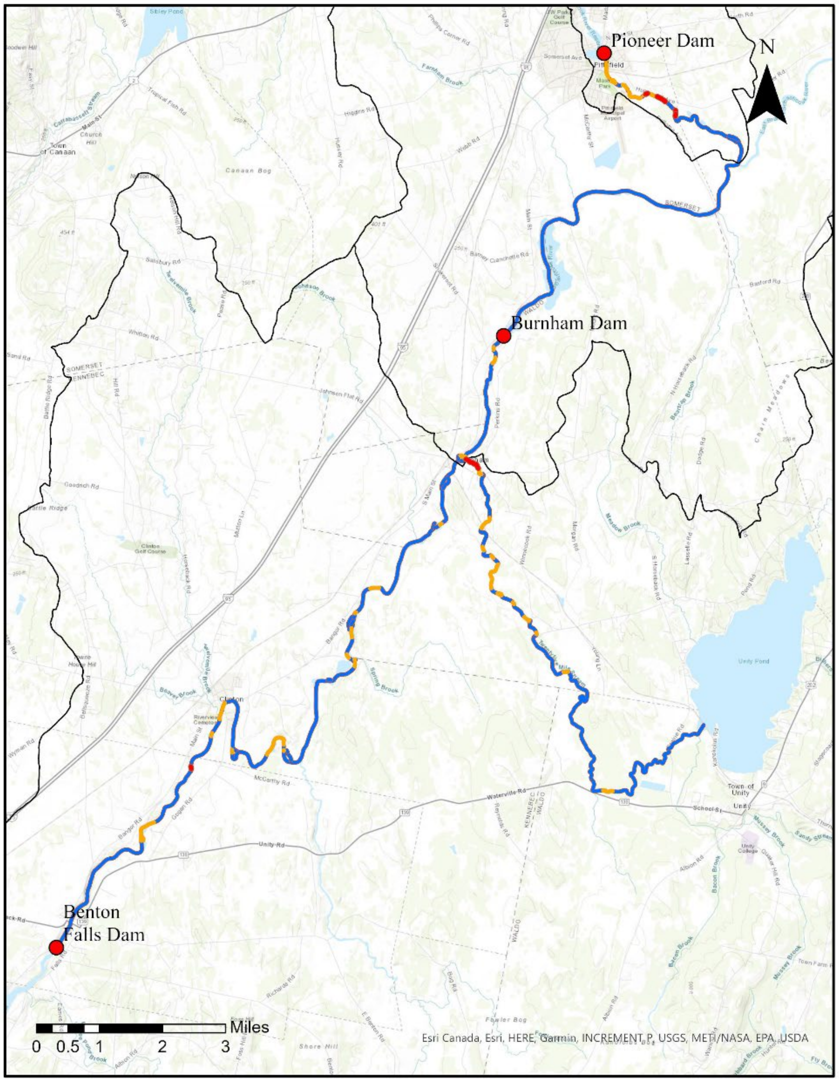

Figure 9. Field surveyed rearing and spawning habitat within the Sebasticook River (MDMR, 2017). The blue line represents areas that were surveyed; the orange areas have been identified as rearing habitat; and the red areas have been identified as potential spawning habitat. It is probable that unsurveyed tributaries also contain habitat characteristics that would support spawning and rearing.

No stocking of juvenile Atlantic salmon occurs in the Sebasticook River. Natural production of juveniles may have occurred in the years when more than one salmon passed Benton Falls (2009, 2022, and 2023), with any resulting smolts potentially leaving the system in 2011, 2024, and 2025. However, in general, we expect that few juvenile salmon are produced in the action area, and that even fewer survive to migrate through the action area as smolts. If Atlantic salmon runs increase in the Kennebec River, we expect that more salmon will stray to the habitat in the Sebasticook, which would increase the probability that adult and juvenile salmon (smolts) would be migrating through the action area.

4.2 Status of Shortnose Sturgeon in the Action Area

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). The historical upstream extent of shortnose sturgeon in the Kennebec is considered to be Ticonic Falls (river kilometer 103, the current location of the Lockwood Dam) (NMFS & USFWS, 1998). While the range of shortnose sturgeon only overlaps with the small portion of the action area downstream of the Benton Falls Dam, information on use of the Kennebec River generally is presented here for context. We currently have no information on the use of the Sebasticook River by shortnose sturgeon; however, there is nothing preventing them for accessing the action area below the dam and shortnose sturgeon are known to occur in the lower reaches of other tributaries; therefore, it is reasonable to expect that at least occasional shortnose sturgeon occur in the action area.

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, it does not include an estimate of the size of the juvenile population. A comparison of the population estimate for the estuarine complex from 1981 (Squiers et al., 1982) to 2000 (MDMR, 2003) suggests that the adult population grew by approximately 30% between 1981 and 2000. In 1999, the removal of the Edwards Dam on the mainstem of the Kennebec River opened up an additional 29 rkm of habitat, restoring access to the presumed historical spawning habitat. Use of this area has been documented and is considered to have possibly facilitated even further recruitment into this river (Wippelhauser et al., 2015). Tagging and tracking studies indicate that some Kennebec River fish migrate to the Penobscot River but return to the Kennebec River to spawn. It is hypothesized that this may be a result of increased competition for estuarine foraging resources in the Kennebec River due to increased population size (Altenritter et al. 2018). It is currently unknown if the Kennebec River population of shortnose sturgeon is continuing to increase; however, there are no indications that it has decreased from the 1998-2000 population estimate. As such, we consider the population to at least be stable 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.

4.2.1.1 Spawning in the Kennebec River

In 1999, the Edward's Dam (river kilometer 74), which represented the first significant impediment to the northward migration of shortnose sturgeon in the Kennebec River, was removed. The Lockwood Dam continues to operate, though it is not thought to impede shortnose access to historic habitat given its location at Ticonic Falls (river kilometer 103), the presumed historic upstream extent of shortnose in the Kennebec River. Similarly, Benton Falls is thought to be the upstream extent on the Sebasticook River. Thus, with the removal of the Edwards and Fort Halifax dams almost 100% of historic habitat is now accessible. Since the removal of the Edwards Dam, shortnose sturgeon have been documented just downstream of the Lockwood Dam (river kilometer 103) indicating this habitat is being utilized (Wippelhauser et al., 2015). Sturgeon have not been observed in the vicinity of the Benton Falls Dam nor in the Sebasticook River itself (Gray, N. MDMR. Personal Communication. Email dated 8/3/2023).

Wippelhauser and Squiers (2015) summarized field studies on shortnose and Atlantic sturgeon from 1977-2001 in the Kennebec River system that sought to produce population estimates and documentation of spawning, overwintering, and foraging habitat. Based on the capture of 172 adult shortnose sturgeon between May 1-31 over a period of 22 years (including two ripe males releasing sperm during handling) from river kilometer 47.5-74 in the Kennebec River, they identified spawning run timing and potential spawning habitat. Maine DMR conducted ichthyoplankton surveys from 1996 through 2001. Sampling sites were located both above and below the dam and were surveyed using surface tows with plankton nets and stationary sets with D-shaped plankton nets. Through these efforts, researchers captured 54 eggs and 10 larvae at two sampling locations (river kilometer 65 and 72.7), confirming that spawning occurs in that 9 river kilometer stretch below the former Edwards Dam (Wippelhauser and Squiers, 2015).

Between 2007 and 2013, Wippelhauser et al. (2015) tagged 134 adult shortnose sturgeon throughout the Gulf of Maine (Penobscot, Kennebec, Saco, and Merrimack). Twenty-one (20%) of 104 shortnose sturgeon tagged in the Penobscot River, two (50%) of four tagged in the Kennebec system, one (50%) of two tagged in the Saco River, and 16 (37%) of 43 tagged in the Merrimack River moved into the Kennebec system and made suspected spawning runs. These adults displayed two distinct prespawning behaviors. Some (~35%) emigrated to the Kennebec system in the summer or fall and overwintered one to two seasons before participating in a spring spawning run, while the majority (~65%) migrated to the Kennebec system in the early spring and participated in a spawning run that same year. Tagged shortnose were detected in spawning areas from April 7 through June 6 as water temperatures increased and discharge decreased. During this time, bottom temperatures in the Kennebec River ranged from 5.8-17.6 ºC and fish spent an average of 9.9-12.5 days in the spawning sites (varied by Kennebec location). Discharge when shortnose sturgeon were at the spawning areas was typically ≤558 m^3/s; however, flows reached as high as 1,487 m^3/s in some years. Spawning was documented for the first time in the restored portion of the Kennebec (above the former Edwards Dam (river kilometer 74)) between May 17-19, 2010, as two larvae were captured below the Lockwood Dam at rm 63.4 (river kilometer 102) using D-nets. Spawning was again confirmed below the former Edwards Dam with the capture of 23 larvae between river kilometer 64-72 in a sampling period from May 19-June 15, 2009, as well as the capture of seven larvae between rm 42-45 (river kilometer 67-73) in a sampling period from May 3-June 6, 2011 (Wippelhauser et al., 2015).

A study conducted by ERC in 2001 in preparation for the relicensing of the Lockwood project, determined that although suitable depths, temperatures and substrates exist within the Lockwood Project waters, suitable spawning area is likely limited by low water velocities, particularly in the bypassed reach. Although any spawning would occur during high spring flows, mean water column velocities within the deeper portions of the bypassed reach are relatively low (<0.5 feet/second) at both leakage and spillage flows, due to the inherent bedrock-ledge hydraulic controls that create the deep backwatered pool that occupies much of the bypassed reach. The only suitable water velocities within the project area are in the tailwaters below the project, but based upon all habitat characteristics, this reach is thought to contain only marginal spawning habitat (ERC, 2001).

4.2.1.2 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 Maine Department of Transportation (DOT), 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 (~river kilometer 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.

4.2.1.3 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. As noted above, the action area extends from the dam downstream to the confluence with the Kennebec River.

There is no evidence that sturgeon currently use the habitat within the action area. However, as there is no barrier preventing access, and as there is evidence that they use the habitat in the mainstem Kennebec just downstream, we assume that could occur in the area seasonally. Since 2008, electrofishing surveys have been conducted in the Kennebec River, including the lower Sebasticook River, but there have never been any sturgeon observed in the Sebasticook (MBI 2020).[15] Likewise, MDMR has indicated that sturgeon have never been observed at the Benton Falls Project or in the downstream reach. As such, we expect that any individuals in the area would likely be transient adults, subadults, or juveniles.

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 and Smith, 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 3.3.3. We currently have no information on the use of the Sebasticook River by Atlantic sturgeon; however, there is nothing preventing them for accessing the action area below the dam and Atlantic sturgeon are known to occur in the lower reaches of other tributaries; therefore, it is reasonable to expect that at least occasional Atlantic sturgeon occur in the action area.

4.3.1.1 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

[15] Midwest Biodiversity Institute (MBI). 2020. Letter to NMFS. Re: Application for an Incidental Take Permit (ITP) under the Endangered Species Act of 1973 – Lower Kennebec River Fish Assemblage Assessment – Revised July 1, 2020. https://s3.amazonaws.com/media.fisheries.noaa.gov/2020-11/MBI%202020%20ITP%20Application%20Lower%20Kennebec%20ME%20508%20REVISED%2020200701.pdf?null=

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).

4.3.1.2 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 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).

4.3.1.3 Expected Seasonal Distribution of Atlantic Sturgeon in the Action Area

As we described for shortnose sturgeon above, there is no evidence that Atlantic sturgeon currently use the habitat within the action area. However, as there is no barrier preventing access, and as there is evidence that they use the habitat in the mainstem Kennebec just downstream, we assume that could occur in the area seasonally. As they have not been documented in the action area, we expect that any individuals would likely be transient adults, subadults, or juveniles, and that they would not spend a significant amount of time in the action area.

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

4.4.1 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. No formal section 7 consultations have taken place for projects in the action area, or in the Sebasticook River.

4.4.1.1 Dams and Hydroelectric Facilities

There are three FERC-licensed dams within the lower Sebasticook River that are currently accessible to Atlantic salmon (i.e., Pioneer Dam on the West Branch, Burnham Dam, and Benton Falls Dam on the mainstem). Of these, only the Benton Falls Project is within the action area of this consultation. The effects of the proposal to amend the license for the Benton Falls Project is the subject of this Opinion; therefore, we will analyze the future effects over the remainder of the existing license under the terms of the proposed SPP in the *Effects of the Action* section (section 6.0). However, as the project has been in place for over 35 years, it has affected listed salmon and sturgeon within the action area. Here, we will consider the past effects of the Benton Falls Project, including the effects to riverine processes (e.g., flow fluctuations, impoundments) and fish passage in the Sebasticook 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 consequences of the proposed action. Other effects are consequences of the operation of the projects to produce electricity or to pass fish, which will be modified by the proposed action, 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 has and will continue to affect the environmental baseline for the action.

Impoundment Effects

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 Sebasticook 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 Benton Falls Project operates as run-of-river and does not have significant fluctuations in headpond level, it does have a 2 mile long, 83-acre impoundment. As explained above, there have been very few years when more than two salmon have passed upstream of the project, therefore there has been limited opportunity for successful spawning to occur. Consequently, there are likely few smolts migrating downstream and smolt migration has not likely occurred every year. As no studies have been carried out, there is no information available regarding the survival of smolts through the project impoundment.

Reach-specific survival estimates for Atlantic salmon smolts have been made at six similar run-of-river dams in the GOM DPS by Brookfield Renewable (i.e., Brunswick and Pejepscot on the Androscoggin River; Lockwood, Hydro-Kennebec, and Shawmut on the Kennebec River; and the Ellsworth Project (excluding Graham Lake Dam) on the Union River). The information provided from these studies can be used to approximate the effect that the Benton Falls Dam impoundment would have on any Atlantic salmon smolts. Our analysis, as explained in our Biological Opinions for each of these projects, indicates that impoundment mortality is generally low, and in some cases cannot be distinguished from background levels (Accession # 20230320-5179, 20200227-5225, 20211228-5096, 20220124-5167). Considering the information from these projects, we expect that the average impoundment mortality can vary between 0% and 2.5%. Mortality rates likely vary significantly based on the project and river system, but lacking specific information for Benton Falls, we assume that the midpoint of this range (1.3%) is a reasonable estimate of the proportion of migrating smolts that could be killed during their migration in the Sebasticook River due to the effect of the project impoundment.

4.4.1.2 Fish Passage

The Benton Falls Project has both an upstream fishway and a downstream fishway and, as described previously, a limited number of adult salmon migrate upstream of the project.

Juvenile Atlantic salmon

The Benton Falls Project affects 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.

No empirical studies evaluating smolt survival have occurred at the Benton Falls Project; however, BFA hired Kleinschmidt Associates to conduct a desktop analysis to estimate smolt survival at the project (BFA 2022; FERC Accession # 20220104-5154). Their evaluation considered survival through turbine, bypass, and spill routes under high (10% flow exceedance), median (50% flow exceedance), and low (90% flow exceedance) flow conditions in the Sebasticook. Their baseline analysis estimated survival if the downstream fish bypass was not being operated during the smolt run (April 15-June 15), which is consistent with their current operation. Under these conditions, fish can only pass the project through the turbines or over the spillway. In their analysis, Kleinschmidt estimated that median smolt survival at the project is 92.9%, ranging between 90.3% and 94.7% at low and high flow, respectively, when the bypass isn't being operated. As would be expected, high flows lead to more spillway passage, which leads to a higher survival rate.

Injury

Some proportion of the salmon smolts that pass the Benton Falls Project are expected to 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. We have no information with which to evaluate passage-related injury rates at the Benton Falls Project. However, FPL Energy (2013) conducted a desktop analysis of injury rates for Kaplan-style turbines, similar to those present at the Benton Falls Project (FPL Energy, 2013; Accession #20130221-5160). Using injury rates from FPL (2013) and the route utilization predicted by Kleinschmidt's Smolt Survival Assessment (BFA, 2022; Accession # 20220104-5154), we estimate that the turbine entrainment-related injury rate at the Project is approximately 7.1% at low to median flows, but that it may be reduced to 3.7% at high flow when smolts would have access to the project spillway.[16]

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).

As there have not been any empirical studies of salmon in the Sebasticook, we do not have project specific information on smolt migratory delay at the Benton Falls Project. However, studies conducted at five dams on the Androscoggin and Kennebec Rivers can be used to approximate anticipated delay here. The average proportion of smolts delayed by more than 24 hours (once they come within 200 meters of the dam) at these projects is 7% (ranging between 5% and 9%).[17] It is likely that delay at this project is similar and therefore, on average, we expect that no more than 7% of salmon smolts would take longer than 24 hours to pass the Benton Falls Project once they approach within 200 meters.

<u>Hydrosystem Delayed Mortality</u>

In addition to direct mortality sustained by Atlantic salmon at the Benton Falls Project, smolts may exhibit delayed mortality in the estuary attributable to their experience at the project. Numerous studies have investigated what is referred to as latent or delayed mortality,[18] 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; Stevens, 2019; Stich et al., 2015; Storch et al., 2022).

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

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[16] Information derived from FPL (2013) Table 8 shows an average 7.1% injury rate through Kaplan turbines. BFA (BFA 2022) estimated that 100% of smolts would use the turbines at low and median flow, but that only 52% would at high flow.

[17] Information from Brookfield study reports for the Brunswick, Pejepscot, Lockwood, Hydro-Kennebec, and Shawmut, and summarized in our Biological Opinions for these projects (Accession # 20230320-5179, 20211228-5096, 20220124-5167), was used to develop this estimate. The Weston Project was excluded from this analysis, as the delay documented at that project was well outside of what would be considered typical.

[18] Hydrosystem delayed mortality is also referred to as latent mortality (Budy et al., 2002; Haeseker et al., 2012; ISAB, 2007; Schaller & Petrosky, 2007). For clarity, we will utilize the term delayed mortality throughout.

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 routes (e.g., 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.

A recent study by Storch et al. (2022) indicates that "while there are several factors that may dictate SARs [smolt to adult return rates] in any given year, the strong influence of hydrosystem effects is evident when comparing the success of populations in different subbasins throughout the system. Populations of yearling Chinook Salmon and steelhead in the Columbia River Basin that migrate past four or fewer mainstem dams survive at rates higher than those that must pass eight dams". They indicate that Chinook salmon that pass three or four dams in the Columbia River system have SAR rates that are nearly four times as high as those that have to pass eight dams; and nearly three times higher for steelhead (Storch et al., 2022). They attribute the cause of these much lower return rates to sub-lethal effects of dams that make it more difficult for juveniles to transition from freshwater to saltwater. Specifically, they indicate that "the condition of these fishes can be compromised by mechanical injury and stress during passage through bypass systems and turbines, with substantial delay in migration", and that "slowed outmigration may increase exposure to predation, competition, and elevated temperatures, thus increasing energetic costs and propensity for disease, and result in poorly timed estuary arrival" (Storch et al., 2022).

Although much of the research on hydrosystem delayed mortality has focused on Pacific salmon, studies have been conducted on the potential for it to affect Atlantic salmon in Maine. Stich et al. conducted an analysis on eight 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 10). They estimated that each dam passed in the Penobscot led to a mortality rate of 6% in the estuary, which is distinct from direct mortality that occurs in the freshwater environment. Similar to Storch et al. (2022), Stich et al. (2015) attributed the cause of this mortality to migratory delay and sublethal injuries (such as scale loss) sustained during dam passage. These effects make smolts more susceptible to predation and disease.

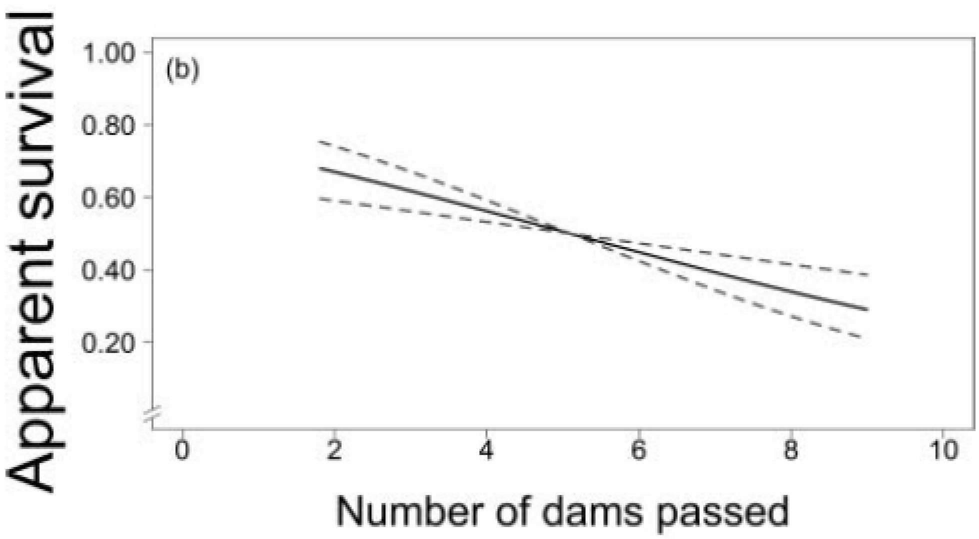

Figure 10. Apparent (or estimated) survival of Atlantic salmon smolts in the Penobscot River estuary based on the number of dams they passed during freshwater migration. The dark line is the mean survival and the dashed lines show the 95% confidence interval. The figure is excerpted from Stich et al.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

No directed studies have been conducted to assess the amount of hydrosystem delayed mortality that occurs at the Benton Falls 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 7.1% under existing conditions, and that approximately 7.0% 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 Benton Falls 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 consider 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 Benton Falls 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 Benton Falls Project, including passage mortality through the impoundment, mortality associated with the direct effects of dam passage, and hydrosystem delayed mortality. Given the mortality estimated above (impoundment mortality: 2.5%, direct mortality: 7.1%, and hydrosystem delayed mortality: 6%) we anticipate that if 100 smolts migrated through the action area, only 85 would survive (impoundment survival (97.5%) x direct survival (92.9%) x delayed survival (94%) = 85.1%). This does not include background levels of mortality in the action area that would occur regardless of the presence of the dam.

4.4.1.3 Kelts

Based on recent returns to the Sebasticook River, we anticipate that a small number of kelts (post spawn adults) pass downstream through the Benton Falls Project in some years in the spring and late fall. There is potential for turbine entrainment, in addition to spillway and fishway passage. The Miramichi Salmon Association (MSA) measured the width of 93 Atlantic salmon kelts in 2012 and determined that the average width was 4.1 inches (Range 2.6-6.1 inches) (Reid, J., MSA, Personal Communication, May 18, 2012). Although one of the two Kaplan units (unit 2) has a rack with 1" spacing in front of it (which would preclude kelts), a portion of the rack in front of unit 1 has 3" spacing, which would not exclude small adult salmon between 2.5-3 inches in width. There is a hinged overlay with 1-inch spacing that is lowered over the unit 1 intake during the fall, but not for the entirety of the kelt migration period. Of the salmon evaluated for width by the MSA, however, only 10% (9/93) were less than 3-inches in width and, thus, narrow enough to migrate through the racks.

Although we lack empirical information specific to the Benton Falls Project regarding kelt survival, we can estimate it by applying estimated route utilization and survival rates. The best available information indicates that all salmon less than three inches in width (10%) could pass through the racks in front of unit 1 and that the remaining 90% would have to pass over the project spillway because they are too wide to fit through the racks. However, just because a salmon is small enough to swim through the racks, does not mean that it would. An unknown proportion of these small salmon would likely be attracted to the flow over the spillway and pass via that route when it is available. Given the width distribution documented by the MSA, we expect that the proportion of adults that would pass downstream through the racks could range between 0% and 10%. Using this range, we can approximate total kelt passage survival by averaging the survival under the two passage route scenarios (turbine entrainment of 0%; turbine entrainment of 10%). FPL Energy estimated that only 72% of adult salmon that passed through the Kaplan unit at the Lockwood Project would survive (FPL Energy 2013; Accession #20130221-5160). We do not know precisely what the survival of kelts would be through non-turbine routes, but based on similar conditions in the Penobscot, Alden Research Laboratory (2012) anticipated that kelt survival past projects that do not allow for turbine entrainment (due to narrow space racks) would be approximately 97%. Using these route utilization and survival rates, we estimate that kelt mortality at the Benton Falls Project would not exceed 5% if all the small salmon (10% of total) went through turbines (i.e., (10% turbine passage x 72% turbine survival) + (90% spillway passage x 97% spillway survival) = 95% project survival). Conversely, if all of the small salmon pass over the spillway (i.e., 0% turbine entrainment), we would expect that mortality would not exceed 3% (Alden 2012). If we average these two potential scenarios, we can estimate that kelt mortality at the project under baseline conditions is approximately 4%.

4.4.1.4 Prespawn Adult Atlantic salmon

The Benton Falls Project has a fish lift that provides upstream passage for diadromous fish. While shad, herring, and salmon have been documented using the fishway, 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 successfully entering the lift.

As indicated above, zero to five Atlantic salmon have passed through the fish lift annually since 2009, with an average annual return of less than one. Salmon have only been passed in four of the fifteen years that the fish lift has been operating. There have been no studies to document the abundance of salmon below the dam and there is no information available on the passage efficiency of motivated pre-spawn Atlantic salmon at the Benton Falls Project. Although it is expected to occur in some years when at least one male and one female pass upstream, production of salmon upriver of Benton Falls is limited due to the small amount of suitable habitat. As few salmon are reared in that habitat, and none are stocked there, we expect that very few adults will be homing back to it. The salmon that use the fishway are expected to be strays from the Kennebec River, where there is a small run of salmon returning to the Sandy River due to egg and smolt stocking in the Sandy River. Should an increase in salmon production (due to stocking, or an increase in spawning activity) occur upriver of the Benton Falls Project, we would expect the progeny of those spawning events to result in an increase in the number of pre-spawn adults motivated to access upriver habitat. It is more likely, however, that an increase in the size of the Kennebec run (due to passage improvements at the dams, increased stocking, and/or natural production in the Sandy River) would lead to an increase in the number of strays that enter the Sebasticook.

Atlantic salmon are known to successfully utilize the upstream fishway at the Benton Falls 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 fish lifts. 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 fish lifts similar to the one at the Benton Falls Project. That said, relevant information can be extracted from his analysis. Hershey (2021) considered two studies (Gowans et al, 2003; Izzo et al, 2016) that specifically studied the effectiveness of lock-lift fishways for Atlantic salmon.[19] The study conducted by Izzo et al (2016) was on Atlantic salmon at the Milford Project in the Penobscot River in Maine. In addition to those two studies, both Normandeau Associates (for Brookfield Renewable) and Rubenstein (2021) evaluated passage of salmon at the lift at the Lockwood Dam on the Kennebec River (BWPH 2017, 2018; Rubenstein, 2021). Collectively, these four studies monitored 174 tagged Atlantic salmon as they attempted to use lifts at three different projects, and determined that 138 (or 79%) were successful. The annual passage success varied between 45% and 100%. Therefore, lacking specific information for the Benton Falls Project, we expect that the average passage efficiency of the fish lift is 79%.

Adult salmon that are unable to pass the Benton Falls dam most likely drop out of the Sebasticook and continue their migration in the Kennebec. Although no studies have looked directly at the fate of fish that fail to pass upstream on the Sebasticook 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

[19] 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

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). Therefore, we anticipate that except for the salmon that could die (i.e., 1% of the fish that fail to pass), all salmon that fail to pass the Benton Falls Dam stray to the neighboring Kennebec River and attempt to spawn.

Upstream 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. Additionally, migratory delay has negative 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 (Rubenstein, 2021). 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. Multi-year spawners tend to be larger and have increased reproductive potential, and therefore, are important demographic components of a population (Fleming, 1996; Maynard et al., 2017). However, repeat spawners have nearly been eliminated from the GOM DPS (Maynard et al., 2017).

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 also use more energy than those that migrate under cool conditions. Water temperature directly affects the rate of all biochemical reactions in ectothermic animals, such as Atlantic salmon, including metabolic processes (Angilletta Jr et al., 2002). This effect predicts a theoretical doubling of biological processes every 10°C; 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. Frechette et al. (2018) found that Atlantic salmon used thermal refuges to maintain body temperatures between 16-20°C, indicating that temperatures above that range are likely to induce thermal stress. It is not unusual for the temperature of mainstem riverine habitat in the GOM DPS to exceed 20°C, particularly in the summer months at the tail end of the typical migration period (July through September).

Upstream delay of spawning adults associated with ineffective passage at dams may therefore force salmon to spend more time in warm water, which can increase the energy costs of migration, particularly if they cannot locate or make use of cold-water refuge. Rubenstein (2021) found that salmon lost an average of 16.4% (range between 2.1% and 38.3%) of their original endogenous fat reserves between capture and recapture at the Lockwood Dam on the Kennebec River. This is likely an overestimate of dam-related energy depletion, as Rubenstein released fish 14 km downstream of the Lockwood Project, and therefore some proportion of that fat loss occurred prior to fish encountering the dam (average approach time to the dam was 4 days and 7.7 days in 2018 and 2019, respectively, as compared to average delay of 18.8 days and 15.1 days at the dam itself) (Rubenstein et al., 2022). Regardless, the energetic effects of cumulative delay imposed by multi-dam systems likely increase the chance that a returning adult Atlantic salmon will die before or after spawning (Rubenstein, 2021). In a model that utilized Kennebec River temperature data, Rubenstein demonstrated that the energetic effects to salmon due to migratory delay at one dam could result in 10.5% of adults dying before spawning and only 13.6% of adults surviving after spawning. To put this into context, the model results for a free-flowing (i.e., no dams) river indicated that 7% of salmon could die due to energetic effects before spawning, and that 17.4% would survive after spawning (Rubenstein, 2021).

The level of existing upstream migratory delay at the Benton Falls Project has not been studied. 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) (HDR Engineering, 2015; Kleinschmidt Associates, 2016). Similarly, Peterson (2022) indicated that median annual delay at Milford between 2014-2016 and 2018-2020 ranged between 4 and 14 days. 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). A passage study was conducted at the Lockwood Dam on the Kennebec River in 2016 and 2017. The study demonstrated significant migratory delay, ranging between 0.7 to 123.0 days, with median delays of 9.9 and 16.0 days in 2016 and 2017, respectively (BWPH, 2017; BWPH, 2018). Rubenstein (2021) documented similar passage delays with medians of 16 days and 18 days in 2018 and 2019, respectively.

It is unknown what level of delay occurs at the Benton Falls Project. Of the fishways where migratory delay information exists, however, the Milford Project most resembles the Benton Falls Dam in terms of operation, configuration, and fishway type. In summarizing multiple studies of passage delay at Milford, Peterson (2022) found that 89% of salmon were delayed for over 48 hours (median = 7 days). Therefore, absent project specific data, we assume that under existing conditions, upstream delay at Benton Falls is similar to that reported at Milford, and 89% of the salmon that pass the Benton Falls Project take more than 48 hours to pass. However, there are tributaries both upstream and downstream of the Benton Falls Project that could provide suitable holding habitat during the warm months. As such, we do not expect that delay at the Benton Falls Project results in a failure to spawn or a failure to find suitable cold water refuge.

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 Sixth Assessment Report (AR6) from 2021, the Intergovernmental Panel on Climate Change (IPCC) stated that the "global surface temperature in the first two decades of the 21st century (2001–2020) was 0.99 [0.84 to 1.10] °C higher than 1850–1900" (IPCC 2021). Similarly, the total increase between the average of the 1850-1900 period and the 2010-2019 period is 1.07°C (likely range: 0.8° to 1.3°C). On a global scale, ocean warming has on average increased by 0.88 [0.68–1.01] °C from 1850-1900 to 19 2011-2020, with 0.60 [0.44–0.74] °C of this warming having occurred since 1980 (Fox-Kemper et al., 2021). In regards to resultant sea level rise, the global mean sea level increased by 0.20 (0.15 to 0.25) meters between 1901 and 2018. The average rate of sea level rise between 2006 and 2018 increased to 3.7 mm/yr (likely range of 3.2 to 4.2), up from 1.3 mm/yr between 1901 and 1971.

The IPCC (2021) climate model projections exhibit five scenarios, or shared socioeconomic pathways (SSP's) that cover a range of plausible future development of anthropogenic drivers of climate change, for both temperature and precipitation over the next several decades. SSP3-7.0 and SSP5-8.5 represent very high emission scenarios with CO_2 levels continuing to increase; SP2-4.5 represents a moderate emission scenario; and SP1-1.9 and SP1-2.6 represent low emission scenarios. Under all scenarios global surface temperature will continue to increase by 1.5ºC to 2.0ºC until at least mid-century unless there are deep reductions in CO_2 and other greenhouse gas emissions. A warmer climate is expected to result in increased climate extremes including intensified periods of very wet and very dry conditions resulting in increased periods of flooding and drought (IPCC, 2021). Climate warming has also resulted in increased river discharge and glacial and sea-ice melting (Greene et al*.*, 2008). Over the remainder of the 21st century, upper ocean stratification, ocean acidification, and ocean deoxygenation will continue to increase at rates dependent on future scenarios (IPCC, 2021).

The most recent estimate of likely global mean sea level rise by 2100 ranges from 0.28-0.55 m under the lowest emissions scenarios, to 0.63 - 1.01 m under the highest emission scenarios (IPCC, 2021). Over the long term, sea levels are expected to rise for centuries to millennia due to continuing deep-ocean warming and ice sheet melting.

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 (Greene et al., 2008; IPCC, 2007). 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). 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.

5.1.1 Regional Impacts

In the Northeast U.S. (West Virginia to Maine), between 1895 and 2011, temperatures increased by nearly 2ºC; precipitation increased by approximately 13 cm, and sea levels rose by approximately 30 cm (Melillo et al., 2014). Relative to other regions, the Northeast has experienced greater increases in extreme precipitation, and the rate of sea level rise exceeds the global average (Melillo et al., 2014). Looking forward, it is expected that temperatures in the Northeast could warm between 4.5ºC to 10ºC by the 2080s if carbon emissions continue to increase (Melillo et al., 2014).

In Maine, the average annual temperature has increased nearly 1.8ºC in the last 124 years with northern and western Maine (1.7ºC) warming at slower rates than coastal Maine (1.8ºC) (Fernandez et al., 2020). Most of the warming that has occurred in Maine has happened since 1960 with an average annual increase of 0.026ºC per year (Fernandez et al., 2020). The average annual precipitation in Maine has also increased. Maine's average annual precipitation has increased 15% (~15 cm) since 1895, with most of that increase in the form of rain and less snow. Much of the increased precipitation is associated with increases in storm intensity predominantly during the fall time (*summarized in* Fernandez et al., 2020). As for snowfall, the average annual snow depth has decreased by 20% (5.8 cm) since 1895 (Fernandez et al., 2020). Although Maine has seen a considerable increase in the average annual precipitation, Maine has also experienced increases in the severity and duration of drought events (Fernandez et al., 2020).

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 time period considered in this consultation 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. The longest duration action considered in this consultation is the proposed relicensing of the Shawmut Project; if issued, the new license is expected to authorize operations for up to 50 years. Warming is very likely to continue in the U.S. over the time period considered in this consultation regardless of reduction in greenhouse gasses, due to emissions that have already occurred (Pörtner et al., 2022). It is very likely that the magnitude and frequency of ecosystem changes will continue to increase over this period, and it is possible that they will accelerate (Portner et al., 2022). 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 include 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). Increased warming may also invoke mutualistic and antagonistic interactions among species (Hulme, 2005) (i.e., give warmer water species an advantage over cool or cold water species). 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. 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 demands for water resources, 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).

5.2 Anticipated Effects to Atlantic salmon

Atlantic salmon are one of the most vulnerable managed fish species in the Northeast U.S. Shelf to climate change as a function of their sensitivity and exposure to climate stressors (Hare et al., 2016). Factors such as fecundity, anadromy, and finite range of suitable habitats and prey resources contribute to salmon's vulnerability. Water temperature is one of the most important environmental factors affecting all forms of aquatic life in rivers and streams (Annear et al., 2004). Temperature is especially important for Atlantic salmon given that they are poikilothermic (i.e., their body temperatures and metabolic processes are determined by the temperature of the surrounding environment). Although temperature can be a stimulant for salmon migration, spawning, and feeding (Elson, 1969), they are cold water fish and, therefore, have a thermal tolerance zone where activity and growth is optimal (DeCola, 1970). Elliot (1991) identified the upper incipient lethal maximum temperature (i.e., the temperature at which 50% of the test fish survive) for juvenile Atlantic salmon as 27.8°C (survival over 7 days). Adult Atlantic salmon in rivers may experience thermal stress when temperatures exceed 20°C, and some fish will experience mortality when temperatures exceed 26°C (Shepard, 1995; Wilkie et al., 1996). 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).

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). 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 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 in the Action Area

Information on how climate change will impact the action area is extremely limited. As reported by the University of Maine's Climate Change Institute (Fernandez et al. 2020), models predict that Maine's annual temperature is projected to increase between 1.7–2.8°C by 2050, with continued increases in precipitation frequency and intensity. Under moderate to high emissions scenarios ocean temperatures in the Gulf of Maine are also expected to rise as much as 1.2ºC (2.2ºF) by 2050 and 2.2ºC (3.9ºF) by 2100, and sea levels are expected to rise as much as 30 to 90 cm by 2050 and 1.10 to 3.3 m by 2100. These rising sea levels would likely shift the salt wedge (i.e., layer of salt water in an estuary that underlies a layer of less dense freshwater) in the Kennebec River and other rivers in the GOM DPS. Because there remains 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. However, we use the best available information to anticipate how Atlantic salmon and designated critical habitat in the action area may be affected by climate change over the life of the actions considered in this consultation.

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.
The timing of spawning could shift later into the fall as water temperatures warm and spawning migrations could occur earlier in the year as salmon attempt to avoid peak summer water temperatures. 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. Increasing water temperatures will also likely increase energy consumption of upstream migrating Atlantic salmon, depleting energy reserves that may lead to lower spawning success and postspawn recovery (Rubenstein, 2021).

Dams and their associated impacts have been shown to exacerbate the effects of climate change as changes in streamflow, including dam impoundments and flow management through dams, can significantly affect water temperatures due to changes in thermal capacity, with water temperature being inversely related to discharge (Webb et al., 2003). Furthermore, any increases in stream temperatures associated with project operations, or delays in the migration of Atlantic salmon that increase their exposure time to warmer temperatures can negatively affect their reproductive success (Mantua et al., 2010; Rubenstein, 2021).

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. 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 actions. 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.

Despite the lack of certainty, we can make some predictions regarding potential outcomes of the warming climate. With an expected air temperature increase of 1.7–2.8°C by 2050, there is potential for effects to Atlantic salmon in the action area during the term of the proposed action (2023-2034). First, it is possible that the already thermally challenged mainstem of the Sebasticook will become uninhabitable by juvenile Atlantic salmon during the summer months. The thresholds for mortality in juvenile and adult salmon discussed previously would be exceeded regularly, and it is less likely that any spawning in the mainstem would produce any outmigrating smolts. There may be times in the summer months when the mainstem becomes a thermal barrier to migrating adults. Under these conditions, adults would need to access cold water refuge, where they may need to hold for days at a time. Warmer water will also take an energetic toll on adult salmon (prespawn and postspawn) as they will deplete their energy reserves more quickly during their upstream and downstream migration. If delay at the dams is excessive, we would anticipate a large proportion of adults would not survive to spawn, and that repeat spawning will become a rarer event. The further warming of the impoundments will make them more suitable for warm water nonnative species, such as smallmouth and largemouth bass, which prey on juvenile Atlantic salmon (Baum, 1997). This increase in impoundment mortality could lead to a reduction in the number of salmon smolts leaving the Sebasticook River, which will have a corresponding reduction in the number of returning adults coming back to the river.

5.1 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, Ocean Acidification, and Air Temperature. 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 (e.g., 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. (2016), 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.

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 well upstream from the present upper limit of salt water intrusion; as noted above the primary behavior of sturgeon in the action area is spawning and then development of eggs. It is extremely unlikely that salt water intrusion would extend into the action area. As such, we do not expect climate change to result in changes to the use of the action area. 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.

While additional modeling for climate change impacts, particularly salt water intrusion and seasonal temperature shifts, are needed for the action area to better assess the potential effects on shortnose and Atlantic sturgeon, based on the best available information we do not expect use of the action area by shortnose or Atlantic sturgeon to change over the life of the proposed actions due to climate change.

6. EFFECTS OF THE ACTION

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

FERC is proposing amend the license for the Benton Falls Project, which expires in February of 2034. As such, the proposed amendment will cover a term of 10 years. As described previously, the past effects of the Project that are not affected by the amendment of the license to operate under the terms of the SPP are considered as part of the environmental baseline (section 4.4.1), and therefore are not addressed in this section. In this section we will consider the effects of amending the license for the Benton Falls Project to incorporate fish passage measures for Atlantic salmon. We anticipate that the passage measures will affect salmon passage efficiency, downstream survival and injury, and migratory delay.

The Licensee is also proposing measures to safely remove sturgeon from the project fish passage facility in the unlikely event they enter it.

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 Sebasticook River (average of one per year over the last 15 years). Over the last 15 years, there were only three years when more than one adult salmon was documented in the river. Stocking of juvenile salmon does not occur in the Sebasticook River. Therefore, under current passage and stocking conditions, salmon presence is 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 Benton Falls Project. Correspondingly, we would expect few spawning events that would lead to juvenile production upstream of the project. When spawning occurs, we would expect the number of smolts produced to be low given the small number of adults passed, as well as the expected low egg-to-smolt survival rate. Based on an analysis of dam survival on the Penobscot River by the Northeast Fisheries Science Center (NEFSC), we expect that approximately 108 smolts could be produced by a successful spawning event (Nieland & Sheehan, 2020).[20] Given the maximum number of adults passed at the Project since the fishway was constructed (i.e., 5), we can estimate that, at most, two spawning events are likely to occur upstream of the project in any given year. This would suggest that the number of smolts passing the project is unlikely to exceed 216 smolts under baseline conditions (i.e., no stocking or active restoration).

A significant increase in salmon returning to the Sebasticook River will require either an increase in stocking to "jumpstart" the population and/or an increase in strays and marine survival. The only factor 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, USFWS and Maine DMR are actively engaged in programs to recover Atlantic salmon, including in the Kennebec River and the Merrymeeting Bay SHRU. We expect that as recovery actions in the Kennebec are addressed, the salmon populations will respond and we will see more salmon straying to the Sebasticook River.

6.1.2 Atlantic and shortnose sturgeon

Atlantic and shortnose sturgeon occur in the mainstem Kennebec River and may occasionally occur in the Sebasticook River below the Benton Falls Project. There is no documentation of any such occurrences and we expect that presence is limited to rare, transient adults, subadults, or juveniles that wander from the mainstem Kennebec. It is also possible that individuals may enter the lower Sebasticook in high flow conditions (if velocity is lower in the Sebasticook than in the Kennebec) or for opportunistic foraging. No spawning is anticipated to occur. We do not expect that any sturgeon are attempting to move upstream past the project.

[20] Nieland & Sheehan (2020) estimated that the mean eggs produced per female was 8,304 (st. dev. = 821), and that the mean egg-to-smolt survival rate is 1.3% (st. dev. = 0.9%). To estimate the average number of smolts produced in a spawning event we multiplied the average number of eggs by the average survival rate (i.e., 8,304 eggs x 1.3% survival = 108 smolts).

6.1.3 Hydroelectric Operations

6.1.3.1 Fish Passage

Downstream Passage of Smolts

Sturgeon are not passed at the Benton Falls Project, so downstream effects associated with the proposed action are limited to a small number of Atlantic salmon smolts and kelts that pass the project in some years on their way to the marine environment.

Under the proposed action, the Benton Falls 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 4.4.1.2 describes the past effects of the project on out migrating salmon smolts. In their analysis, Kleinschmidt estimated that smolt survival at the project under median flow is 92.9%, ranging between 90.3% and 94.7% at low and high flow, respectively, when the bypass isn't being operated. BFA has proposed operational measures that would reduce turbine entrainment by operating the fish bypass and by lowering the 1-inch overlay rack over the turbine intakes in years when smolts could be migrating out of the Sebasticook. With these modifications, Kleinschmidt's model predicts that smolt survival under median flow is 95.8%, ranging between 94.7% and 96.5% at low and high flow, respectively. As such, we expect that survival will be at least 95% with the implementation of the proposed measures.

The available information indicates that a certain amount of sublethal injury will occur when smolts pass the Benton Falls Project. These fish either succumb to their injuries in the river or estuary, are 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 fall into any of these three categories. As described above, sublethal injury is considered to be one of the causes of hydrosystem delayed mortality in the estuary. Although no empirical studies of injury have been conducted at this project, FPL Energy (FPLE) conducted a desktop assessment of initial injury rate at projects on the Kennebec River (FPLE, 2013; Accession #20130221-5160). This model can be used to approximate the injury of smolts that survived passage at Benton Falls. FPL Energy evaluated smolt injury and mortality rates based on numerous studies at projects with similar turbine characteristics. In their analysis, they estimated that 7.1% of smolts that migrated through Kaplan units would be injured (FPLE, 2013), although they did not approximate survival of smolts through non-turbine routes. In a 2017 study report at the Ellsworth Project on the Union River in Maine, Normandeau Associates conducted an analysis of the potential factors leading to injury rates through non-turbine routes (BBHP, 2017). In their analysis they compiled data from studies conducted at 22 facilities under 200 test conditions. They determined that the project head (i.e., the difference in elevation between the water level upstream and downstream of a dam) had a significant correlation with visible injury rate. The dam considered in this opinion is a low-head dam (29.5-feet), which according to Normandeau's analysis, would suggest that fish that migrate through a non-turbine route would have an injury rate of close to 0%. Based on these assumptions, as well as the expected route utilization estimated in Kleinschmidt's smolt analysis (BFA 2022; FERC Accession # 20220104-5154), we estimate that the proposal to operate the downstream bypass and lower the racks during the smolt run will reduce injury rates from 7.1% to 2.9% at low and median flows; and from 3.7% to 1.5% at high flows. As such, we expect that no more than 3% of smolts will be injured at the project due to the effects of dam passage.

Migratory Delay

In section 4.4.1.2, we describe the ongoing migratory delay currently caused by the Benton Falls Dam. As indicated previously, migratory delay can lead to smolts missing their physiological smolt window and result in increased exposure to predation. We estimated that the migratory delay at the project (measured as the proportion of smolts that take longer than 24 hours to pass the dam; based on an average of documented at projects on the Kennebec and Androscoggin) is 7%. As the proposed operational measures are designed to increase bypass and spill passage, we anticipate that there would be a reduction in migratory delay. To estimate this reduction, we have considered how route selection through turbine and non-turbine routes relates to migratory delay upstream of a dam. In 2015, Normandeau Associates, LLC conducted smolt survival studies at five different hydroelectric projects in the Kennebec and Androscoggin Rivers that are operated by Brookfield Renewable Energy Group (BWPH, 2016). In these studies, Normandeau documented the residence time of smolts that passed via turbine and non-turbine routes. We have evaluated the results and estimate that the median delay for smolts that passed through turbines was, on average, more than five-times higher than what was documented at spillways and bypasses (i.e., 5.2 hours versus 0.9 hours). On further analysis of the data, however, we determined that delay of smolts at the turbines at one of the projects (i.e., the Weston Project on the Kennebec River) was well outside the typical range, with delay documented as being 10 times higher than non-turbine delay. With that project removed from the analysis, the median residence time, on average, was only 2.5 times higher through the turbine routes than through the non-turbine routes (i.e., 1.4 hours versus 0.5 hours). Given this, and the route utilization rates predicted by Kleinschmidt in their Benton Falls analysis (BFA 2022; FERC Accession # 20220104-5154), we can estimate the proportional reduction in migratory delay that would result from the proposed measures. In their analysis, Kleinschmidt estimated that at median flow 0% of smolts would pass through non-turbine routes under baseline conditions, but that under the proposed measures approximately 59% would pass through those routes. Multiplying the route specific delay estimates by the proportion of smolts passing through those routes can provide an estimate of the relative change in delay that could be expected due to the proposal (i.e., Baseline: (100% of smolts use turbines x 1.4 hour median delay=1.4 hours; Proposal: (41% of smolts using the turbines x 1.4 hour median delay at turbines) + (59% of smolts using bypass or spillway x 0.5 hour median delay) = 0.9 hours). As such, we expect that the proposal will reduce median delay at the project by 38% (i.e., (1.4-0.9)/1.4 = 0.38). Assuming the reduction in median delay is equivalent to a reduction in the proportion of fish taking longer than 24 hours to pass the dam, we expect that the proposal will reduce the proportion of delayed fish from 7% to approximately 4% (i.e., (1-0.38) x 0.07 = 0.043).

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

Here, we carry out 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 4% 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 4% 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

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

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 4.4.1.2, some of the smolt mortality that occurs in the estuary downstream of the Benton Falls 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 a Sebasticook-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 Benton Falls 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 38% reduction in the proportion of fish that take more than 24 hours to pass the Project (4.3% compared to 7%), and a 59% reduction in sublethal injury at median flow (2.9% compared to 7.1%), we expect that there will be a reduction in hydrosystem delayed mortality. Despite the uncertainty regarding precisely how these factors contribute to delayed mortality, the best available information suggests that the proposal will lead to a 38% reduction in the effect (i.e., a reduction equivalent to the reduction in migratory delay). Therefore, we anticipate that after the fishway improvements have been implemented and evaluated, hydrosystem delayed mortality will be reduced to approximately 4% (i.e., (100% - 38%) x 6% = 3.7%). Therefore, we anticipate that no more than 4% of smolts will die as a result of hydrosystem delayed mortality in the Sebasticook River.

Given the above information, we anticipate that during the term of the SPP, direct smolt mortality associated with downstream passage will not exceed 5%. With an anticipated 4% hydrosystem delayed mortality rate, we expect that during this period approximately 91% of out migrating smolts will survive passage at the Benton Falls Project.

<u>Downstream Passage of Kelts</u>

In the Environmental Baseline (section 4.4.1.3), we estimated that kelt survival at the Benton Falls project is approximately 96%. We assumed that due to the spacing on the turbine intake racks that between 0% and 10% of kelts would be entrained in the turbines and that some proportion of those would be killed. The proposal to lower the 1-inch rack over the intakes in years when adult salmon are migrating downstream past the project will reduce the proportion of adults able to swim through the rack spacing to 0%. As such, all adult salmon would be passed through the downstream bypass or over the spillway, and survival would be increased to at least

97%.

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 stocking and very limited natural production occurring in the Sebasticook River at this time. Therefore, we expect very few salmon to be exposed to passage effects during the 10 year term of the SPP. That said, with the proposed improvements to passage at the project, our expectation is that salmon abundance may increase.

Upstream Passage of Adults

The Benton Falls Project is a barrier to sea-run fish migration in the Sebasticook River. The Project has a fish lift that is operated to pass alosines and salmon upstream of the project. Sturgeon are not passed at the Project as the falls underneath the dam are thought to be the upstream historical limit for both species, and none have ever been observed in the fish lift.

The number of adult salmon that are motivated to pass the Benton Falls Project is very low as there is no stocking upriver of the dam, and natural production is expected to be a very rare event. We are not aware of any plans to stock salmon into this habitat during the term of the SPP and therefore we consider that the number of salmon homing to habitat upstream of the dam will continue to be near zero during the duration of the proposed action. However, as indicated previously, we do expect that salmon in the mainstem of the Kennebec could stray to the Sebasticook during their upstream migration.

As indicated in section 4.4.1.4, zero to five Atlantic salmon have passed through the fish lift annually since 2009, with an average annual return of less than one. Given fish counts at the Project since 2009, we would expect that between 0 and 50 salmon (i.e., up to five fish per year for 10 years) will be exposed to the effects of trapping at the Project over the term of the proposed action. The average annual return to the Sebasticook is only one salmon, however, we expect that the number will increase over the term of the SPP due to improvements being made at the mainstem dams on the Kennebec, as well as increased smolt stocking in the Sandy River, which will increase the number of salmon straying to the Sebasticook annually. In 2022, five salmon (five times the annual average) were passed at the Benton Falls Project, all of which were likely a result of a smolt stocking effort in the lower Kennebec River that was initiated in 2020 (USASAC, 2022). Although we don’t expect smolt stocking to occur in the lower river in most years, we do expect that egg stocking and natural production will continue to occur in the Sandy River, and that it is reasonable to assume that as many as five salmon a year could be passed at the project. We note that effects would be the same if the number of salmon in any given year was higher than five.

Based on Atlantic salmon passage rates at other projects with fish lifts, we have estimated that an average of 79% of adult salmon that approach Benton Falls will successfully pass it. Therefore, we estimate that 21% of the Atlantic salmon that approach project will fail to pass and, according to the expert panel’s conclusions (NMFS, 2012), that 1% of those (or 0.2% (i.e., 1% x 21%) of the total number of fish that approach the dam) would be expected to die. As we expect no more than 50 salmon to pass the project during the 10-year term of the proposed action, we do not expect that any salmon will actually be killed due to their failure to pass (i.e., 0.2% x 50 salmon = 0.1 salmon). Therefore, we anticipate that all of the salmon that fail to pass will survive, but will be delayed in their migration, and will return to the nearby Kennebec River 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 dam, which will cause a disruption of their upstream migrations (step 1) and that 21% will be blocked from passing the project, 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 may spawn in less suitable habitat. 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 21% will be blocked from accessing spawning habitat in the Sebasticook River and will need to locate alternative habitat, which will lead to potential spawning delay, which we consider to meet the definition of harassment.

Any affected salmon are likely straying from the Kennebec River where there is abundant rearing and spawning habitat, and is likely where they will return once they fail to pass Benton Falls Dam. Adult salmon that are unable to pass the Benton Falls Dam are within close proximity (~10-50km) to tributaries in the mainstem of the Kennebec River, downstream of the dam, where spawning habitat has been documented (e.g., Bond Brook, Togus Stream, Seven Mile Stream, Messalonskee Stream) (MDMR, 2017; MASRSC, 1986). Abundant cold-water spawning habitat in the Kennebec River (where most of the salmon were likely stocked as juveniles) is a significant distance upstream of the confluence with the Sebasticook River (i.e., the Sandy River). However, any salmon that drop out of the Sebasticook River would likely migrate 1km upstream in the Kennebec River to the existing fishway at the Lockwood Dam that operates a trap and truck program for upstream migrating adult salmon. The trap and truck operation will result in salmon being transported and released into cold water spawning habitat in the Sandy within hours of being trapped. Given the relatively short length of the Sebasticook River reach, the proximity to spawning and cold water habitat, and the proximity to an operative trap and truck operation, we do not anticipate that the effect of passage failure leads to "harm" of the individual fish (i.e., we do not anticipate that this disruption of behavior will lead to mortality). As we anticipate that a small number of salmon will continue to stray to the Project as stocking increases and passage improvements are implemented on the Kennebec, we anticipate that this source of harassment will remain during the 10 year term of the proposed action.

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. In section 4, we estimated that the Benton Falls Dam would pass 11% of motivated prespawn salmon within 48 hours under baseline conditions. BFA has proposed to increase lift frequency for a month after the first salmon is passed each year. As this would increase the number of opportunities for a fish to pass for a portion of the passage season, it would likely increase the passage rate and reduce migratory delay. However, we do not have any information to suggest to what degree these factors would be affected. Therefore, the best available information suggests that 89% is a reasonable estimate of the proportion of migrants that would be delayed during the term of the SPP.

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 have determined that up to 89% of returns would experience delay in excess of 48 hours (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 potentially 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 Benton Falls Project during their upstream migration are likely to be adversely affected and that effect meets the definition of harassment. Therefore, we anticipate that up to 89% of adult salmon that pass the Benton Falls 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 this project. Adult salmon that are delayed by more than 48 hours prior to passing the Benton Falls Project will only have a short distance to migrate to access spawning habitat (section 4.1). According to field surveys conducted by MDMR biologists, there are approximately 8,000 habitat units of spawning habitat within 26-km upstream of the dam (MDMR 2017). The closest habitat is only 6-km upstream of the dam. As such, we expect that even a salmon that experiences delay greater than 48 hours is unlikely to fully deplete their energy reserves. Given the relatively short distance to habitat, and the fact that this is the first, and potentially only, dam salmon will encounter, we do not consider delay of adults during their upstream migration at this project 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 average return to the Benton Falls dam in the last decade is one salmon, with a maximum return in recent years of only five salmon. At the Benton Falls Project, we would anticipate no more than 45 salmon ((5 salmon*10 years) * 89%) to be delayed over the 10 year term of the SPP.

Stranding

It is possible that operation of the Benton Falls Project could affect migrating Atlantic salmon by inadvertently trapping or stranding them in the pools downstream of the Project, particularly during flashboard replacement and/or during and after spill events. Although not included in their SPP or BA, BFA has agreed to coordinate with NMFS to develop a plan to reduce the potential effects of stranding on Atlantic salmon and other fish species (Mineau, M., BFA, personal communication, email on 8/28/2023). We anticipate that this plan would include monitoring of downstream pools after significant spill events and during flashboard replacement, as well as the collection of any stranded Atlantic salmon for release back into the river.

Given the very small number of salmon in the Sebasticook, and the fact 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 ten year SPP period for the Brenton Falls Project. Any stranded fish could potentially be injured due to abrasions caused with contact with ledges, and from the effects of handling and transport. The implementation of a stranding plan will ensure that any salmon that are stranded in isolated pools are relocated in a way that will reduce the likelihood of injury and will eliminate this potential source of mortality in the Sebasticook River. While the capture of salmon in nets and the subsequent transport and handling may stress the fish, this stress is not likely to be long lasting and will have no effect on the survival of the fish. The implementation of a handling plan and the use of proper handling techniques will minimize the potential for major injury. We do not expect the temporary holding and relocation of a stranded salmon to have any impact on its ability to spawn successfully.

Here, we carry out the four-step assessment for determining if the stranding of adult salmon meets the definition of harassment. We have established that during the term of the action, prespawn adult salmon could be exposed to the effects of stranding, which constitutes a disruption of their upstream migrations (step 1). We expect one salmon will be subject to the effects of stranding as it migrates to spawning habitat upstream of the dam (step 2). We have established the expected response of the exposed adult (step 3). The stranded salmon can be injured, stressed, and are delayed in its upstream migration. This can lead to increased energy costs, and an increased potential for predation. Minor injuries (such as scale loss) may expose fish to increased rates of infection, and could make the fish less fit for migration and spawning. Finally, we establish that the nature and duration of the response is a significant disruption of migration (step 4). Based on this four-step analysis, we find that one salmon is likely to be adversely affected over the term of the SPP and that effect amounts to harassment. For the reasons described above, we do not anticipate that the effect stranding leads to “harm” of the individual fish (i.e., we do not anticipate that this disruption of behavior will lead to mortality).

6.1.3.2 Effects of Aquatic Monitoring and Evaluation

BFA has proposed to conduct upstream (prespawn adults) and downstream (smolts) passage studies to assess the effectiveness of the existing passage facilities at the Benton Falls Project. An upstream adult study will be initiated if, and when, there are two consecutive years of at least 40 returning adult Atlantic salmon. Given the low returns and current stocking practices, it is unlikely that such a study will be triggered during the ten 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. BFA has proposed to conduct a downstream smolt survival study two years after two or more salmon are passed upstream of the project in a given passage season. More than two adult salmon were passed at the project in both 2022 and 2023, so we anticipate that a study could be initiated as soon as 2024, assuming study fish are available.

These studies are necessary to monitor the effect of the proposed action, and would not occur but for the proposed action. We anticipate that the effects of handling and tagging will lead to minor injury of every study fish, but that they will recover after a short period and will be able to continue their migration. This conclusion is based on the results of numerous similar studies within the GOM DPS of Atlantic salmon (BWPH 2013, 2014, 2015, 2016; BBHP 2017, 2017b, 2018, 2019). Therefore, we do not expect that these effects will lead to a significant disruption of behavior. Although BFA has not proposed specific study methods (including sample sizes) or duration of these studies, we assume that, based on similar studies at other projects in the GOM DPS, no more than 50 adult salmon would be used in a one year upstream passage study, and no more than 200 smolts per year would be used in a three year smolt survival study (estimated total of 600 smolts).

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.

The usual method for downstream passage studies is to surgically implant tags within the body cavities of the smolts. These tags do not interfere with feeding or movement. However, the tagging procedure requires considerable experience and care (Nielsen, 1992). Because the tag is placed within the body cavity, it is possible to injure a fish's internal organs. Infections of the sutured incision and the body cavity itself are also possible (Chisholm & Hubert, 1985; Mellas & Haynes, 1985).

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

All fish used in the proposed study will be handled by one or more people. There is an immediate risk of injury or mortality and a potential for delayed mortality due to mishandling. Those same fish that survive initial handling will also be subject to tag insertion for identification purposes during monitoring activities. It is assumed that 100% of the fish that are handled and tagged will be injured and therefore, harmed.

A proportion of the smolts are anticipated to be killed due to handling and tagging. There is some variability in the reported level of mortality associated with tagging juvenile salmonids. We did not document any immediate mortality while tagging 666 hatchery reared juvenile Atlantic salmon between 1997 and 2005 prior to their release into the Dennys River. After 2 weeks of being held in pools, only two (0.3%) of these fish died. Over the same timeframe, we surgically implanted tags into wild juvenile Atlantic salmon prior to their release into the Narraguagus River. Of the 679 fish tagged, 13, or 1.9%, died during surgery (NMFS, unpublished data). It is likely there were delayed mortalities as a result of the surgeries, but this could not be quantified because fish were not held for an extended period. In a study assessing tagging mortality in hatchery reared yearling Chinook salmon, Hockersmith et al. (Hockersmith et al., 2000) determined that 1.8% (20 out of 1,133) died after having radio tags surgically implanted. Given this range of mortality rates, it is anticipated that no more than 2% of Atlantic salmon smolts will be killed due to handling and tagging during the proposed downstream monitoring studies. As monitoring may require the tagging of up to 600 Atlantic salmon smolts, we anticipate that no more than 12 (four a year) would be killed due to tagging effects.

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 worst-case estimate of tagging mortality in the adult salmon being used in the passage studies at the Benton Falls Project. Given the number of Atlantic salmon being tagged (no more than 50), it is expected that no more than one adult Atlantic salmon will be killed as part of the upstream passage study. Injuries are expected to be minimized by having trained professionals conduct the procedures using established protocols.

Summary of Effects to Atlantic salmon

If the proposed license amendment is not issued by FERC, BFA would continue to operate the Benton Falls Project without the identified measures to reduce effects to Atlantic salmon; as such, all of the effects associated with the dam in the action area, as described in the environmental baseline (section 4) would continue over the remaining term of the license (i.e., through February 2034 or until a new license is issued). The issuance of the license amendment will require BFA to make changes that are expected to reduce some effects of the continued operation of the project on Atlantic salmon. As such, during the remainder of the license term, the effects identified in the environmental baseline (section 4) will continue as modified by the changes to the project as reflected in 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 operate the downstream fish bypass and the installation of the 1" clear bar hinged overlay screen during the smolt and kelt migration will reduce the extent of adverse effects of the project on Atlantic salmon in the action area compared to the baseline condition, but passage inefficiencies will continue to adversely affect Atlantic salmon in the action area.

As described previously, we anticipate that few salmon will occur in the Sebasticook River until either stocking or natural production increases in the river. It is highly unlikely that either will occur during the ten year term of the SPP at the Benton Falls Project. While we expect that there will be increases to the number of adult returns to the Kennebec River over this 10 year period, any increase in the number of strays to the Sebasticook will be small and therefore there is likely to be little increase in the number of salmon passing upstream of the Benton Falls project and little, if any, increase in the number of smolts or kelts passing downstream of the project. We expect that no more than a few salmon will be passed upstream annually (no more than 50 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 Sebasticook and produce a small number of smolts. However, we anticipate that during the remaining term of the Benton Falls license there will be few, if any, smolts out migrating in the Sebasticook River annually. The small number of smolts will be exposed to mortality of approximately 9% (5% 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 above, we expect that no more than 3% of adults passing downstream will be killed due to effects of the Benton Falls Project.

We do not have project specific information on upstream passage efficiency for adult salmon but, based on other projects, we anticipate that approximately 21% of salmon that approach will fail to pass. We expect this level of passage failure to persist through the term of the SPP. The monitoring studies will lead to the injury and handling of up to 50 adult salmon. We anticipate that no more than one adult salmon will die as a result of tagging and handling. The downstream monitoring studies will lead to the harm of up to 600 salmon smolts, and the mortality of no more than 12 smolts due to the effects of tagging.

6.1.3.3 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 Benton Falls on the Sebasticook River (Houston et al. 2007). Therefore, with the removal of the Edwards Dam the mainstem Kennebec in 1999 and the Fort Halifax Dam on the Sebasticook in 2008, both species currently can access the entirety of their historical mainstem habitat in the River. Although no sturgeon have been observed at the Benton Falls Project or in the Sebasticook itself since the dam removals, we expect at least occasional, transient individuals are present in the action area. As no spawning is thought to occur in the Sebasticook, we do not expect any early life stages or juveniles to be present. We expect that the presence of sturgeon in the action area would be limited to occasional, transient adult or subadult Atlantic or shortnose sturgeon that were otherwise in the freshwater reach of the Kennebec River and wandered into the Sebasticook.

Stranding

The habitat immediately below the Benton Falls Dam is dominated by ledge, which becomes exposed during low flow periods. Although no stranding of sturgeon has been observed at the project, it is possible that if a sturgeon was in this area during a time when there is a rapid change in river flows (i.e., during flashboard replacement), that fish could become trapped in pools as flow recedes in the river. Data from the Holyoke Hydroelectric project on the Connecticut River can help in assessing the likely effects of stranding on sturgeon. Shortnose sturgeon are occasionally stranded following significant changes in flow. Some sturgeon that have been rescued from the pools at Holyoke 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 below the Holyoke Dam.

The proposed Sturgeon Handling and Protection Plan does not include monitoring for stranding at the Benton Falls Project. However, BFA has agreed to coordinate with NMFS to develop a plan to reduce the potential effects of stranding on Atlantic salmon and sturgeon (Mineau, M., BFA, personal communication, email on 8/28/2023). We anticipate that this plan would include monitoring of downstream pools after significant spill events and during flashboard replacement, as well as the collection of any stranded sturgeon for release back into the river. The implementation of a stranding plan will ensure that any sturgeon that are stranded in isolated pools are relocated in a way that will reduce the likelihood of injury and will eliminate this potential source of mortality in the Sebasticook 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 will have no effect on the survival of the fish. Stranding would require sturgeon not only to be present in the area just downstream of the dam but also to be there during a period when there is a rapid decrease in flow, and end up in a pool that was isolated from the main flow such that an individual became stranded until there was additional flow to allow egress. As no sturgeon have been observed in the vicinity of the project, we expect stranding to be a rare event and anticipate that no more than one shortnose sturgeon or one Atlantic sturgeon are likely to become stranded in isolated pools over the remaining term of the project's license. We expect the stranded fish would experience stress and minor injury. 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. We do not expect the temporary holding and relocation of a stranded sturgeon to have any impact on its ability to spawn successfully or carry out any other life function.

Here, we carry out the four-step assessment for determining if the stranding of adult sturgeon meets the definition of harassment. We have established that during the term of the action, adult or subadult shortnose and Atlantic sturgeon could be exposed to the effects of stranding, which constitutes a disruption of their movement in the action area (step 1). We expect one Atlantic sturgeon or one shortnose sturgeon will be stranded in an isolated pool below the dam (step 2). We have established the expected response of the exposed individual (step 3). The stranding creates a likelihood of injury; individuals could be injured or stressed due to attempts to find a means of egress during which the individual could experience minor (and recoverable) scrapes and bruises or due to exposure to poor water quality (such as warming of the pool and decreased dissolved oxygen). This creates a likelihood of temporary physiological impacts that could increase the potential for more serious injury, including infection or fatigue that makes response to other threats less efficient. Finally, we establish that the nature and duration of the response is a significant disruption of normal behavioral patterns that creates a likelihood of injury (step 4). Based on this four-step analysis, we find that one shortnose sturgeon and one Atlantic sturgeon are likely to be adversely affected over the term of the SPP and that effect amounts to harassment. For the reasons described above, we do not anticipate that the effect stranding leads to "harm" of the individual fish (i.e., we do not anticipate that this disruption of behavior will actually kill or injure any individual Atlantic or shortnose sturgeon).

Downstream Passage

As explained above, Benton Falls represents the historic limit of upstream migration for sturgeon and they are not known to occur upstream of the Benton Falls Dam. As no sturgeon will be passed upstream of the project, there will be no sturgeon upstream that could attempt to pass downstream of the project.

Upstream Passage

The fishway at the Benton Falls project will be operational during the time of year when adult shortnose and Atlantic sturgeon are likely to be present in the Kennebec River at the confluence with the Sebasticook River (April to July); any sturgeon that wander into the action area during this time of year could theoretically attempt to ascend further upstream in the Sebasticook and encounter the fishway. Consistent with the Sturgeon Handling Plan, the fishway will be monitored during the time of year that sturgeon may be present and rescue procedures will be implemented to relocate any sturgeon that unexpectedly enter the fishway.

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. Since 2009 when the fish lift was constructed at the Benton Falls Dam, no shortnose or Atlantic sturgeon have been captured. Data on the effects of the fish lift at the Holyoke Hydroelectric Project on the Connecticut River suggests that fish lifts that successfully attract other species (e.g., shad, salmon) do a poor job of attracting sturgeon without being specifically designed to improve attraction and access. As the fishway at the Benton Falls 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). These instances are rare. As such, it is reasonable to expect that no more than one shortnose or one Atlantic sturgeon will become entrapped in the existing fishway at the Benton Falls Project through the term of the FERC license expiration date. We anticipate that these fish would be captured and exposed to stress and minor injury (scale loss and biological sampling) associated with handling consistent with the Sturgeon Handling Plan.

We anticipate that no more than one shortnose sturgeon or Gulf of Maine DPS Atlantic sturgeon will be captured in the fishway at the Benton Falls Project and that no more than one shortnose sturgeon or Gulf of Maine DPS Atlantic sturgeon will be harassed by becoming temporarily stranded and rescued from isolated pools below Benton Falls as a result of flashboard replacement and receding flows after high water events. Capture, handling, and biological sampling could lead to the minor injury of these sturgeon.

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 Sebasticook 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.

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

8. INTEGRATION AND SYNTHESIS OF EFFECTS

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.

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

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 considers that the status of shortnose sturgeon throughout their range is stable (SNSSRT, 2010). The Schnabel estimate from 1998-2000 is the most recent population estimate for the Kennebec River System shortnose sturgeon population; however, it does not include an estimate of the size of the juvenile population. A comparison of the population estimate for the estuarine complex from 1981 (Squiers et al., 1982) to 2000 (MDMR, 2003) suggests that the adult population grew by approximately 30% between 1981 and 2000.

In 1999, the removal of the Edwards Dam on the mainstem of the Kennebec River opened up an additional 29 rkm of habitat (including in the Sebasticook River tributary), restoring access to the presumed historical spawning habitat. Use of this area has been documented and is considered to have possibly facilitated even further recruitment into this river (Wippelhauser et al., 2015). Tagging and tracking studies indicate that some Kennebec River fish migrate to the Penobscot River but return to the Kennebec River to spawn. It is hypothesized that this may be a result of increased competition for estuarine foraging resources in the Kennebec River due to increased population size (Altenritter et al., 2018). It is currently unknown if the Kennebec River population of shortnose sturgeon is continuing to increase; however, there are no indications that it has decreased from the 1998-2000 population estimate. As such, we consider the population to at least be stable.

Shortnose sturgeon only occur in the portion of the action area downstream of the Benton Falls Dam. Adults may be present in the action area if they wander in from the mainstem Kennebec River. Use of the action area is expected to be limited to occasional, transient individuals; no spawning is expected to occur. We have determined that shortnose sturgeon may rarely be stranded in pools below the dam and require rescue and on rare instances may enter the fishway and require removal. No serious injury or mortality of any shortnose sturgeon is anticipated as a result of any of the actions considered here.

As the Benton Falls Project is located at the upstream extent of the historical range of shortnose sturgeon, it is not considered a barrier to upstream migration. We have determined that the proposed action will affect shortnose sturgeon by resulting in the capture of one adult in the fishway at the Benton Falls Project. Additionally, the stranding of one shortnose sturgeon is expected in pools downstream of the spillway during the replacement or maintenance of flashboards, or after a high flow event. Over the remaining term of the existing license, therefore, it is anticipated that two shortnose sturgeon (one trapped in the fishway, one stranded in downstream pools) would be captured, collected, and handled at the 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, 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 or the substrate in isolated pools. 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, and subsequent removal and placement back downstream would cause an individual shortnose sturgeon to abandon their spawning attempt. Considering this analysis, the capture of two shortnose sturgeon is not likely to result in any serious 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. We have determined that these adverse effects meet the definition of harassment, but not harm, in the context of the definition of ESA take. These fish will also be captured/collected.

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. The distribution of shortnose sturgeon within the action area will not be affected by the action.

Based on the information provided above, the non-lethal collection and harassment of two shortnose sturgeon 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) there will be no mortalities and therefore no loss of any age class; 2) because there will be no mortalities there will be no change in the status or trends of the Kennebec River population or the species as a whole; 3) there will be no effect on reproductive output or the levels of genetic heterogeneity in the population; 4) 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; 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; 7) the continued operation of the dam will have only a minor and temporary effect on the distribution of no more than two shortnose sturgeon in the action area (limited to only the temporary holding of these individuals) and no effect on the distribution of the species throughout its range; and, (8) the continued operation of the dam will have no effect on the ability of shortnose sturgeon to shelter and no effect on individual foraging shortnose sturgeon.

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 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 Kennebec 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 Benton Falls Dam is the historical limit of sturgeon in the Sebasticook River, habitat connectivity will not be affected and individuals will 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 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

As described in the 2022 5-Year Review, the status of the Gulf of Maine DPS has likely neither improved nor declined from what it was when we listed the DPS in 2012. The Kennebec River remains the only known spawning population for the Gulf of Maine DPS despite the availability of suitable spawning and rearing habitat in other Gulf of Maine rivers. The estimated effective population size is less than 70 adults which suggests a relatively small spawning population and it is currently the only DPS with only one known spawning population. The Gulf of Maine DPS has low abundance and the current numbers of spawning adults are considered to be one to two orders of magnitude smaller than historical levels. Gulf of Maine DPS Atlantic sturgeon are still captured and killed as a result of fishery interactions, vessel strikes, and dredging but, to a lesser degree than for the other DPSs. Capture of Atlantic sturgeon in fishing gear continues to occur in other areas of the DPSs range but appears to be less prevalent in Gulf of Maine waters where sturgeon belonging to the DPS are most likely to occur. The ASMFC's 2017 Stock Assessment, concludes there is a 51 percent probability that abundance of the Gulf of Maine DPS has increased since implementation of the 1998 fishing moratorium but also a relatively high likelihood (74 percent probability) that mortality for the Gulf of Maine DPS exceeds the mortality threshold used for the Stock Assessment (ASMFC 2017a). The Stock Assessment Peer Review Report described that it was not clear if: (1) the percent probability for the trend in abundance was a reflection of the actual trend in abundance or of the underlying data quality for the DPS; and, (2) the percent probability that the Gulf of Maine DPS exceeds the mortality threshold actually reflects lower survival or was due to increased tagging model uncertainty owing to low sample sizes and potential emigration.

Atlantic sturgeon only occur in the portion of the action area downstream of the Benton Falls Dam. The Project is located at the upstream extent of the historic range of Atlantic sturgeon and, therefore, is not considered a barrier to upstream migration. Although they have not been observed doing so, Atlantic sturgeon may utilize habitat downstream of the project; this is expected to be limited to transient individuals that were migrating in the Kennebec River. No spawning is expected to occur in the Sebasticook; therefore, no early life stages or juveniles are expected in the action area.

As explained in the "Effects of the Action" section, the operation of fishway at the Lockwood Project and the lowering of water levels during flashboard maintenance is expected to result in the stranding of no more than one adult Atlantic sturgeon. We also expect that no more than one adult Atlantic sturgeon will become trapped in the fishway over the same timeframe. We expect all adult Atlantic sturgeon in the action area to originate from the Gulf of Maine DPS.

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 captured Atlantic sturgeon could experience minor injuries, such as abrasions, due to contact with the concrete surface of the fish lift or to the substrate in isolated pools. Atlantic sturgeon captured in the fishways or isolated pools 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 fishway, or in the pools, and subsequent removal and placement back downstream would cause an individual Atlantic sturgeon that was stranded in the action area while attempting to migrate to upstream spawning habitat in the Kennebec River to abandon their spawning attempt. Considering this analysis, the capture of two Atlantic sturgeon, is not likely to result in any serious 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 effect on spawning. The distribution of the GOM DPS of Atlantic 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 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) there will be no mortalities of any Atlantic sturgeon and therefore no impact on the strength of any age class; 2) there will be no effect on reproductive output or 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 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; 5) the operations of the project will not affect the ability of Atlantic sturgeon to successfully spawn or for eggs and larvae to successfully develop; 6)the continued operation of the dam will have only a minor and temporary effect on the distribution of no more than two Atlantic sturgeon in the action area (limited to only the temporary holding of these individuals) and no effect on the distribution of the species throughout its range; and, 7) the continued operation of the dam will have no effect on the ability of Atlantic sturgeon to shelter and no effect on individual foraging Atlantic sturgeon.

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 that 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).[22] 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 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

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

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.

8.3 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 Benton Falls Project for a ten year period pursuant to the amended license that incorporates the proposed SPP will lead to an improvement in downstream passage for Atlantic salmon as compared to current operations. However, the Project will continue to affect the abundance, reproduction, and distribution of salmon in the Sebasticook 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, Atlantic salmon in the Sebasticook River watershed will be adversely affected by continued operation of the Benton Falls Project.

Summary of Upstream Passage Effects

Atlantic salmon use the upstream fishway at the Benton Falls 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 Benton Falls Dam will be at least 79% effective during the SPP period, which means that 21% of adults that approach the project will fail to pass. Adult salmon that are not passed at the Project will either spawn in downstream areas, or return to the Kennebec River and continue their migration upstream to the Sandy 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 Benton Falls Dam is 1%, which equates to no more than 0.2% (1% of the 21% 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 Benton Falls 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 50 salmon will pass the project, 13 (i.e., (50/79%) – 50 = 13) will be delayed and harassed due to passage inefficiencies, and 0 will be killed. We also anticipate that one salmon could be harassed at the Benton Falls Project 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, 89% of the salmon that successfully navigate the Benton Falls 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 89% of adults will be harassed due to migratory delay, we expect that there are some features of the Benton Falls Project 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 Sebasticook River, the overall energy needs for upstream migrants is significantly less. Additionally, the presence of cool water refuge both downstream in in the Kennebec River, as well as upstream of the dam, reduces the probability that salmon will be stranded in warm water when temperatures are high.

Summary of Downstream Passage Effects

Atlantic salmon smolts migrate downstream to the estuary past the Benton Falls Dam in the spring in years following successful upstream spawning events. Although spawning likely occurs upstream of the dam, we consider it to be a very rare event, as insufficient adults are passed at the project to spawn (i.e., < 2 adults) in most years. In years where spawning occurs, we would expect the number of smolts produced to be low given the small number of adults passed, as well as the expected low egg-to-smolt survival rate. As described above, we expect that the number of smolts passing the project is unlikely to exceed 216 smolts under existing conditions (i.e., no stocking or active restoration). As indicated in section 6, we expect that the proposed measures will lead to a direct smolt survival rate of 95% at the Benton Falls Dam.

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 Sebasticook River, we assume a similar proportion of smolts will be subject to delayed mortality in the estuary due to their passage experience at the Benton Falls 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 Sebasticook River to approximately 4%. We anticipate that this level of mortality will continue to occur for the duration of the SPP in years when smolts are migrating through the action area. Therefore, we anticipate that smolt mortality associated with the Benton Falls Project will not exceed 9% (5% direct mortality + 4% hydrosystem delayed mortality) annually.

In summary, we expect that in most years no smolts will be killed at the Benton Falls Project as none will be produced upstream of the dam. In the few years when smolts could be in the action area (two years after a sufficient number of male and female adult salmon are passed at the project), we would not expect any more than 216 smolts to pass downstream of the project. In those years, we would expect that no more than 9% (or 19 individuals (9% x 216)) of smolts would die due to the direct and indirect effects of dam passage.

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 Sebasticook 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 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 our analysis, we assume that kelt survival at the Benton Falls Project will be increased from approximately 95% to 97% due to the lowering of the narrow spaced rack over the intake to unit 1 when kelts are expected to migrating past the project. As such, we expect that 3% of adults that migrate back downstream after spawning will be killed due to the effects of passage.

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 10 year life of the amended license.

8.3.1.1 Survival Analysis

The first step in conducting the jeopardy analysis is to assess the effects of the proposed action on the survival of the species. Survival is defined as the condition in which a species continues to exist into the future while retaining the potential for recovery. This condition is characterized by a species with a sufficient population, represented by all necessary age classes, genetic heterogeneity, and number of sexually mature individuals producing viable offspring, which exists in an environment providing all requirements for completion of the species' entire life cycle, including reproduction, sustenance, and shelter (USFWS and NMFS 1998).

The jeopardy analysis makes a conclusion regarding the survival and recovery of the GOM DPS of Atlantic salmon as a whole, and not just survival and recovery of the species in the action area. Therefore, in the survival and recovery portions of this analysis, we consider how the effects to individual salmon that were identified in the "Effects of the Actions" section of this Opinion will affect the Sebasticook River population of Atlantic salmon, how the effects to the Sebasticook 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 Benton Falls Project passes Atlantic salmon upstream and downstream in some years. A basic model can predict the effect that the proposed changes at the Benton Falls Project will have on the number of returning Atlantic salmon to the Sebasticook River during this phase given the lack of stocking in combination with poor marine and freshwater survival. As indicated above, an average of one salmon per year have passed the Benton Falls Project over the last 15 years, ranging between 0 and 5 individuals annually. Based on information from NOAA's Northeast Fisheries Science Center (Nieland et al., 2013), we expect approximately 216 smolts to be produced from two potential spawning events[23], which is likely the most that would be expected if only five 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 maximum number of adults that would be expected to return to the river. If all 216 smolts successfully transitioned to the marine environment, we would expect 0.28 adults to return to the Sebasticook River to spawn. Adding the mortality rates for smolts estimated for the Benton Falls Project (including hydrosystem delayed mortality, but excluding impoundment mortality), reduces the estimated number of returns to 0.24 adults under baseline conditions, and 0.26 adults 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 five spawning adults, it is extremely unlikely that those adults would produce any returning adults, regardless of the effects of the Benton Falls 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 Benton Falls 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 8% ((0.26-0.24)/0.24) compared to current conditions; however, given the very small numbers being considered, the impact on the population is not likely to be detectable.

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

[23] Nieland et al (2013) estimated an average egg-to-smolt survival rate of 1.31%. When multiplied by the estimated average number of eggs per female (8,304 eggs), we can estimate that 108 smolts can be produced by a single female. If we assume that only half of the salmon passed are female, then we can conclude that only two spawning events would likely occur if only five salmon are passed at the project.

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 Sebasticook 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 Sebasticook River contributes minimally, if at all, 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 SHRU ranged between 18 and 127 annually; with an average return of 55 individuals (derived from data in USASAC 2020). The Sebasticook River has not significantly contributed to the number of returns during this timeframe. Therefore, we anticipate that although effects to salmon will continue to occur at the Benton Falls Project, the consequences of the reduction in reproduction and numbers resulting from the loss of individual salmon in the Sebasticook River during the SPP period (i.e., 2024-2034) 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) would lead to approximately an 8% 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 Sebasticook 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 Benton Falls Project would continue to affect every salmon that passes upstream 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 Sebasticook River, as we don't anticipate that the operation the fishway 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 Sebasticook under these conditions.

In summary, the proposed actions improve passage conditions in the Sebasticook River and will not result in a reduction of the numbers, reproduction, and distribution of Atlantic salmon in the action area, the Sebasticook 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 Sebasticook 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 Sebasticook 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 Benton Falls Project, which would result in an increase in numbers and reproductive output of Atlantic salmon in the Sebasticook 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 Sebasticook 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 Sebasticook River.

8.3.1.2 Recovery Analysis

The second step in conducting the jeopardy analysis is to assess the effects of the proposed action on the recovery of the species. Recovery is defined as the improvement in the status of listed species to the point at which listing is no longer appropriate under the criteria set out in section 4(a)(1) of the ESA (USFWS and NMFS, 1998). As with the survival analysis, there are three criteria that are evaluated under the recovery analysis: reproduction, abundance, and distribution.

In 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 license 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.

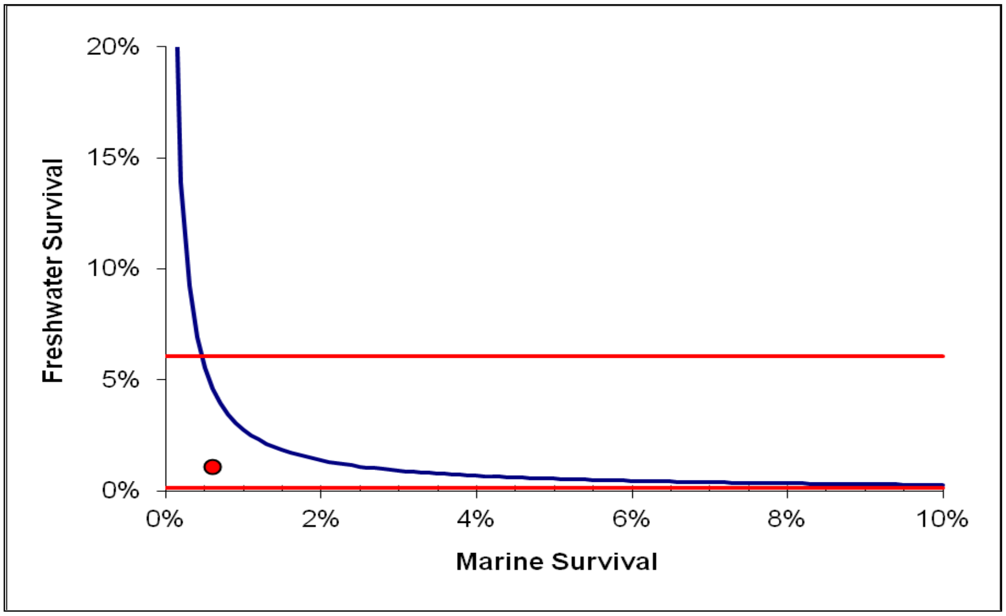

Figure 11. NMFS (2010) conceptual model depicting marine and freshwater survival relative to recovery of the GOM DPS of Atlantic salmon (Note: The dot represents current conditions, the curved line represents recovery, and the straight lines are the historic maximum and minimum freshwater survival).

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 Sebasticook River, which reduces the number of smolts and adults surviving to reproduce in the Sebasticook River and in the Merrymeeting Bay SHRU. We anticipate that these effects will be reduced with the implementation of the proposed action at the Benton Falls 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 an 8% increase in returns to the Sebasticook 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 Sebasticook 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 4.4.1) 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. The Project will continue to limit access to almost all of the habitat in the Sebasticook River

Although the Benton Falls Project will continue to adversely affect juvenile and adult Atlantic salmon in the Sebasticook River, they will not affect salmon outside of the Sebasticook River; that is, salmon in the rest of the habitat within the Merrymeeting Bay SHRU. The SHRU contains three rivers (i.e., Sheepscot, Kennebec, and Androscoggin) that support small runs of Atlantic salmon. While the proposed action will adversely affect Atlantic salmon in the Sebasticook River, it will not significantly affect the salmon in the Kennebec as a whole, as most of the high quality spawning and rearing habitat, as well as stocking and natural reproduction, occurs upstream of the dams on the mainstem Kennebec. Additionally, the actions at Benton Falls will not affect the runs in the other two rivers (Sheepscot, Androscoggin) in any way. 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 Benton Falls Project will result in a reduction in the number of Atlantic salmon in the Sebasticook River compared to the number that could occur if there was no dam related mortality. While Atlantic salmon mortality caused by the Benton Falls Project will continue to reduce the numbers and reproduction of Atlantic salmon in the Sebasticook 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 ten year term of the action given the low freshwater and marine survival, as well as the lack of stocking or natural production in the Sebasticook 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 very small proportion of salmon in the Merrymeeting Bay SHRU that return to the Sebasticook River, 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.

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, the environmental baseline for the action area, the effects of the action, and the cumulative effects, it is our biological opinion that the proposed action may adversely affect but is not likely to jeopardize the continued existence of the GOM DPS of Atlantic salmon, shortnose sturgeon, or the GOM DPS of Atlantic sturgeon. As there is no designated critical habitat in the action area, there will be no effects to any critical habitat.

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."*[24] 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. §

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

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 BFA 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 BFA 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 Benton Falls Project will not exceed 5% (Table 6). In addition to direct mortality, it is anticipated that 4% of smolts that survive passage at Benton Falls could die in the estuary due to migratory delay and sublethal effects of dam passage (i.e., hydrosystem delayed mortality). We, therefore, anticipate that 9% of all smolts that pass downstream of the Benton Falls Project during the ten year term of the SPP will be killed. In addition to mortality, we anticipate that the proposed action will lead to the sublethal injury of 3% of smolts, and the harassment of 4% 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., 4%) or sublethal injury rates (i.e., 3%).

Kelts

The best available information indicates that 97% of kelts will survive passage at the Benton Falls Project under proposed conditions. Therefore, this ITS exempts the death of up to 3% of kelts migrating in the action area annually.

Prespawn Adults

We conservatively estimate that the Benton Falls fishway will pass a minimum of 79% of motivated prespawn salmon. As such, 21% of pre-spawn Atlantic salmon in the action area could be prevented from passing upstream during each of the ten years remaining in the project's license (i.e., the term of the SPP). These fish will be harassed due to the energetic costs associated with migratory delay and the need to search for alternative spawning habitat. Given these rates and a maximum of five salmon expected annually, we anticipate that no more than 50 Atlantic salmon will pass the project over the term of the SPP, and an additional 13 will fail to pass and will be harassed. Additionally, we anticipate that 89% of salmon that successfully pass the Benton Falls Project (in addition to the 21% that fail to pass), 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 will be harassed during the term of the SPP if it becomes stranded in the ledges downstream of the Benton Falls Project.

Table 6. Anticipated take of Atlantic salmon associated with the Benton Falls (10-year) proposed license amendment.

Species	Life Stage	Source	Type	Take Estimate
Atlantic salmon	Smolt	Downstream Passage	Mortality	5%
		Indirect (HDM)	Mortality	4%
		Passage Injury	Injury	3%
		Delay (%>24 hr)	Harrass	4%
	Adult	Downstream Passage (kelts)	Mortality	3%
		Passage Failure (prespawn)	Harrass	21%
		Delay (%>48 hr)	Harass	89%
		Stranding	Harass	1 adult
Shortnose sturgeon	Adult	Trapping	Capture	1 adult
	Adult	Stranding	Harass	1 adult
Atlantic sturgeon	Adult	Trapping	Capture	1 adult
	Adult	Stranding	Harass	1 adult

Fish Passage Monitoring

All Atlantic salmon smolts used in the downstream passage studies will be handled and injured due to tag insertion. The proposed smolt studies are expected to involve handling and surgical implantation of radio tags in up to 200 smolts per project per year, for a total of 600 smolts. Of these, up to 2% (12 smolts) are expected to die due to handling and tagging. The remaining smolts are expected to be harmed and injured due to tag implantation and handling.

If sufficient stocking occurs upstream of the dams to allow for 40 or more fish to return to the Benton Falls project, a one-year efficiency study will be conducted to determine the level of take. For this study, up to 50 adults will be surgically implanted with radio tags. Given the number of Atlantic salmon being tagged, it is expected that no more than one adult Atlantic salmon would be killed as part of the upstream passage study. Injuries are expected to be minimized by having trained professionals conduct the procedures using established protocols.

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 no more than two adult shortnose sturgeon will become stranded or captured in the fish lift (one each) at the Benton Falls Project over the ten year term of the proposed license amendment (Table 6). Capture, handling, and biological sampling could lead to the minor injury of two shortnose sturgeon at the Benton Falls Project as a result of the proposed action.

Similarly, we anticipate that no more than two adult Atlantic sturgeon will become stranded or captured in the fish lift (one each) at the Benton Falls Project over the ten year term of the proposed license amendment (Table 6). Capture, handling, and biological sampling could lead to the minor injury of two Atlantic sturgeon at the Benton Falls Project as a result of the proposed action.

10.2 Reasonable and Prudent Measures

The following reasonable and prudent measures are necessary and appropriate to minimize and monitor incidental take of Atlantic salmon, shortnose sturgeon, and Atlantic sturgeon. These reasonable and prudent measures and terms and conditions are in addition to the measures contained in the January 24, 2022 SPP and BA 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 license, we do not repeat them here as they are considered to be part of the proposed action.

1. Effects to ESA listed salmon and sturgeon must be minimized and monitored during project operations.

2. Project modifications and operations and effects to ESA listed species must be documented and reported throughout the life of the licenses.

10.2.1 Terms and Conditions

In order to be exempt from the prohibitions of section 9 of the ESA, FERC must comply (and ensure that the Licensee comply) with the following terms and conditions, which implement the reasonable and prudent measures above. These include take minimization, monitoring, and reporting measures required by the section 7 regulations (50 C.F.R. §402.14(i)). If FERC fails to ensure compliance with these terms and conditions and the reasonable and prudent measures they implement, the protective coverage of section 7(o)(2) may lapse.

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

1. Prepare and implement, in consultation with NMFS, a plan to measure the survival, migratory delay, and injury of downstream migrating Atlantic salmon smolts at the Benton Falls Project using a scientifically acceptable methodology. This plan must be submitted to NMFS for review and concurrence at least 90 days prior to the planned start of the study, which should occur two years after the first year where more than two salmon are passed upstream of the project.
    a. The survival study must include the following components:
        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. BFA should consult with NMFS to identify a location that is sufficiently far downstream to document the effect of passage.
        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. Use a sufficient number of study fish to provide statistically valid results.
        iii. Procedures for the licensee to consult with NMFS concerning the application of appropriate statistical methodology and requirements for providing an electronic copy of model(s) and data to NMFS.
    b. BFA must develop a plan to evaluate smolt injury attributable to dam passage at the Benton Falls Project. This plan must be submitted to NMFS for review and concurrence at least 90 days prior to the planned start of the study. BFA must consult with NMFS regarding appropriate study timing and methodology.
    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.
    d. A draft of the study report must be submitted to NMFS for review and comment by the end of the calendar year in which the study is conducted. The final report should be filed by March 31 of the following year.
2. Prepare in consultation with NMFS a plan to evaluate adult Atlantic salmon upstream and downstream passage at the Benton Falls Dam. This plan must be submitted to NMFS for review and concurrence, and must be modified in accordance with any comments provided by NMFS. The plan must be completed one year after the first year of 40 or more fish passing the project, or one year after the stocking of sufficient juveniles upstream of the dam to produce at least 40 returning adult Atlantic salmon, whichever occurs first.
    a. Conduct an upstream passage study at the Benton Falls Project after two years of 40 or more salmon passing the project, or when sufficient juvenile salmon stocking

occurs upstream of the project to produce at least 40 returning adult Atlantic salmon, whichever occurs first. If sufficient stocking occurs upstream of the project, the study should be conducted in the year that adults are anticipated to return.

i. As a component of their upstream passage studies, BFA must document the amount of migratory delay that occurs at the Benton Falls Dam.
ii. As a component of this study, BFA must monitor the survival of downstream migrating adult salmon 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.
iii. A Cormack-Jolly-Seber (CJS) model, or other acceptable approach, must be used to determine if the survival estimate and associated error bounds are within the scope of published telemetry work for salmon in the region.
iv. BFA must consult with NMFS concerning the application of appropriate statistical methodology and must provide an electronic copy of model(s) and data to NMFS.
v. 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 Benton Falls Project, BFA 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. Within one year of the issuance of this Opinion, consult with NMFS regarding the timing, location, and placement of the receiver. Provide all PIT tag data to NMFS in a written report annually by December 31.

3. Require that BFA operate the upstream and downstream fishways at the Benton Falls Project to ensure that passage of Atlantic salmon is safe, timely, and effective.
   a. Remove any debris that could affect the ability of fish to pass either the downstream or upstream fish passages immediately upon identification of any such debris.
   b. Planned annual maintenance requiring the shutdown of upstream fish ways must be conducted during a two week period during the month of August. The fishway must not be inoperable for any longer than it takes to make the necessary repairs. NMFS must be notified of any emergency repairs during the fish passage seasons and all efforts must be made to reduce any downtime.
   c. Consult with NMFS regarding the timing of the replacement of flashboards in order to minimize potential effects of reduced flow to listed fish and passage conditions at the project.
   d. Develop, in consultation with NMFS, an appropriate schedule for regularly surveying the pools downstream of the Benton Falls Dam for stranded Atlantic salmon, shortnose sturgeon, and Atlantic sturgeon. This plan must be completed no later than March 31, 2024 and be implemented for the 2024 fish passage season and all subsequent fish passage seasons.
4. Require that BFA update the sturgeon handling plan to incorporate the following conditions:
   a. BFA must record the weight, length, and condition of all sturgeon that are handled and submit this information to NMFS on the appropriate form (see: https://media.fisheries.noaa.gov/2021-07/Take%20Report%20Form%2007162021.pdf?null). Sturgeon must also be scanned for PIT tags. Fin clips will be taken and submitted to

the Atlantic Coast Sturgeon Tissue Repository for genetic analysis, following NMFS recommended procedures as outlined here: https://media.fisheries.noaa.gov/dam-migration/sturgeon_genetics_sampling_revised_june_2019.pdf (or in any update to those procedures). Captured sturgeon, regardless of the presence or scale of injury, must be safely returned to the Sebasticook River downstream of the Benton Falls Project.

b. In the unlikely event that a dead sturgeon is observed, it must be held until disposition instructions are provided by NMFS. If at all possible, the carcass must be placed on ice or be refrigerated. NMFS must be contacted immediately (nmfs.gar.incidental-take@noaa.gov) for further instructions on transport and/or disposal.

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

5. Inspect the upstream and downstream fish passage facilities at the Benton Falls Project daily when they are open. The licensee must submit written summary reports to NMFS weekly during the fish passage season. Reports should be submitted on Monday and briefly characterize passage events and conditions, including any notable issues observed during daily inspections, at the project fishways the previous week. Reports should include the number of Atlantic salmon documented passing the project, the number of sturgeon captured in the fishway, as well as any observations regarding the physical condition of the fish.
6. Notify NMFS in writing of any changes in operation including maintenance activities and debris management at the project within 30 days of identifying the need for such changes. This must include an opportunity for NMFS to provide comments on the proposed changes.
7. Submit as-built drawings to NMFS for the current configuration of the upstream and downstream fishways within 90 days of the license being amended.
8. Allow NMFS staff to inspect the upstream and downstream fishways at reasonable times, including but not limited to annual engineering inspection. NMFS staff will coordinate with the licensee directly each year to schedule routine inspections.
9. Update the Fishway Operations and Maintenance Plan within 90 days of issuance of the license amendment to ensure it is consistent with the requirements of the license amendment, the terms and conditions of this Opinion, and the most recent version of the State of Maine's *Atlantic salmon Trap Operating and Fish-Handling Protocols* (except where it may conflict with the terms and conditions included with this Incidental Take Statement). A draft of the plan must be provided to NMFS for review and concurrence. Following NMFS concurrence with the revised plan, the licensee must coordinate with NMFS at least every 3 years to review the plan and make any necessary updates.
10. In the event of a serious injury or mortality of any ESA listed species, the licensee must immediately notify NMFS of the incident (as required in T&C #12) and allow NMFS access to investigate the source of the mortality and work in cooperation with NMFS to identify the cause of the serious injury/mortality. The licensee must develop a plan to reduce or eliminate the cause of serious injury or mortality and, upon receipt of any necessary approvals, implement that plan as soon as possible to prevent additional incidences.
11. Submit annual reports summarizing the results of the proposed action (including fishway operation dates, numbers of fish captured or passed, anomalous passage conditions experienced, flashboard replacement timing, results of stranding monitoring in the

downstream ledges) and any takes of listed sturgeon or Atlantic salmon to NMFS by March 31 of each year.

12. 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: nmfs.gar.incidental-take@noaa.gov.
13. In the event of any lethal takes, any dead specimens or body parts must be photographed, measured, and preserved (refrigerate or freeze) until disposal procedures are discussed with NMFS.

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

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

RPM #1 and its associated Term and Conditions for FERC are necessary and appropriate as they describe how FERC and BFA will be required to implement the measures and monitor their success. These terms and conditions also describe the protocol BFA must follow to adequately minimize effects to individual salmon and sturgeon that use the Benton Falls fishway or are stranded downstream of the dams. Term and Conditions #1 and #2 require that BFA 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 Condition #2(a) establishes a realistic schedule for the initiation of an upstream passage evaluation at the project. The proposal indicates that a study will be initiated if 40 or more salmon pass the project in two consecutive years. We would not expect this to occur unless a significant stocking effort was underway upstream of the project. If such an effort occurred, we would be able to estimate with some degree of certainty the year that 40 or more fish would be expected to pass the Benton Falls Project. As such, the stocking effort is a more reliable trigger for the upstream passage evaluation. Term and condition #2(b) requires that BFA 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. Term and Conditions #3 and #4 make minor modifications to the action that will allow for more effective protection for listed salmon and sturgeon. 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 Benton Falls 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 BFA 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.

10.2.2 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.

FERC should require that BFA develop a comprehensive strategy to compensate for all unavoidable effects of their actions in the GOM DPS of Atlantic salmon by requiring the licensee to carry out activities that improve the environmental baseline. This could involve the removal of other barriers to fish migration, or the construction of fishways. FERC and the licensee should work closely with the state and federal fisheries agencies to identify suitable projects that contribute to the recovery of Atlantic salmon and address the effects of degradation of designated critical habitat, over the duration of the new license and license amendments.

10.2.3 Reinitiation Notice

This concludes formal consultation concerning FERC's proposal to amend the licenses of the Benton Falls Project for ten years. 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 BFA not carry out the non-discretionary RPMs or associated Terms and Conditions contained within this Opinion.

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