NATIONAL MARINE FISHERIES SERVICE

ENDANGERED SPECIES ACT
BIOLOGICAL OPINION

Agency:	Federal Energy Regulatory Commission (FERC) US Army Corps of Engineers, New England District
Activity Considered:	**Amendment of the Licenses for the Lockwood (2574), Shawmut (2322), Weston (2325), Brunswick (2284), and Lewiston Falls (2302) Projects**
	NER/2013/9613 GARFO-2013-00018
Conducted by:	National Marine Fisheries Service Northeast Region
Date Issued:	7/19/2013
Approved by:	

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1. INTRODUCTION AND BACKGROUND

This constitutes the biological opinion (Opinion) of NOAA's National Marine Fisheries Service (NMFS) 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) approval of applications to amend the licenses for the construction of new upstream fishways at the Lockwood (P-2574), Shawmut (P-2322), and Weston (P-2325) Projects, as well as the incorporation of an Interim Species Protection Plan (ISPP) for Atlantic salmon at the Lockwood, Shawmut Weston, Brunswick (P-2284), and Lewiston Falls (P-2302) Projects. Additionally, this consultation will address the effects of a proposed Atlantic and Shortnose Sturgeon Handling and Protection Plan at the Lockwood and Brunswick Projects.

By an application filed with FERC on February 21, 2013, FPL Energy Maine Hydro LLC (FPL Energy), representing Merimil Limited Partnership (Merimil) and itself (licensee), requested that the licenses for the Lockwood, Shawmut, Weston, Brunswick, and Lewiston Falls Projects be amended to incorporate provisions from a proposed seven year ISPP for Atlantic salmon (2013-2019). This Opinion only considers the effects of these Projects on salmon for the duration of this interim period; therefore, take authorization for Atlantic salmon expires in 2019. In addition, the licensee filed an application on March 29, 2013 to implement an Atlantic and Shortnose Sturgeon Handling and Protection Plan at the Lockwood and Brunswick Projects. The Sturgeon Handling and Protection Plans would become part of the project licenses and, therefore, this Opinion considers the effects to sturgeon between 2013 and the license expiration dates (2029 at Brunswick and 2036 at Lockwood). In letters dated February 7, 2013 and March 25, 2013, the FERC designated the licensee as their non-federal representative to conduct informal ESA consultation with us.

This Opinion is based on information provided in the FERC's March 14, 2013 (Atlantic salmon) and May 1, 2013 (shortnose and Atlantic sturgeon) Biological Assessments, as well as the ISPP and Sturgeon Handling and Protection Plan. A complete administrative record of this consultation will be maintained at our Maine Field Office in Orono, Maine. Formal consultation was initiated on March 14, 2013.

In addition to FERC, another federal agency, the U.S. Army Corps of Engineers (ACOE), may take action to authorize the construction of the new fishways at the Lockwood, Shawmut, and Weston Projects. The ACOE would authorize the proposed actions pursuant to section 404 of the Clean Water Act and section 10 of the Rivers and Harbors Act for wetlands impacts and fill associated with the projects. Pursuant to the section 7 regulations (50 CFR §402.07), when a particular action involves more than one Federal agency, the consultation responsibilities may be fulfilled through a lead agency. FERC is the lead Federal agency for the proposed actions under consideration in this consultation.

1.1. Consultation History

- July 30, 2009 – FPL Energy submitted a letter to us stating their intention to take measures to protect Atlantic salmon.

- May 21, 2010 – FPL Energy submitted a letter to us indicating their intent to obtain an Incidental Take Permit through a Habitat Conservation Plan under section 10 of the ESA.

- September 23, 2010 – FPL Energy met with us to discuss the section 10 process and to review the content requirements of a Habitat Conservation Plan.
- October 2010 – FPL Energy initiated the section 10 process and formed technical advisory and steering committees that met several times in 2011 and 2012.

- February 2012 – FPL Energy submitted a draft Habitat Conservation Plan to us for review.

- November 2012 – FPL Energy met with us to discuss the section 7 process and the species protection plan process.

- January 30, 2013 – FPL Energy met with us and indicated their intention to proceed with developing a interim species protection plan, and that they would request that FERC modify the project licenses to incorporate the proposed provisions.

- January 31, 2013 – FPL Energy submitted a letter to FERC requesting designation as a non-federal representative for the purposes of informal consultation on Atlantic salmon.

- February 7, 2013 – FERC designated FPL Energy to act as its non-federal representative in conducting informal consultation under section 7 of the ESA regarding federally listed Atlantic salmon at the Lockwood, Shawmut, Weston, Brunswick, and Lewiston Falls Projects.

- February 21, 2013 - FPL Energy submitted a draft BA to FERC.

- March 14, 2013 – FERC adopted the BA and submitted a letter to NMFS requesting the initiation of formal consultation.

- March 25, 2013 - FERC designated FPL Energy to act as its non-federal representative in conducting informal consultation under section 7 of the ESA regarding federally listed shortnose and Atlantic sturgeon at the Lockwood and Brunswick Projects.

- March 29, 2013 – FPL Energy submitted a draft BA for Atlantic and shortnose sturgeon to FERC as an addendum.

- May 1, 2013 - FERC adopted the BA and submitted a letter to NMFS requesting the initiation of formal consultation for Atlantic and shortnose sturgeon at the Lockwood and Brunswick Projects.

- May 10, 2013 – NMFS submitted a letter to FERC indicating that all of the information required to initiate a formal consultation for Atlantic salmon, shortnose sturgeon, and Atlantic sturgeon had been received. In this letter NMFS noted that the date that the original initiation request was received (March 14, 2013) will serve as the commencement of the formal consultation process.

1.2. Relevant Documents

The analysis in this Opinion is based on a review of the best available scientific and commercial information. Specific sources are listed in Section 13 and are cited directly throughout the body of the document. Primary sources of information include: 1) information provided in FERC's March 14, 2013 initiation letter and attached BA and ISPP in support of formal consultation under the ESA; 2) information provided in the draft BA submitted to FERC by the licensees describing the effects of the sturgeon handling and protection plan; 3) Determination of Endangered Status for the Gulf of Maine Distinct Population Segment of Atlantic salmon; Final Rule (74 FR 29345; June 19, 2009); 4) Status Review for Anadromous Atlantic Salmon (*Salmo salar*) in the United States (Fay *et al.* 2006); 5) Designation of Critical Habitat for Atlantic salmon Gulf of Maine Distinct Population Segment (74 FR 29300; June 19, 2009); 6) Final Recovery Plan for Shortnose Sturgeon (December, 1998); and 7) Final listing determinations for the five distinct population segments of Atlantic sturgeon (*Acipenser oxyrinchus oxyrinchus*). On February 6, 2012, we published notice in the *Federal Register* listing the Atlantic sturgeon as endangered in the New York Bight, Chesapeake Bay, Carolina, and South Atlantic DPSs, and as threatened in the Gulf of Maine DPS (77 FR 5880 and 77 FR 5914).

1.3. 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 (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. In conducting analyses of actions under section 7 of the ESA, we take the following steps, as directed by the consultation regulations:

- Identifies the action area based on the action agency's description of the proposed action (Section 2);
- Evaluates the current status of the species with respect to biological requirements indicative of survival and recovery and the essential features of any 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 any designated critical habitat (Section 4);
- Evaluates the relevance of climate change on environmental baseline and status of the species (Section 5);
- Determines whether the proposed action affects the abundance, reproduction, or distribution of the species, or alters any physical or biological features of designated critical habitat (Section 6);
- Determines and evaluates any cumulative effects within the action area (Section 7); and,
- Evaluates whether the effects of the proposed action, taken together with any cumulative effects and the environmental baseline, can be expected, directly or indirectly, to reduce

appreciably the likelihood of both the survival and recovery of the affected species, or is likely to destroy or adversely modify their designated critical habitat (Section 8).

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

The critical habitat analysis determines whether the proposed action will destroy or adversely modify designated or proposed critical habitat for ESA-listed species by examining any change in the conservation value of the primary constituent elements of that critical habitat. This analysis focuses on statutory provisions of the ESA, including those in section 3 that define "critical habitat" and "conservation", in section 4 that describe the designation process, and in section 7 that set forth the substantive protections and procedural aspects of consultation. Although some "properly functioning" habitat parameters are generally well known in the fisheries literature (e.g., thermal tolerances), for others, the effects of any adverse impacts are considered in more qualitative terms. The analysis presented in this Opinion does not rely on the regulatory definition of "adverse modification or destruction" of critical habitat at issue in the 9th Circuit Court of Appeals (Gifford Pinchot Task Force *et al.* v. U.S. Fish and Wildlife Service, No. 03-35279, August 6, 2004).

2. PROJECT DESCRIPTION AND PROPOSED ACTION

FERC is proposing to amend the licenses held by the licensee for the Lockwood, Shawmut, Weston, Brunswick, and Lewiston Falls Projects to incorporate the provisions of an ISPP for Atlantic salmon. The Lockwood, Shawmut, and Weston Projects are, respectively, the first, third, and fourth dams on the Kennebec River; while the Brunswick and Lewiston Falls Projects are the first and fourth dams on the Androscoggin River (Figure 1). The provisions of the ISPP include the installation of new upstream fishways at the Lockwood, Shawmut, and Weston Projects in the Kennebec River, and the implementation of upstream and downstream passage and survival studies for Atlantic salmon. These studies are to be conducted as part of an adaptive management strategy designed to achieve high passage and survival rates for Atlantic salmon through the Lockwood, Shawmut, Weston, and Brunswick Projects. Although no new measures or structures are being proposed for the Lewiston Falls Project, FERC is proposing to amend the license to require the licensee to meet with us every five years to ensure that operation of the Project is consistent with the recovery objectives for Atlantic salmon and other listed fish species. The licensee will also cooperate with NMFS, USFWS, and MDMR on the installation and operation of a rotary screw trap (RST) in the Sandy River, for a period of up to three years (2013-2015). The purpose of the RST is to improve knowledge and to identify the period of downstream migration of Atlantic salmon smolts on the Kennebec River. In addition, the licensee proposes to implement a Sturgeon Handling and Protection Plan at the Brunswick and Lockwood Projects.

This Opinion considers effects of the operation of Lockwood, Shawmut, Weston, Brunswick, and Lewiston Falls Projects by the licensees between 2013 and 2019 under the terms of the revised operating licenses as proposed by FERC (Table 1).

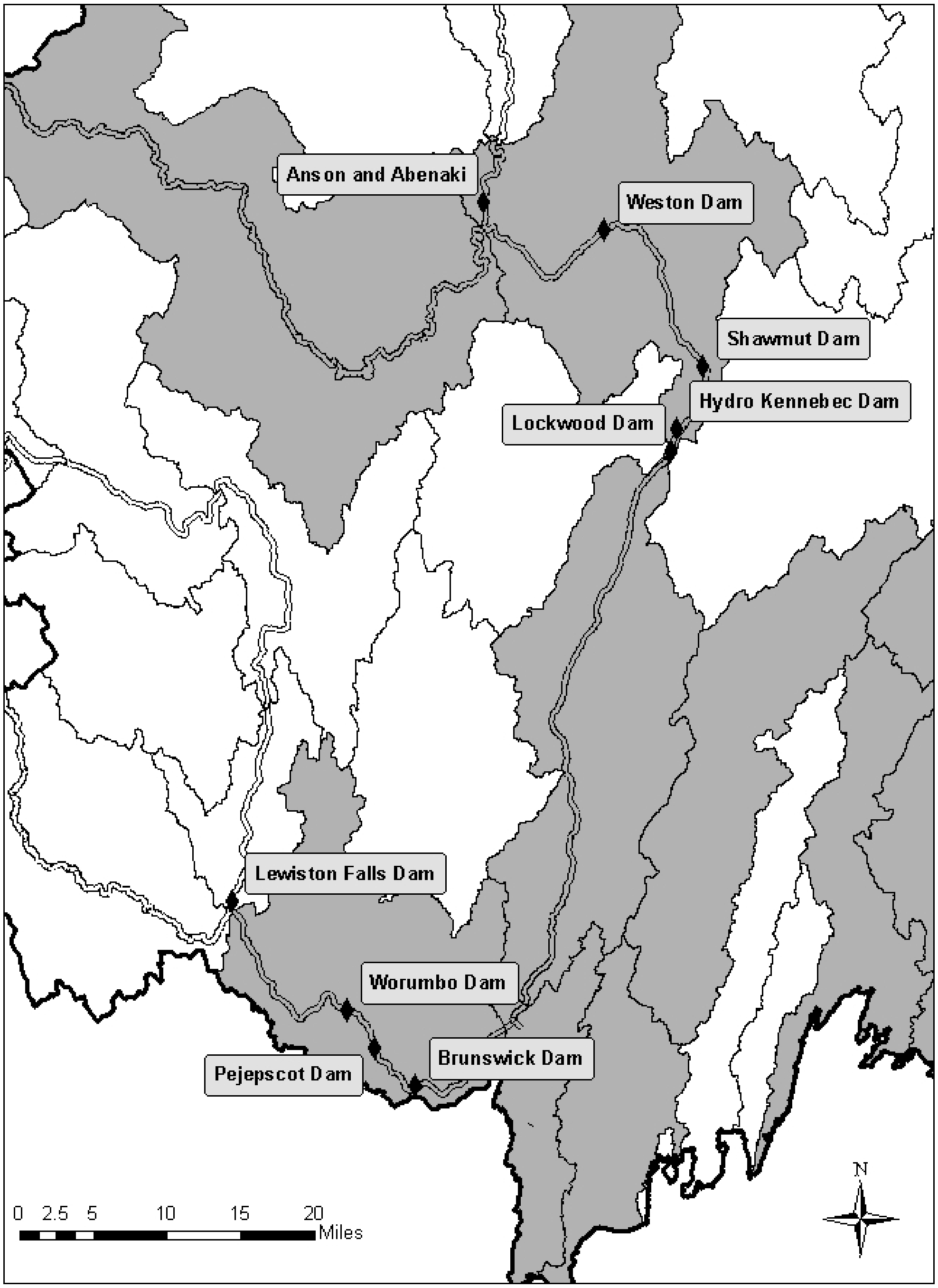

Figure 1. The lower Kennebec and Androscoggin River watersheds with mainstem dams and Atlantic salmon critical habitat (in gray) indicated.

Table 1. The licensee's proposed schedule for the implementation of the interim species protection plan for Atlantic salmon and the Atlantic and shortnose sturgeon handling and protection plan.

Year	Activity
2013	• Licensee develops Atlantic salmon ISPP and draft BA and file them with FERC • Licensee files a Sturgeon Handling and Protection Plan for Atlantic sturgeon and shortnose sturgeon as an addendum • FERC issues BA • Assuming the proposed action does not jeopardize the continued existence of any listed species or destroy/adversely modify designated critical habitat, NMFS will issue a BO and ITS covering Lockwood, Shawmut, Weston, Brunswick, and Lewiston Falls projects for the period 2013 – 2019 • FERC issues license amendments for the Lockwood, Shawmut, Weston, Brunswick and Lewiston Falls projects • Licensee conducts Atlantic salmon smolt downstream passage survival studies (paired release) at Lockwood, Shawmut, Weston, and Brunswick projects (year 1)* • Licensee extends period that upstream and downstream bypass facilities are operated at Brunswick Project • Licensee conducts Atlantic salmon adult upstream passage effectiveness monitoring studies at Brunswick Project, in cooperation with licensees for the Pejepscot and Worumbo projects (year 1) • Licensee operates rotary screw trap in cooperation with NMFS and MDMR to collect smolt out-migration data in Sandy River (year 1)* • Licensees implement the provisions of the Sturgeon Handling Protection Plan at the Lockwood and Brunswick Projects. These plans will be implemented throughout the terms of the existing licenses.
2014	• Licensee conducts Atlantic salmon smolt downstream passage survival studies (paired release) at Lockwood, Shawmut, Weston and Brunswick projects (year 2) • Licensee conducts Atlantic salmon kelt downstream passage survival studies at Lockwood, Shawmut, Weston and Brunswick projects, in cooperation with upstream projects (year 1) • Licensee operates rotary screw trap to collect smolt out-migration data in Sandy River (year 2) • Licensee designs new upstream volitional fish passage component for the existing Lockwood fishway and investigates upstream passage improvement opportunities at the development • Licensee conducts Atlantic salmon adult upstream passage effectiveness monitoring studies at Brunswick Project, in cooperation with licensees for the Pejepscot and Worumbo projects (year 2)

Year	Activity
2015	• Licensee conducts Atlantic salmon smolt downstream passage survival studies (paired release) at Lockwood, Shawmut, Weston and Brunswick projects (year 3) • Licensee conducts Atlantic salmon kelt downstream passage survival studies at Lockwood, Shawmut, Weston and Brunswick projects, in cooperation with upstream projects (year 2) • Licensee operates rotary screw trap to collect smolt out-migration data in Sandy River (year 3) • Licensee constructs new upstream volitional fish passage component for existing Lockwood fishway • Licensee conducts Atlantic salmon adult upstream passage effectiveness monitoring studies at Brunswick Project, in cooperation with licensees for the Pejepscot and Worumbo projects (year 3)
2016	• Licensee operates new volitional upstream fishway at Lockwood** • Licensee conducts Atlantic salmon adult upstream passage effectiveness monitoring studies at Lockwood (year 1) • Licensee conducts Atlantic salmon kelt downstream passage survival studies at Lockwood, Shawmut, Weston and Brunswick, in cooperation with upstream projects (year 3) • Licensee designs new upstream fish passage facility for Shawmut Project • Licensee initiates FERC relicensing process for Shawmut Project
2017	• Licensee constructs new upstream fish passage facility at Shawmut • Licensee conducts Atlantic salmon adult upstream passage effectiveness monitoring studies at Lockwood (year 2)
2018	• Licensee operates new upstream fish passage facility at Shawmut** • Licensee conducts Atlantic salmon adult upstream passage effectiveness monitoring studies at Lockwood (year 3) • Licensee designs new upstream fish passage facility for Weston Project • Licensee and FERC reinitiate Section 7 consultation
2019	• Licensee constructs new upstream fish passage facility at Weston Project • Licensee develops final SPP covering the period from 2020 to issuance of new FERC project licenses, including additional Atlantic salmon enhancement/protection measures, if determined necessary, based on interim SPP monitoring results • Licensee files final SPP with FERC in 2019 • NMFS issues a BO and ITS to cover period of subsequent SPP (through FERC license expiration date), assuming the proposed action does not jeopardize the continued existence of any listed species or destroy/adversely modify designated critical habitat

* Take from these activities will be authorized under a section 10 research and recovery permit with USFWS
** In accordance with the KHDG Agreement and license requirements, the licensee will begin operating permanent downstream fish passage facilities at the time that upstream passage facilities become operational.

The licensee is committed to an adaptive management approach to implementing this ISPP. The agreed upon fish passage measures and activities are laid out within an adaptive management framework, with integration of management and research in order to provide feedback and the ability to adapt measures, as necessary, for further protection and enhancement of Atlantic salmon. As the proposed interim process is intended to be adaptive, the licensees will be coordinating and consulting with us throughout the seven year period (2013-2019). If early downstream passage study results indicate that the study design is not adequately measuring survival, the licensee will work with us to correct it. Likewise, if the early study results indicate that the downstream fishway is not highly efficient at passing Atlantic salmon, they will coordinate with us and modify operations at the Projects as appropriate to avoid and minimize effects to Atlantic salmon to the extent practicable. To that end, we will meet with the licensee annually to discuss study results, potential modifications to the study design and/or potential changes to the operation of the facility that may be necessary to reduce adverse effects to the species.

In 2020, the new upstream fishway at Weston will be operational. At that time, we expect that Atlantic salmon will be passed volitionally upstream of the Lockwood, Shawmut, Hydro-Kennebec, and Weston Projects. Although not proposed as part of the ISPP, the licensee is committed to meeting their obligations under the 1998 Kennebec Hydro Developers Group (KHDG) Agreement and the terms of their licenses, which require them to have permanent downstream passage facilities operating no later than the date when the new upstream fishways become operational. The proposed studies will be conducted prior to the installation of permanent facilities as required by the KHDG Agreement “to determine the effectiveness of various downstream passage techniques in preparation for the design and installation of permanent downstream facilities” (KHDG 1998). The design of the downstream facilities will be based on the results of the proposed survival studies and will be conducted in consultation with state and federal resource agencies.

Data to inform downstream passage survival standards for Atlantic salmon smolts and kelts in the Kennebec and Androscoggin Rivers are very limited. However, given the best available information, it is anticipated that downstream survival standards that will be incorporated in the final SPP will likely need to be between 96% and 100% at each Project. These standards will be refined using information from passage studies that will be undertaken as part of the ISPP. It is possible that the proposed studies will indicate that the interim downstream passage facilities currently in place are not sufficient to meet the standard and that significant structural and/or operational changes may be necessary to achieve such a high level of survival. The interim period will be used to determine how best to operate or modify the Projects to achieve sufficiently high survival rates. In addition, over the term of the interim period we and/or the licensee will develop a model for the Androscoggin and Kennebec Rivers to provide data that will be used to inform the development of upstream and downstream performance standards.

2.1. Lockwood Project - FERC No. 2574

2.1.1. Existing Hydroelectric Facilities and Operations

The Lockwood Project, owned by the Merimil Limited Partnership (Merimil), is a 6.8 MW hydroelectric project located at river mile 63 and is the first dam on the mainstem Kennebec River (Figure 1). The Lockwood Project includes an 81.5-acre reservoir, an 875 foot long and 17 foot high dam with two spillway sections and a 160 foot long forebay headworks section, a 450 foot long forebay canal, and two powerhouses. The dam and forebay headworks span the Kennebec River at or near the U.S. Route 201 bridge along a site known as Ticonic Falls. The east spillway section begins at the east abutment of the dam and extends about 225 feet in a westerly direction to a small island. The west spillway extends about 650 feet from the small island in a southwesterly direction to the forebay canal headworks, which extend to the west bank of the river. Each spillway is equipped with 15 inch high flashboards.

From the headworks, the forebay canal directs water to two powerhouses located on the west bank of the Kennebec River. The original powerhouse contains six generating units, each with a hydraulic capacity of 660 cfs, and the second powerhouse contains one generating unit with a hydraulic capacity of 1,700 cfs (Table 2). At maximum flow efficiencies for these turbines range from 82 to 86 percent, and at minimum flow efficiencies range from 10 to 51 percent.

Table 2. Lockwood Project Generating Unit Summary

Unit	Turbine Design/Type	Capacity (cfs)	RPM	Max Flow		Peak Efficiency		Min Flow	
				CFS	Effic. (%)	CFS	Effic. (%)	CFS	Effic. (%)
1	Francis/vertical	660 cfs	133	721	86	600	90	266	25
2	Francis/vertical	660 cfs	133	679	85	607	90	297	10
3	Francis/vertical	660 cfs	133	710	84	597	90	266	26
4	Francis/vertical	660 cfs	133	666	82	607	90	239	32
5	Francis/vertical	660 cfs	133	676	86	578	90	289	51
6	Francis/vertical	660 cfs	133	670	82	599	90	314	51
7	Kaplan/horizontal	1,700 cfs	144	1,689	86	775	90	111	35

The Lockwood Project impoundment is 1.2 miles long encompassing a surface area of 81.5 acres and a gross storage volume of only 250 acre-feet. The Lockwood impoundment is riverine in nature and has no significant embayments or shoal areas. The impoundment width is nearly uniform throughout. The substrate of the impoundment consists of a mixture of bedrock, cobble, and rubble with gradual accumulations of silt deposits moving from upstream to downstream. A few shallow littoral areas with gravel or finer substrate and scattered submerged aquatic vegetation beds exist, but much of the shoreline is steep, with depths of five feet only a few feet from the shoreline (FERC 2005).

The Lockwood Project operates as run-of-river. Impoundment drawdowns are generally limited to no more than six inches below the top of the spillway flashboards when the flashboards are in place, and no more than one foot below the spillway crest when the flashboards are being replaced.

The Lockwood Project is operated to provide a minimum flow of 2,114 cfs, or inflow, whichever is less. In addition, three orifices, each three feet long by eight inches high, are annually placed along the spillway. The purpose of the orifices is to pass a 50 cfs minimum flow into the bypass reach. The orifices also provide downstream passage routes along the spillway even when the project is not spilling over the top of the flashboards. During periods of no spillage (approximately 30 percent of the time on an annual basis), the bypassed reach receives leakage plus orifice flows, which range from approximately 50 cfs at full headpond level to approximately 30 cfs at a drawdown of six inches below the top of the flashboards. During flashboard installation, the reach receives only leakage flows.

2.1.1.1. Upstream Fish Passage

In accordance with the FERC license and the 1998 KHDG Agreement, the licensee completed construction of a fish lift, trap, sort, and transport system in 2006. The system was completed and became operational in May 2006. In consultation with resource agencies, the licensee developed operational and effectiveness study plans for the new fish lift. These plans were filed with FERC on January 30, 2006, and approved on April 26, 2006.

The Lockwood fish lift facility is located on the west side of the powerhouse adjacent to Unit 7. The lift operates with an attraction flow of up to150 cfs, and entrance water velocities are four to six feet per second (fps). The lift has an approximate ten minute cycle time.

The attraction flow attracts the fish through the fish lift entrance gate into the lower flume of the fish lift. The fish then swim through a vee-gate crowder and remain in the lower flume of the lift. During the cycling process, the vee-gate crowder closes to hold the fish in the hopper area. The 1,800 gallon water-filled hopper lifts the fish to the holding tank elevation and the fish are sluiced into the 2,500 gallon round discharge tank. Liquid oxygen is introduced into all tanks via carbon micro porous stones to reduce stress and mortality. Two auxiliary water pumps provide a constant flow of ambient river water to all the tanks, and they provide ambient river water to the stocking trucks. The fish lift operates to accommodate all target species, and attraction flows are passed continuously during lift operation. The fish lift is designed to pass up to 164,640 alewives, 228,470 American shad and 4,750 Atlantic salmon per year.

The sorting and trucking portion of the facility includes: one 2,500 gallon, 12 foot diameter, round discharge tank, which collects fish discharged from the 1,800 gallon fish lift hopper; two 1,250 gallon, ten foot diameter, round holding tanks that sluice fish into MDMR stocking trucks; and one 250 gallon, rectangular holding tank for Atlantic salmon. The 2,500 gallon discharge tank is also equipped with piping that can discharge fish back into the tailrace.

The Lockwood upstream fish passage facility operates between May 1 and October 31 to pass anadromous fish. Under a cooperative agreement, the Project owner is responsible for capturing shad, river herring and Atlantic salmon, and the Maine Department of Marine Resources (MDMR) is responsible for collecting biological data and trucking fish to upstream spawning locations. MDMR's role in handling fish at the Lockwood Project is expected to continue through the term of this ISPP, and authorization for that handling will be covered under a section 10 research permit issued by USFWS to MDMR.

During the fish lift operation season, the licensee coordinates daily with the MDMR regarding sorting, counting and trucking operations. During the river herring, American shad and Atlantic salmon migration season (approximately May through mid-July), the fish lift is generally staffed seven days per week, as necessary, to meet resource agency trap and truck requirements. During the run, the fish lift is generally operated from early morning to late afternoon. During other times of the year, the fish lift is generally operated three to five times per day, seven days per week for Atlantic salmon capture. The licensee determines the precise timing of the fish lift operation, in consultation with the MDMR, based on factors such as the number of migrating fish, water temperature, time of year, and river flow. As outlined in the ISPP, the licensee proposes to increase the fish lift cycle to five to eight times per day from approximately mid-July to October 31.

During periods of fish lift operation, personnel routinely monitor four underwater cameras that are connected to a monitor and DVD recorder. The monitor and DVD recorder are located in the control room of the fish lift and typically record from dawn until dusk. The cameras are also used in real time to help determine the presence of fish in the lift and maximize fishing effectiveness. Camera 1 is located just downstream of the vee-gates and provides a good view of fish moving through the vee-gates into the hopper area. Camera 2 is located just upstream of the entrance gate and provides a good view of fish swimming towards and into the fish lift. Camera 3 is located in the river just downstream of the fish lift entrance gate. This location provides a view of the tailrace area below the entrance gate. Camera 4 is positioned between the entrance gate and the sorting tank sluice pipe on the edge of the river. This camera offers another good view of the fish lift entrance gate vicinity. Since all four cameras show good detail, fishway personnel are able to identify species, obtain an approximate number of fish, and initiate the lift cycle manually, when appropriate.

2.1.1.2. Downstream Fish Passage

In accordance with the KHDG Agreement, the licensee is also providing interim measures for downstream Atlantic salmon passage at Lockwood. In addition to the adult salmon trucked to the Sandy River, the MDMR has been stocking Atlantic salmon eggs in the Sandy River above the Weston Project since 2003. Therefore, Atlantic salmon smolts and kelts migrate past the Project every spring.

In 2009, the licensee installed a downstream fish passage facility in the Lockwood power canal. This facility consisted of a ten foot deep floating boom leading to a new seven foot wide by nine foot deep fish sluice and associated mechanical over-flow gate. Maximum flow through the gate is 6% of station capacity or 340 cfs. The sluice is located on the river side of the power canal just upstream of the Unit 1 trash rack and discharges directly into the river. To enhance use of the sluice gate, a guidance boom is seasonally installed in the power canal. The boom is approximately 300 feet long, is secured on the land side of the canal, and angles downstream to the new sluice gate. The boom has flotation, and is suspended in the water column.

The 2009 shakedown period and associated evaluation of the new floating guidance boom and surface sluice gate indicated that the boom was not buoyant and strong enough to handle existing unit flows. In the winter of 2009/2010, the licensee reviewed the available floating boom products on the market and subsequently selected a product manufactured by "Tuffboom."

In early April 2010, the licensee developed a new guidance boom design and consulted with resource agency personnel. The new design consists of two ten foot long plastic cylindrical "Tuffboom" brand floats per section (i.e., 30 sections which equate to 300 feet long) with a four foot deep section of 5/16-inch metal punch plate located in between the floats. Attached to the punch plate is six feet of the 5/16-inch dynema netting used in the 2009 system. All gaps between the panels are covered by rubber flanges. The new boom was installed in May of 2010 and then evaluated using Atlantic salmon smolts and PIT tags. The results of the PIT tag tests were suspect due to issues associated with PIT tag antenna interference, limited PIT tag antenna range, and non-detection of fish.

The licensee subsequently conducted another evaluation using radio telemetry techniques in the spring of 2011. Based upon the 2011 study results, a number of recommendations for enhancing the downstream bypass for Atlantic salmon smolts at Lockwood were developed. These modifications, which were implemented in the spring of 2012, included the replacement of 32 feet of the downstream section of the boom with ten foot deep metal punch plate panels (to replace the vulnerable portion of the existing netting). The modification also included a new flexible attachment point and new larger floats. Finally, the existing trash rack exclusion bars at the entrance of the bypass, which were causing noise and vibration, were removed.

The licensee completed a second Atlantic salmon smolt radio telemetry downstream passage study at Lockwood in the spring of 2012 in order to evaluate the effectiveness of the guidance boom modification completed earlier that spring. During the study, five groups of radio-tagged smolts were released upstream of the Weston Project and their passage routes and bypass usage were recorded at Weston, Shawmut and Lockwood. Two groups of radio-tagged smolts were released upstream of Lockwood, and their passage routes and bypass usage were recorded. Additional data on smolt passage routes and bypass usage at Lockwood were collected from four groups of smolts radio-tagged and released upstream of the Hydro-Kennebec Project, located about one mile upstream from Lockwood. Kennebec River flow conditions during the 2012 study did not allow for all turbine units to run at a 100% gate setting; however, river conditions did allow for the evaluation of passage routes under limited to no spill conditions at Weston, Shawmut and Lockwood, as well as the assessment of downstream passage effectiveness at the Weston and Lockwood Projects. Kennebec River flows during smolt releases were low (exceeded 94% of the time based on the May flow duration curve for the Lockwood Project).

Results of the 2012 study at Lockwood indicate that when smolts from all releases are combined, the bypass effectiveness rate of radio-tagged individuals entering the Lockwood forebay canal (n =128) was 66.4%. This was a significant improvement over the 2011 bypass effectiveness (20.9% at 6% of powerhouse flow), which indicates that the modifications completed during spring 2012 improved downstream passage conditions for smolts. Data was also collected on how many smolts passed through all available passage routes. Individual smolts detected passing Lockwood were originally released upstream of the Weston (n =42), Hydro-Kennebec (n = 72) and Lockwood (n = 39) Projects. Of the 153 smolts that passed the Lockwood Project, 55.6% (85 of 153) passed through the downstream bypass, 13.7% (21 of 153) passed through the Kaplan turbine, 14.4% (22 of 153) passed through the Francis turbines, and 15.7% (24 of 153) passed on spill.

In addition to the new surface sluice gate and associated guidance boom, downstream passage is also provided through the three orifices (three foot long by eight inches high) cut into the flashboards along the spillway. The orifices pass approximately 50 cfs, and provide downstream passage routes along the spillway even when the Project is not spilling over the top of the flashboards. In addition, river flows exceed the turbine capacity for much of the time period that downstream fish migrations occur; thus, providing passage capability via spill over the dam.

2.1.2. Proposed Action

2.1.2.1. Interim Species Protection Plan

The ISPP is valid for a seven-year period (2013- 2019) to allow the licensee to study existing and proposed measures to protect migrating Atlantic salmon. Provisions of the ISPP require the licensee to undertake the following activities:

- Upstream Passage
  - Increase the number of lifts per day from three to five to five to eight between mid-July and the end of October;
  - Construct a volitional upstream fishway (operational in 2016);
  - Continue to use underwater cameras in and around the fish lift to observe Atlantic salmon behavior and identify any issues with Atlantic salmon movement into the fish lift;
  - Monitor areas of the tailrace that can be visually observed for the presence of holding Atlantic salmon and collect information on numbers and time periods;
  - Monitor angler activity near the fish lift and collect available information on numbers of Atlantic salmon accidentally captured or observed;
  - Monitor the bypass reach ledge area during flashboard replacement. With MDMR assistance, collect adult Atlantic salmon for transfer to Sandy River or release back into the Kennebec depending on fish condition and water temperature;
  - Collaborate with Hydro Kennebec Project personnel to gather visual observation data on Atlantic salmon that may migrate to the Hydro Kennebec Project via the Lockwood spillway section; and
  - Conduct Atlantic salmon adult upstream passage effectiveness monitoring studies (2016-2018).

- Downstream Passage
  - Extend period that downstream bypass facilities operate from April 1 to June 15 and November 1 to December 15 to April 1 to December 31, as river and ice conditions allow;
  - Ensure that the bypass gate is open and operating to pass the maximum flow through the gate, which is 6% of station unit flow;
  - Undertake measures necessary to keep the guidance boom in place and in good operating condition. If the guidance boom becomes dislodged or

damaged, repair or replacements to the guidance boom will be made as soon as can be safely and reasonably done; and
- Conduct downstream survival studies for outmigrating smolts (2013-2015) and kelts (2014-2016).

At the end of the seven year period (2019), the licensee will file a final SPP for Atlantic salmon in consultation with FERC. The final SPP will reinitiate formal section 7 consultation under the ESA.

The licensee has proposed to conduct upstream passage studies at the Lockwood Project using pre-spawn Atlantic salmon between 2016 and 2018 as part of the ISPP. Given that few salmon return to the Kennebec River every year, the licensee will need to conduct the studies in such a way that salmon would not be released upriver of the Lockwood Project. If released, they would face a dead end in their migration to suitable spawning and rearing habitat in the Sandy River due to barriers at the Shawmut and Weston Projects.

The ISPP indicates that the new volitional upstream fishway at Lockwood will be designed in 2014, constructed in 2015, and operational in 2016. Although the fishway has yet to be designed, the licensee has indicated that the construction of the fishway will involve a modification to the existing fishway and that the project will not involve any in-water work (R. Richter, Brookfield Renewable Power, pers. comm., 2013).

2.1.2.2. Sturgeon Handling and Protection Plan

Atlantic and shortnose sturgeon have been documented using the habitat downstream of the Lockwood Project. The Lockwood Project has an existing FERC-approved handling plan for shortnose sturgeon, which was updated in March, 2013 (BWPH 2013). On January 12, 2005, we issued an Opinion that considered the effects of the handling plan on shortnose sturgeon. In the Incidental Take Statement (ITS), we exempted the take of up to two shortnose sturgeon annually at the Lockwood Project. The handling plan outlines the procedures that the Project licensees use for handling sturgeon and documenting such interactions at the Lockwood Project. The existing handling plan envisions possible interaction between sturgeon and the project under two scenarios: 1) sturgeon that may find their way into the upstream fish lift, and 2) sturgeon that may become stranded in pools below the Lockwood Dam. The plan outlines measures to be undertaken by the licensee in the event of these two occurrences. The current handling plan is approved for shortnose sturgeon, but identical procedures and measures are appropriate for Atlantic sturgeon, as well. As part of the proposed Sturgeon Handling and Protection Plan amendment, the licensee has updated the Lockwood handling plan for both shortnose and Atlantic sturgeon.

Fish Lift Operations

Atlantic and shortnose sturgeon will not be passed upstream of the Lockwood Project as the dam location is thought to be the historical limit of upstream migration for sturgeon on the Kennebec River (Houston *et al.* 2007), and because of concerns regarding the safety of downstream passage for shortnose and Atlantic sturgeon. The handling plan requires that if sturgeon are found in the fish lift, the following procedures will be implemented:

- For each sturgeon detected, the licensees shall record the weight, length, and condition of the fish. Fish will also be scanned for PIT tags. River flow, bypass reach minimum flow, and water temperature will be recorded.
- If alive and uninjured, the sturgeon will be immediately returned downstream. A long handled net outfitted with non-abrasive knotless mesh will be used to place the sturgeon back into the river downstream of the dam. The fish should be properly supported during transport in the net to ensure that it is not injured. The licensees will report to us within 24 hours any live, uninjured sturgeon that are removed and relocated back to the river.
- If any injured sturgeon are found, the licensees shall report it to us immediately. Injured fish must be photographed and measured, if possible, and the reporting sheet must be submitted to us within 24 hours. If the fish is badly injured, the fish should be retained by the licensees until notified by NMFS with instructions regarding potential rehabilitation.
- If any dead sturgeon are found, the licensees will report it to us within 24 hours. Any dead specimens or body parts should be photographed, measured, scanned for tags and all relevant information should be recorded. Specimens should be stored in a refrigerator by the licensees until we can obtain them for analysis.

Sturgeon Stranding

Annually, the impoundment of the Lockwood Project is lowered to a point where the flashboards can safely be replaced, resulting in a short period (a few hours) of receded flows downstream. During this time, fish could become stranded in isolated pools in the bypass reach. In May 2003, an adult sturgeon, believed to be a shortnose sturgeon, was rescued from a pool at the base of Lockwood Dam during the annual flashboard replacement. The handling plan includes measures to ensure safe handling of any sturgeon stranded during this period. If shortnose or Atlantic sturgeon become stranded, the licensees will return them to the river downstream. The handling plan requires that they follow this protocol:

- Designated employees and fish lift operation staff must monitor the pools below the dam while the flashboards at the project are replaced.
- For each fish removed from the pool, the licensees will record the weight, length, and condition. Fish should also be scanned for PIT tags. River flow, bypass reach minimum flow and water temperature will be recorded.
- If stranded but alive and uninjured, the sturgeon will be moved to the river below the Ticonic Falls that will provide egress out of the area. The licensees shall report to us within 24 hours any live, uninjured sturgeon that are removed and relocated back to the river.
- If any injured sturgeon are found, the licensees will report it to us immediately. Injured fish must be photographed and measured, if possible, and a reporting sheet must be submitted to us within 24 hours. If the fish is badly injured, the fish should be retained by the licensees, if possible, until obtained by a NMFS recommended facility for potential rehabilitation.

- If any dead sturgeon are found, the licensees will report it to us within 24 hours. Any dead specimens or body parts should be photographed, measured, scanned for tags and all relevant information should be recorded. Specimens should be stored in a freezer by the licensees until we can obtain them for analysis.

2.2. Shawmut Project - FERC No. 2322

2.2.1. Existing Hydroelectric Facilities and Operations

The Shawmut Project is located at river mile 66 and is the third dam on the mainstem of the Kennebec River (Figure 1). The Shawmut Project includes a 1,310-acre reservoir, a 1,135 foot long dam with an average height of about 24 feet, headworks and intake structure, enclosed forebay, and two powerhouses. The crest of the dam has a 380 foot section of four foot high hinged flashboards serviced by a steel bridge with a gantry crane; a 730 foot long section of dam topped with an inflatable bladder composed of three sections, each 4.46 feet high when inflated; a 25 foot wide by eight foot deep log sluice equipped with a timber and steel gate; and a surface sluice (four feet wide by 22 inches deep), next to Unit # 7, which discharges into a three foot deep man-made plunge pool.

The headworks and intake structure are integral to the dam and the powerhouse. The forebay intake section contains 11 headgates and two filler gates. A non-overflow concrete gravity section of dam connects the west end of the forebay gate openings with a concrete cut-off wall, which serves as a core wall for an earth dike. The forebay is located immediately downstream of the headgate structure and is enclosed by two powerhouse structures, the 1912 powerhouse located to the east, and the 1982 powerhouse located to the south. Located at the south end of the forebay between the two powerhouses is a ten foot wide by seven foot deep Taintor gate and a six foot wide by six foot deep gate. The 1912 powerhouse contains six generating units, and the 1982 powerhouse contains two generating units (Table 3).

Table 3. Shawmut Project Generating Unit Summary

Unit	Turbine Design/Type	Capacity (cfs)	RPM	Max Flow		Peak Efficiency		Min Flow	
				CFS	Effic. (%)	CFS	Effic. (%)	CFS	Effic. (%)
1	Francis/ horizontal	650	200	648	78	581	83	400	52
2	Francis/ horizontal	650	200	645	80	583	84	438	41
3	Francis/ horizontal	650	200	641	82	581	84	453	40
4	Francis/ horizontal	650	200	672	71	539	81	367	67
5	Francis/ horizontal	650	200	742	71	520	84	326	55
6	Francis/ horizontal	650	200	667	78	575	83	264	37
7	Propeller/horizontal	1,200	160	N/A	N/A	1,312	82	N/A	N/A
8	Propeller/horizontal	1,200	160	N/A	N/A	1,347	85	N/A	N/A

The Shawmut Project typically operates as run-of river, with a target reservoir elevation near the full pond elevation of 112.0 feet during normal conditions. The maximum hydraulic capacity of the turbines is 6,755 cfs. After maximum flow to the turbines has been achieved, excess water is spilled through the existing log sluice. When flows exceed the capacity of the log sluice, sections of the rubber dam are deflated to pass additional water.

2.2.1.1. Upstream Fish Passage

The Shawmut Project has used the Lockwood fish lift and transport system as its means of interim upstream fish passage since 2006. The MDMR capture Atlantic salmon (and other anadromous species) at the Lockwood lift and transport the fish in trucks to areas of suitable habitat, primarily the Sandy River, which is upstream of the Shawmut Project.

2.2.1.2. Downstream Fish Passage

Interim downstream passage for Atlantic salmon at Shawmut is provided through a sluice located on the right-hand side of the intake structure next to Unit 6. The sluice, which is manually adjusted and contains three stoplogs, is four feet wide by 22 inches deep. With all stoplogs removed, this sluice passes flows between 30 and 35 cfs. Flows from this sluice discharge over the face of the dam and drain into a man-made three feet deep plunge pool connected to the river. In addition, there is a Taintor gate located next to this sluice that measures seven feet high by ten feet wide and can pass 600 cfs. This gate is used to pass debris and excess flows, which also discharge over the face of the dam into a shallow plunge pool connected to the river.

In 2009, FPL Energy engineers, operations personnel, and biologists investigated options to resolve both ongoing debris issues and downstream anadromous and catadromous fish passage needs at Shawmut. It was agreed that options for debris resolution could be designed to also address downstream fish passage needs. In 2010, the licensee subsequently hired a team of consultants, including Wright Pierce Engineers, Alden Research Labs and Blue Hill Hydraulics, to design a new facility at the Shawmut Project that would address both the debris and fish passage needs.

In 2011, the licensee, in consultation with resource agencies, developed designs for a new combined intake structure and downstream fish bypass facility at the Project. At that time, the proposed facility included the use of new full depth one inch angled trashracks and a new surface sluice and flume leading to the river. The proposed location and design of this facility, which resulted from significant efforts in hydraulic modeling and evaluation of alternatives by both the licensee and resource agencies, was just upstream of the existing intake structure. However, the need for this proposed facility is being re-evaluated in light of results from a 2012 downstream smolt study conducted at Shawmut. This study indicated that the majority of study smolts (over 80%) used the existing forebay Taintor gate for downstream passage. The licensee will continue evaluations of downstream smolt passage at Shawmut and discussions with the resource agencies regarding how to provide safe and efficient passage to downstream migrants at the Shawmut Project.

The licensee completed an Atlantic salmon smolt radio telemetry downstream passage study involving the Shawmut Project in the spring of 2012. The primary focus of the study was on the Lockwood and Weston projects, but the study also provided information on bypass effectiveness at Shawmut. Five groups of radio-tagged smolts were released upstream of the Weston Project and their passage routes and bypass usage were recorded at Weston, Shawmut and Lockwood. The Shawmut Taintor gate, which was fully opened to simulate a surface sluice, passed approximately 600 cfs for the duration of the study. Relative to the total flows observed during 2012, 600 cfs represented from 9-17% of actual powerhouse flow. When all smolts entering the Shawmut forebay canal are considered (n = 64), 82.8% of smolts passing Shawmut used the downstream bypass. When examined by setting, 100% (15 of 15) of smolts passed Shawmut with the bypass releasing 9-11% of powerhouse flow, 80.0% (24 of 30) of smolts passed Shawmut with the bypass releasing 12-13% of powerhouse flow, and 73.7% (14 of 19) of smolts passed Shawmut with the bypass releasing 15-17% of powerhouse flow. Of the 65 smolts which passed the Shawmut Project, 81.5% (53 of 65) passed through the Taintor gate, 16.9% (11 of 65) passed through the propeller turbines, and 1.5% (1 of 65) passed on spill.

2.2.2. Proposed Action

2.2.2.1. Interim Species Protection Plan

The ISPP is valid for a seven-year period (2013- 2019) to allow the licensee time to implement species protection measures and to study their ability to protect migrating Atlantic salmon. Provisions of the ISPP will require the licensee to undertake the following activities at the Shawmut Project:

- Upstream Passage
    - Construct an upstream fishway facility (operational in 2018).

- Downstream passage
    - Extend period that downstream bypass facilities operate from April 1 to June 15 and November 1 to December 15 to the current period of April 1 to December 31, as river and ice conditions allow;
    - The bypass gate will be operated to maintain an interim flow of 6% of station unit flow through the gate during evening passage hours. Modifications to the bypass flow will be considered as part of the adaptive management approach to the ISPP, based on results of radio telemetry studies and consultation with the agencies; and
    - Conduct downstream survival studies for outmigrating smolts (2013-2015) and kelts (2014-2016).

At the end of the seven year period (2019), the licensee will file a final SPP for Atlantic salmon in consultation with FERC. The final SPP will reinitiate formal section 7 consultation under the ESA.

The ISPP indicates that the new volitional upstream fishway at Shawmut will be designed in 2016, constructed in 2017, and operational in 2018. Although the project has yet to be designed, the licensee has indicated that the construction of the fishway will likely involve a small amount of permanent impact associated with ledge removal and the placement of fill (R. Richter, Brookfield Renewable Power, pers. comm.). It is anticipated that less than 500 square feet of riverine habitat will be temporarily or permanently affected by the construction of cofferdams and the placement of fill. In-water work will occur outside of the smolt and kelt outmigration periods and within the confines of a dewatered cofferdam.

2.3. Weston Project - FERC No. 2534

2.3.1. Existing Hydroelectric Facilities and Operations

The Weston Project is located at river mile 82 in the Town of Skowhegan and is the fourth dam on the mainstem of the Kennebec River (Figure 1). The Weston Project includes a 930-acre reservoir, two dams, and one powerhouse. The two dams are constructed on the north and south channels of the Kennebec River where the river is divided by Weston Island. U.S. Route 2 crosses the island, spanning the South Channel impoundment above South Channel Dam and the North Channel bypass section located below the North Channel Dam.

The North Channel Dam is a concrete gravity and buttress dam 38 feet high, with a crest elevation of 156.0 feet. The dam extends about 529.5 feet from the north bank of the Kennebec River to Weston Island, in a broad V-shape, following the high ledge of a natural falls. The North Channel Dam consists of four sections: a 22.5 foot long concrete non-overflow section; a 244 foot long stanchion section with five bays; a 160.5 foot long pneumatic gate section with 7.5 feet high steel panels; and a 93 foot long gated section (located next to the island) containing two steel Taintor gates. The normal full pond elevation of the impoundment is 156.0 feet.

The South Channel Dam is a concrete gravity and buttress dam 51 feet high, with a crest elevation of 156.0 feet. The dam extends about 391.5 feet between abutment walls from the island to the south riverbank and consists of five sections: a 125 foot long powerhouse/intake section; a 33 foot long concrete spillway section; a 24 foot long sluice section; a 188 foot long stanchion section with five bays; and a 21.5 foot long concrete non-overflow section. The powerhouse/intake section of the dam, located adjacent to the north abutment and integral to the project dam, includes the headworks and four intake bays, one for each of the four turbine generator units. Each bay houses three reinforced concrete gates that can isolate flow to the individual turbines; the hydraulic capacity for each turbine is 1,450 cfs (Table 4). The trashracks, which are situated in front of the gate slots, are cleaned using a motor-operated trash rake. The concrete spillway section has a permanent crest elevation of 154.0 foot and is topped by two foot high stoplogs. A 14 foot high Taintor gate controls flows through the sluice section, which extends 69.5 feet downstream.

Table 4. Weston Project Generating Unit Summary

Unit	Turbine Design/Type	Hydraulic Capacity (cfs)	RPM	Max Flow		Peak Efficiency		Min Flow	
				CFS	Effic. (%)	CFS	Effic. (%)	CFS	Effic. (%)
1	Francis/vertical	1750	100	1,750	82	1,614	90	434	49
2	Francis/vertical	1500	100	1,498	83	1,207	88	426	73
3	Francis/vertical	1750	100	1,750	84	1,614	90	434	49
4	Francis/vertical	1700	100	1,710	81	1,428	87	634	63
4 planned	Francis/vertical	1900	100	1,900	87	1,688	90	TBD	

The Weston Project operates as run-of-river by maintaining the impoundment water surface elevation within one foot of the full pond elevation of 156.0 foot msl, during normal operations. The existing FERC license requires the project to provide an instantaneous minimum flow of 1,947 cfs or inflow, whichever is less.

The hydraulic capacity of the Weston Project is currently 6,075 cfs. When river flow exceeds the hydraulic capacity of the turbines, excess water is passed downstream through the South Channel sluice, and/or Taintor gates. The south channel sluice gate is capable of passing up to 2,500 cfs, and each of the Taintor gates are capable of passing up to 5,000 cfs. If after opening the south channel sluice and Taintor gates the elevation of the impoundment is 156.0 feet and still rising, then additional water is released via hinged flashboards, top boards, and north and south channel stanchions.

2.3.1.1. Upstream Fish Passage

The Weston Project has used the Lockwood fish lift and transport system as its means of interim upstream fish passage since 2006. Atlantic salmon (and other anadromous species) are captured at the Lockwood lift and transported in trucks by the MDMR to areas of suitable habitat, primarily the Sandy River, which is upstream of the Weston Project.

2.3.1.2. Downstream Fish Passage

Interim downstream passage at the Weston Project is provided through a sluice gate and associated concrete flume located on the South Channel Dam. The gate and flume were formerly used as a log sluice during river log drives and both are located near the Unit 4 intake. The sluice is 18 feet wide by 14 feet high and discharges into a deep plunge pool. Maximum flow through the gate at full pond is 2,250 cfs.

In 2011, the licensees enhanced the existing downstream passage facility by installing a guidance boom consisting of a 300 foot long floating boom with suspended ten feet deep sections of 5/16 inch metal punch plate screens. The boom leads to the existing log sluice gate, which in turn discharges via an existing concrete flume to a deep pool in the river. The licensees had previously (in 2010) made some major structural repairs to the existing sluice gate structure, which included resurfacing of the concrete flume.

During the downstream migration period, the gate is opened to pass 6% of station unit flow. The sluice has been opened for smolt and kelt passage generally from April 1 through June 15 and between November 1 and December 31, if river and ice conditions allow. As part of the proposed action, the licensee initially proposed to expand the operation of downstream passage facilities to April 1 to December 31. This was proposed for all four of the Projects to account for the downstream migration of juvenile river herring. As river herring are not stocked upstream of the Weston Project, the licensee has requested to maintain the existing schedule of operation. As detailed in the ISPP, studies to evaluate the effectiveness of the bypass with the new guidance boom will be undertaken after resource agency consultation and approval of a study plan.

On the North Channel side of the Weston Project, there are two Taintor gates, an inflatable rubber dam section, and stanchion gate sections. Interim passage is provided on the North Channel side via spillage.

The licensee completed an Atlantic salmon smolt radio telemetry downstream passage study at the Weston Project in the spring of 2012. During the study, five groups of radio-tagged smolts were released upstream of the Weston Project and their passage routes and bypass usage were recorded at Weston, Shawmut and Lockwood. Downstream bypass usage data were collected for smolts at the Weston Project at 6%, 4% and 2% of actual powerhouse flows during 2012. When examined by setting, 68.4% (26 of 38) of smolts used the downstream bypass with the bypass set at 6%, 45.5% (15 of 33) of smolts used it with the bypass set at 4%, and 43.8% (7 of 16) of the smolts used the downstream bypass with the bypass set at 2%. Of the 89 smolts that passed the Weston Project with known routes, 54.0% (48 of 89) passed through the downstream bypass, 43.8% (39 of 89) passed through the turbines, and 2.2% (2 of 89) passed on spill.

2.3.2. Proposed Action

2.3.2.1. Interim Species Protection Plan

The ISPP is valid for a seven-year period (2013- 2019) to allow the licensee time to implement species protection measures and to study their ability to protect migrating Atlantic salmon. Provisions of the ISPP will require the licensee to undertake the following activities at the Weston Project:

- Upstream Passage
  - Construct upstream fishway facility (operational in 2020).

- Downstream Passage
  - The passage facility will be operated to maintain an interim flow of 6% of station unit flow through the sluice gate during evening passage hours. Modifications to the bypass flow will be considered as part of the adaptive management approach to the ISPP, based on results of radio telemetry studies and consultation with the agencies;
  - The Licensee will undertake measures necessary to keep the guidance boom in place and in good operating condition. If the guidance boom becomes dislodged or damaged, the licensee will repair or replace the guidance boom as soon as can be safely and reasonably done; and
  - Conduct downstream survival studies for outmigrating smolts (2013-2015) and kelts (2014-2016).

At the end of the seven year period (2019), the licensee will file a final SPP for Atlantic salmon in consultation with FERC. With the submission of the final SPP, FERC will reinitiate formal section 7 consultation under the ESA.

The ISPP indicates that the new volitional upstream fishway at Weston will be designed in 2018, constructed in 2019, and operational in 2020. Although the project has yet to be designed, the licensee has indicated that the construction of the fishway will likely involve a small amount of permanent impact associated with ledge removal and the placement of fill (R. Richter, Brookfield Renewable Power, pers. comm., 2013). It is anticipated that less than 500 square feet of riverine habitat will be temporarily or permanently affected by the construction of cofferdams and the placement of fill. In-water work will occur outside of the smolt and kelt outmigration periods and within the confines of a dewatered cofferdam.

2.4. Brunswick Project - FERC No. 2600

2.4.1. Existing Hydroelectric Facilities and Operations

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

The concrete gravity dam consists of two ogee overflow spillway sections separated by a pier and barrier wall. The right spillway section, about 128 foot long, is topped with wooden flashboards that are 2.6 feet high. The left section does not have flashboards. The intake structure and powerhouse are integral with the dam and located adjacent to the Brunswick shoreline. The powerhouse contains three vertical propeller turbine generators. Unit 1 has a hydraulic capacity of 4,400 cfs, and units 2 and 3 have a hydraulic capacity of 1,200 cfs (Table 5).

Table 5. Brunswick Project Generating Unit Summary

Unit	Turbine Design/Type	Hydraulic Capacity (cfs)	RPM	Max Flow		Peak Efficiency		Min Flow	
				CFS	Effic. (%)	CFS	Effic. (%)	CFS	Effic. (%)
1	Propeller/ vertical	4,400	90	5,075	83	4,519	93	2,741	57
2	Propeller/ horizontal	1,200	211.8	N/A	N/A	1,336	88	N/A	N/A
3	Propeller/ Horizontal	1,200	211.8	N/A	N/A	1,336	88	N/A	N/A

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

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

2.4.1.1. Upstream Fish Passage

Upstream passage at Brunswick is provided via a vertical slot fishway and associated trap, sort, and truck facility that were installed in 1983. The fishway is 570 feet long and consists of 42 individual pools, with a one-foot drop between each. The trapping facility, located at the upstream end of the fishway, provides biologists the opportunity to collect data on migratory and resident fish species that use the fishway. As fish swim to the top of the fishway, fixed grating guides them past a viewing window and into a 500 gallon capacity fish hoist (trap). The hoist elevates the fish to overhead sorting tanks where staff sort and pass fish upstream. Atlantic salmon pass upstream above the 40-foot dam after biological data are collected. The fishway is currently operated between May 1 and October 31, but has been proposed to be extended to April 15 to October 31 as part of the proposed ISPP. During the period of fishway operation, an attraction flow of 100 cfs is provided.

The Brunswick fishway facility is maintained by the licensee; however, since its construction, MDMR personnel have operated the fishway each season under prior agreement. According to the annual fishway reports, in some years the upstream fishway is shutdown for several weeks in August and September due to maintenance needs, low staff availability, as well as the harm associated with sampling adult salmon during warm water periods (MDMR 2009, 2012).

The Brunswick Project also has a fish barrier wall located between the dam and Shad Island and a concrete cap over the ledges at the southern end of the spillway section. These structures were installed in the 1980s in an effort to prevent fish from accessing the spillway section and to prevent spill from entering the tailrace and interfering with fish attraction to the fishway.

2.4.1.2. Downstream Fish Passage

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

2.4.2. Proposed Action

2.4.2.1. Interim Species Protection Plan

The ISPP is valid for a seven-year period (2013- 2019) to allow the licensee time to implement species protection measures and to study their ability to protect migrating Atlantic salmon. Provisions of the ISPP will require the licensee to undertake the following activities at the Brunswick Project:

- Upstream Passage
    - Extend period that upstream passage facilities are operated from May 1 – October 31 to April 15 – November 15;
    - MDMR will trap and sort all fish species, including Atlantic salmon. All Atlantic salmon will be released to Brunswick headpond to continue their upstream migration;
    - The licensee will undertake measures necessary to keep the fishway in good operating condition. If the fishway malfunctions or becomes inoperable during the critical months, they will repair the fishway and restore it to normal operation as soon as can be safely and reasonably done;
    - MDMR will maintain records of all fish moved via the fishway. MDMR will maintain detailed records of Atlantic salmon moved via the fish lift, including an assessment of size, age, and condition; and
    - Conduct Atlantic salmon adult upstream passage effectiveness monitoring studies at Brunswick Project (2013-2015). The upstream passage studies will be conducted in coordination with upstream dam owners.

- Downstream Passage
    - Extend period that downstream bypass facilities operate from April 1 to June 15 and November 1 to December 15 to the period of April 1 to December 31, as river and ice conditions allow; and
    - Conduct downstream survival studies for outmigrating smolts (2013-2015) and kelts (2014-2016).

At the end of the seven year period (2019), the licensee will file a final SPP for Atlantic salmon in consultation with FERC. The final SPP will reinitiate formal section 7 consultation under the ESA.

2.4.2.2. Sturgeon Handling and Protection Plan

Atlantic and shortnose sturgeon have been documented using the habitat downstream of the Brunswick Project. Currently, there is no formally approved handling plan for shortnose or Atlantic sturgeon at the Brunswick Project. The proposed handling plan envisions possible interaction between sturgeon and the project under three scenarios: 1) sturgeon that may find their way into the upstream fishway, 2) sturgeon that may become stranded in pools below the Brunswick Project, and 3) sturgeon may be attracted into portions of Unit #1 when it is shut down for annual inspection. The existing plan spells out measures to be undertaken by the licensee in the event of any one of these three occurrences.

Fishway and Trap Operations

Atlantic and shortnose sturgeon will not be passed upstream of the Brunswick Project as the dam location is thought to be the historical limit of upstream migration for sturgeon on the Androscoggin River (Houston *et al.* 2007), and because of concerns regarding the safety of downstream passage for shortnose and Atlantic sturgeon. The handling plan requires that if sturgeon are found in the fishway, the following procedures will be implemented:

- For each sturgeon detected, the licensees shall record the weight, length, and condition of the fish. Fish will also be scanned for PIT tags. River flow, bypass reach minimum flow, and water temperature will be recorded.
- If alive and uninjured, the sturgeon will be immediately returned downstream. A long handled net outfitted with non-abrasive knotless mesh will be used to place the sturgeon back into the river downstream of the dam. The fish should be properly supported during transport in the net to ensure that it is not injured. The licensees will report to us within 24 hours any live, uninjured sturgeon that are removed and relocated back to the river.
- If any injured sturgeon are found, the licensees shall report it to us immediately. Injured fish must be photographed and measured, if possible, and the reporting sheet must be submitted to us within 24 hours. If the fish is badly injured, the fish should be retained by the licensees until notified by NMFS with instructions regarding potential rehabilitation.
- If any dead sturgeon are found, the licensees will report it to us immediately (within 24 hours). Any dead specimens or body parts should be photographed, measured, scanned for tags and all relevant information should be recorded. Specimens should be stored in a refrigerator by the licensees until we can obtain them for analysis.

Sturgeon Stranding

Annually, the impoundment of the Brunswick Project is lowered to a point where the flashboards can safely be replaced, resulting in a short period (a few hours) of receded flows downstream. The boards are typically installed prior to May 1. As described above, there is a ledge outcrop at the outlet of the large pool downstream of the spillway that was augmented with concrete in the 1980's to keep fish from entering the ledge areas downstream of the spillway. At high tide the falls has a six foot drop (approximately nine feet at low tide) that would likely preclude all life stages of sturgeon from being near the spillway. Additionally, the ledge outcrop controls the depth of the water in the large pool downstream of the spillway, which keeps it from dewatering at periods of low flow. Although it is possible, it is unlikely that sturgeon would have access to the area that would be affected by the lowering of the impoundment.

The handling plan includes measures to ensure safe handling of any sturgeon should stranding occur. If shortnose or Atlantic sturgeon become stranded, the licensee will return them to the river downstream. The handling plan requires that they follow this protocol:

- Designated employees and fish lift operation staff must monitor the pools below the dams while the flashboards at the project are replaced.
- For each fish removed from the pool, the licensees will record the weight, length, and condition. Fish should also be scanned for PIT tags. River flow, bypass reach minimum flow and water temperature will be recorded.

- If stranded but alive and uninjured, the sturgeon will be moved downriver of the dam. The licensees shall report to us within 24 hours any live, uninjured sturgeon that are removed and relocated back to the river.
- If any injured sturgeon are found, the licensees will report it to us immediately. Injured fish must be photographed and measured, if possible, and a reporting sheet must be submitted to us within 24 hours. If the fish is badly injured, the fish should be retained by the licensees, if possible, until obtained by a NMFS recommended facility for potential rehabilitation.
- If any dead sturgeon are found, the licensees will report it to us immediately (within 24 hours). Any dead specimens or body parts should be photographed, measured, scanned for tags and all relevant information should be recorded. Specimens should be stored in a refrigerator by the licensees until we can obtain them for analysis.

Unit Inspection and Maintenance

The Brunswick Project units are shut down annually for routine inspection and maintenance, which may require dewatering all or portions of the units. For routine inspections and maintenance, the licensee will reduce the potential for sturgeon interaction with the Project by scheduling such activities to occur outside the sturgeon spawning season (May to July). If unit maintenance is of an emergency nature, they shall immediately notify us of the nature of the emergency and the maintenance required. For both scheduled and emergency unit inspection or repairs that require dewatering of any of the three project generating units, they will implement the following measures:

- Prior to dewatering, areas upstream of the turbine tailrace tail logs and inside the scroll case that are accessible to the maintenance crew and/or divers, will be inspected. Divers with lights will inspect the tailrace area upstream of the tail logs before they are lowered into place. The tail logs may need to be alternately raised or lowered depending on sturgeon encountered. Flexible fencing may need to be deployed to corral the sturgeon out of the tailraces. Upon lowering the tail logs, an inspection inside of the tail logs will be conducted to confirm that no sturgeon are present prior to dewatering.
- After the tail logs are in place and the unit dewatered, the scroll case will be inspected by maintenance crews for sturgeon. If sturgeon are found to be present, fish rescue operation procedures will be implemented:
    - Removal of individuals from scroll case via dip net or other appropriate equipment;
    - For each fish removed from the scroll case, the handlers will record the weight, length, and condition. Fish will be scanned for PIT tags. River flow, bypass reach minimum flow, and water temperature will be recorded. All relevant information will be recorded on the reporting sheet.
- Any live, uninjured sturgeon will immediately be returned to the Androscoggin River safely downstream of the project. The licensees shall report to us within 24 hours any live, uninjured sturgeon that are removed and relocated back to the river.
- If any injured sturgeon are found, the licensees will report it to us immediately. Injured fish must be photographed and measured, if possible, and a reporting sheet must be submitted to us within 24 hours. If the fish is badly injured, the fish should be retained

by the licensees, if possible, until obtained by a NMFS recommended facility for potential rehabilitation.

- If any dead sturgeon are found, the licensees will report it to us within 24 hours. Any dead specimens or body parts should be photographed, measured, scanned for tags and all relevant information should be recorded. Specimens should be stored in a refrigerator by the licensees until we can obtain them for analysis.

2.5. Lewiston Falls Project - FERC No. 2302

2.5.1. Existing Hydroelectric Facilities and Operations

The Lewiston Falls Project includes a dam consisting of several distinct dam sections. There are four stone-masonry dam sections (Dams 1-4), each of which support four foot high flashboards. A fifth dam section (Dam 5) is four feet high and supports 1.34 foot high flashboards. The island spillway is a concrete section located on a small island between Dams 3 and 4 and it is fitted with flashboards. the licensee is in the process of replacing approximately 681 feet of flashboards over four sections of the spillway (Dams #1, #2, #3, & #4) with inflatable rubber dams. The work includes resurfacing the cap and upstream face of the dam to provide a base for the new bladder system; and resurfacing and modifying the end piers on either end of the spillways to support the inflatable bladders that will be required to span the flashboard sections. There are two sections of approximately 154 feet of operational rubber dam (Dam #4) currently installed. There will be three more sections (Dams #1, #2, and #3), approximately 578 feet installed in 2013. It is anticipated that the project will be completed by the end of 2013.

The Project also includes a canal system that originally served to deliver water to small generating facilities located in several mills. The Project was redeveloped in 1990 when a new powerhouse (Monty Station) was added to the project. The Canal generating units are currently out of service and are awaiting final disposition. As detailed in Table 6, the Monty Station units (Units1 and 2) are vertical Kaplan units each with a generating capacity of 12,500 kW when passing 3,300 cfs under a 54 foot gross head. After satisfying a 150 cfs minimum flow requirement for the Lewiston Canal system, all additional river flow goes to Monty Station up to the capacity of the turbines (6,600 cfs). Units 1 and 2 are remotely controlled.

Table 6. Lewiston Falls Project Generating Unit Summary

	Units	Turbine Design/Type	Generator Rating (MW)	Hydraulic Capacity (cfs)	Rotation Speed (rpm)
Monty Station	Unit 1	Kaplan/vertical	12.5	3,300	150
	Unit 2	Kaplan/vertical	12.5	3,300	150
Bates Weave Shed	Unit 1	Francis/horizontal	1.2	650	257
	Unit 2	Francis/horizontal	1.5	650	257
	Unit 3	Francis/horizontal	1.2	650	257
Hill Mill	Unit 1	Francis/vertical	0.36	205	180
	Unit 2	Francis/vertical	0.36	205	180
	Unit 3	Francis/vertical	0.36	205	180

	Unit 4	Francis/vertical	0.36	205	180
	Unit 5	Francis/vertical	0.36	205	180
	Unit 6	Francis/vertical	0.36	205	180
Lower Androscoggin	Unit 1	Leffel/vertical	0.27	340	164
Continental Mills	Unit 1	Hercules/vertical	0.4	325	120
	Unit 2	Hercules/vertical	0.4	325	120
	Unit 3	Hercules/vertical	0.4	325	120
	Unit 5	Hercules/vertical	0.192	150	164
	Unit 6	Hercules/vertical	0.192	150	164

The Lewiston Falls Project is licensed to operate with up to four feet of impoundment fluctuation to allow for peaking under normal conditions. The Project currently cycles in response to the cycling of the Gulf Island Project upriver, which was designed as a weekly cycle station, generally pulling during the week while cycling daily and filling during the weekend. Once the rubber dams at Lewiston Falls are commissioned to operate as minimum flow gates, the Project will be able to cycle independently of Gulf Island. Post commissioning, Lewiston Falls will be available to cycle the four feet available in the pond. Cycling will be predicated on the flows provided by Gulf Island and will likely operate as a daily cycle station. Flows during cycling will likely range between about 1,800 – 6,600 cfs. The station has a minimum flow requirement of 1,430 cfs at Lewiston Falls, with a minimum flow of 1,280 cfs required at Monty Station and 150 cfs through the canal.

The Lewiston Canal is typically operated at a minimum flow of 150 cfs, which is contractually required to supply Androscoggin Upper, a small generating facility owned and operated by the City of Lewiston under a separate license. The City may be considering retirement of this facility in the future. Since the Androscoggin Lower generating facility cannot operate at this low flow, flows are spilled there and released back to the river.

2.5.1.1. Upstream Fish Passage

There are no upstream fish passage facilities at the Lewiston Falls Project.

2.5.1.2. Downstream Fish Passage

There are no downstream fish passage facilities at the Lewiston Falls Project.

2.5.2. Proposed Action

The licensee is not proposing any changes to the physical components of the Project as part of the proposed action. As there are no fish passage facilities at the Project, the licensee is not proposing that any passage studies be conducted at the Lewiston Falls Project. The licensee will meet with us annually, as part of the adaptive management strategy, to ensure that the operations of all five Projects (including Lewiston Falls) are consistent with the recovery objectives for Atlantic salmon.

2.6. Action Area

The action area is defined as "all areas to be affected directly or indirectly by the Federal action and not merely the immediate area (project area) involved in the proposed action" (50 CFR 402.02). The action area must encompass all areas where both the direct and indirect effects of the proposed action would affect listed species and critical habitat.

Operation of the Lockwood, Shawmut, Weston, Brunswick, and Lewiston Falls Projects pursuant to the revised licenses proposed to be approved by FERC, will affect much of the Kennebec and Androscoggin River watersheds, the estuary, and associated waters. Therefore, these watersheds represent the action area for this consultation (Figure 1).

3. STATUS OF AFFECTED SPECIES AND CRITICAL HABITAT RANGEWIDE

We have determined that the following endangered or threatened species may be affected by the proposed action:

Fish

Gulf of Maine DPS of Atlantic salmon	Endangered
Shortnose sturgeon	Endangered
Gulf of Maine DPS of Atlantic sturgeon	Threatened
New York Bight DPS of Atlantic sturgeon	Endangered
Chesapeake Bay DPS of Atlantic sturgeon	Endangered
South Atlantic DPS of Atlantic sturgeon	Endangered
Carolina DPS of Atlantic sturgeon	Endangered

Critical Habitat

Designated for the Gulf of Maine DPS of Atlantic salmon

This section will focus on the status of the various species within the action area, summarizing information necessary to establish the environmental baseline and to assess the effects of the proposed action.

3.1. Gulf of Maine DPS of Atlantic Salmon

3.1.1. Species Description

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

The GOM DPS of anadromous Atlantic salmon was initially listed jointly by the USFWS and

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

The current GOM DPS includes all anadromous Atlantic salmon whose freshwater range occurs in the watersheds from the Androscoggin River northward along the Maine coast to the Dennys River, and wherever these fish occur in the estuarine and marine environment. The following impassable falls delimit the upstream extent of the freshwater range: Rumford Falls in the town of Rumford on the Androscoggin River; Snow Falls in the town of West Paris on the Little Androscoggin River; Grand Falls in Township 3 Range 4 BKP WKR on the Dead River in the Kennebec Basin; the un-named falls (impounded by Indian Pond Dam) immediately above the Kennebec River Gorge in the town of Indian Stream Township on the Kennebec River; Big Niagara Falls on Nesowadnehunk Stream in Township 3 Range 10 WELS in the Penobscot Basin; Grand Pitch on Webster Brook in Trout Brook Township in the Penobscot Basin; and Grand Falls on the Passadumkeag River in Grand Falls Township in the Penobscot Basin. 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 Hatchery (CBNFH), both operated by the USFWS. Excluded from the GOM DPS are landlocked Atlantic salmon and those salmon raised in commercial hatcheries for the aquaculture industry (74 FR 29344; June 19, 2009).

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

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

In the fall, female Atlantic salmon select sites for spawning in rivers. Spawning sites are positioned within flowing water, particularly where upwelling of groundwater occurs, allowing for percolation of water through the gravel (Danie *et al.* 1984). These sites are most often positioned at the head of a riffle (Beland *et al.* 1982); the tail of a pool; or the upstream edge of a gravel bar where water depth is decreasing, water velocity is increasing (McLaughlin and Knight 1987, White 1942), and hydraulic head allows for permeation of water through the redd (a gravel depression where eggs are deposited). Female salmon use their caudal fin to scour or dig redds. The digging behavior also serves to clean the substrate of fine sediments that can embed the cobble and gravel substrates needed for spawning and consequently reduce egg survival (Gibson 1993). One or more males fertilize the eggs that the female deposits in the redd (Jordan and Beland 1981). The female then continues digging upstream of the last deposition site, burying the fertilized eggs with clean gravel.

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

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

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

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

The spring migration of post-smolts out of the coastal environment is generally rapid, within several tidal cycles, and follows a direct route (Hyvarinen *et al.* 2006, Lacroix and McCurdy 1996, Lacroix *et al.* 2004). Post-smolts generally travel out of coastal systems on the ebb tide and may be delayed by flood tides (Hyvarinen *et al.* 2006, Lacroix and McCurdy 1996, Lacroix *et al.* 2004, Lacroix and Knox 2005). Lacroix and McCurdy (1996), however, found that post-smolts exhibit active, directed swimming in areas with strong tidal currents. Studies in the Bay of Fundy and Passamaquoddy Bay suggest that post-smolts aggregate together and move near the coast in "common corridors" and that post-smolt movement is closely related to surface currents in the bay (Hyvarinen *et al.* 2006; Lacroix and McCurdy 1996; Lacroix *et al.* 2004). European post-smolts tend to use the open ocean for a nursery zone, while North American post-smolts appear to have a more near-shore distribution (Friedland *et al.* 2003). Post-smolt distribution may reflect water temperatures (Reddin and Shearer 1987) or the major surface-current vectors (Lacroix and Knox 2005). Post-smolts live mainly on the surface of the water column and form shoals, possibly of fish from the same river (Shelton *et al.* 1997).

During the late summer and autumn of the first year, North American post-smolts are concentrated in the Labrador Sea and off of the west coast of Greenland, with the highest concentrations between 56^{o}N. and 58^{o}N. (Reddin 1985, Reddin and Short 1991, Reddin and Friedland 1993). The salmon located off Greenland are composed of both 1SW fish and fish that have spent multiple years at sea (multi-sea winter fish or MSW) and also includes immature salmon from both North American and European stocks (Reddin 1988, Reddin *et al.* 1988). The first winter at sea regulates annual recruitment, and the distribution of winter habitat in the Labrador Sea and Denmark Strait may be critical for North American populations (Friedland *et al.* 1993). In the spring, North American post-smolts are generally located in the Gulf of St. Lawrence, off the coast of Newfoundland, and on the east coast of the Grand Banks (Reddin 1985, Dutil and Coutu 1988, Ritter 1989, Reddin and Friedland 1993, and Friedland *et al.* 1999). Some salmon may remain at sea for another year or more before maturing. After their second winter at sea, the salmon over-winter in the area of the Grand Banks before returning to their natal rivers to spawn (Reddin and Shearer 1987). Reddin and Friedland (1993) found immature adults located along the coasts of Newfoundland, Labrador, and Greenland, and in the Labrador and Irminger Sea in the later summer and autumn.

3.1.2 Status and Trends of Atlantic Salmon in the GOM DPS

The abundance of Atlantic salmon within the range of the GOM DPS has been generally declining since the 1800s (Fay *et al.* 2006). Data sets tracking adult abundance are not available throughout this entire time period; however, a comprehensive time series of adult returns to the GOM DPS dating back to 1967 exists (Fay *et al.* 2006, USASAC 2001-2012) (Figure 2). It is important to note that contemporary abundance levels of Atlantic salmon within the GOM DPS are several orders of magnitude lower than historical abundance estimates. For example, Foster and Atkins (1869) estimated that roughly 100,000 adult salmon returned to the Penobscot River alone before the river was dammed, whereas contemporary 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 2010).

Contemporary abundance estimates are informative in considering the conservation status of the GOM DPS today. After a period of slow population growth between the 1970s and the early 1980s, adult returns of salmon in the GOM DPS peaked between approximately 1984 and 2001 before declining during the 2000s. Adult returns have been increasing again over the last few years. The population growth observed in the 1970s is likely attributable to favorable marine survival and increases in hatchery capacity, particularly from GLNFH that was constructed in 1974. Marine survival remained relatively high throughout the 1980s, and salmon populations in the GOM DPS remained relatively stable until the early 1990s. In the early 1990s marine survival rates decreased, leading to the declining trend in adult abundance observed throughout 1990s and early 2000s. The increase in the abundance of returning adult salmon observed between 2008 and 2011 may be an indication of improving marine survival.

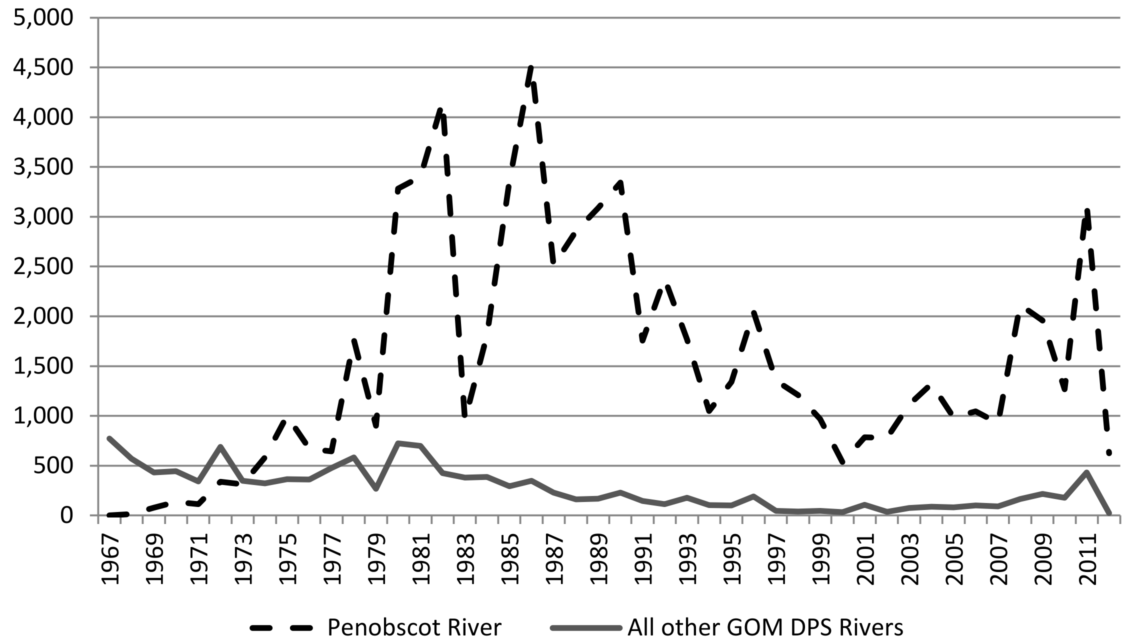

Figure 2. Adult returns to the GOM DPS Rivers between 1967 and 2012(Fay *et al.* 2006, USASAC 2001-2012).

Adult returns to the GOM DPS have been very low for many years and remain extremely low in terms of adult abundance in the wild. Further, the majority of all adults in the GOM DPS return to a single river, the Penobscot, which accounted for 91 percent of all adult returns to the GOM DPS between 2000 and 2011. Of the 3,125 adult returns to the Penobscot in 2011, the vast majority are the result of smolt stocking; and only a small portion were naturally-reared. The term naturally-reared includes fish originating from both natural spawning and from stocked hatchery fry (USASAC 2012). Hatchery fry are included as naturally-reared because hatchery fry are not marked and, therefore, cannot be distinguished from fish produced through natural spawning. Because of the extensive amount of fry stocking that takes place in an effort to recover the GOM DPS, it is possible that a substantial number of fish counted as naturally-reared were actually hatchery fry.

Low abundances of both hatchery-origin and naturally-reared adult salmon returns to Maine demonstrate continued poor marine survival. Declines in hatchery-origin adult returns are less sharp because of the ongoing effects of consistent hatchery supplementation of smolts. In the GOM DPS, nearly all of the hatchery-reared smolts are released into the Penobscot River -- 560,000 smolts in 2009 (USASAC 2010). In contrast, the number of returning naturally-reared adults continues at low levels due to poor marine survival.

In conclusion, the abundance of Atlantic salmon in the GOM DPS has been low and either stable or declining over the past several decades. The proportion of fish that are of natural origin is very small (approximately 6% over the last ten years) but appears stable. The conservation hatchery program has assisted in slowing the decline and helping to stabilize populations at low levels. However, stocking of hatchery products has not contributed to an increase in the overall abundance of salmon and as yet has not been able to increase the naturally reared component of the GOM DPS. Continued reliance on the conservation hatchery program could prevent extinction in the short term, but recovery of the GOM DPS must be accomplished through increases in naturally reared salmon.

3.1.3. Status of Atlantic Salmon in the Action Area

A summary of the status of the species rangewide and designated critical habitat in its entirety was provided above. This section will focus on the status of Atlantic salmon and designated critical habitat in the action area. The action area, identified as the Merrymeeting Bay SHRU, is comprised of the Kennebec and Androscoggin River watersheds.

Kennebec River

The Kennebec River, the largest watershed in the Merrymeeting Bay SHRU, flows 233 kilometers from Moosehead Lake to Merrymeeting Bay where it joins with the Androscoggin River (MDEP 1999) and flows another 32 km out to the Atlantic Ocean. In the Kennebec basin, historically important tributaries to Atlantic salmon included the Dead River, Carrabasset River and Sandy River (Atkins and Foster 1867), which are generally characterized as high elevation tributaries that are dominated by rapids, riffles and the occasional falls with a substrate composed of boulders, cobble, and gravel. The lower Kennebec tributaries, including Messalonskee stream which flows out of the Belgrade Lakes, and the Sebasticook River, which incorporates China Lake, Unity Pond, Moose Lake and Sebasticook Lake, were less important for Atlantic salmon spawning and rearing, yet the Sebasticook drainage was considered first rate by Atkins and Foster (1867) for production of alewives and shad.

The Kennebec River watershed currently supports a small run of Atlantic salmon. Restoration efforts in the watershed have utilized egg, fry, and parr stocking to promote returning adult salmon. As such, all lifestages of Atlantic salmon could be present in the action area of this consultation. On average, 43,000 fry were released annually into the Sandy River between 2001 and 2011, for a total of 399,000 fish (USASAC 2011). More than half of these fish (232,000) were released in 2010 and 2011 (USASAC 2011). While this effort has produced smolts and adult returns, it has not been enough to boost the population to any great extent.

More recently a large-scale restoration project was initiated utilizing eggs. Given shortages of Atlantic salmon hatchery resources, MDMR has been supplementing Atlantic salmon populations by producing fry from streamside incubators and by planting Atlantic salmon eggs directly into gravel (MDMR 2011a). This effort is more substantial in comparison to previous juvenile introductions. In 2010, 2011 and 2012, 568,000, 859,000 and 921,000 eggs respectively were release into the Sandy River (USASAC 2011, 2012, 2013). Based upon life-stage survival estimates from literature (average of 1.5% according to Legault (2004)), the smolt production estimates for each of these cohorts is 8,520, 12,885 and 13,815. Given that the Sandy River is relatively pristine, it is possible that production could exceed these estimates. In fact, some juvenile production data from the Sandy River suggests these smolt estimates are likely low. The first of these cohorts likely migrated in the spring of 2012. Given an annual supply of eggs for this project, smolt production should continue into the unforeseeable future.

In addition, some amount of natural reproduction is likely occurring in the Sandy River. Since the fishway at the Lockwood Project has been operational in 2006, adults have been captured and transported to the Sandy River. The eggs contributed to the Sandy River from these adults have ranged from 11,250 in 2006 to 247,500 in 2011. Estimated smolt production for this range would be between 169 and 3,713 annually.

Counts for Atlantic salmon in the Kennebec River are available since 2006 when a fishlift was installed at the Lockwood Dam (NMFS and USFWS 2009). Adult Atlantic salmon are trapped, and biological data (e.g., fork lengths) are collected before the salmon are trucked and released in the Sandy River, which is an upstream tributary of the Kennebec River containing plentiful spawning and rearing habitat (MDMR 2011a). Returning adult salmon at this first dam on the Kennebec River averaged eight fish per year from 1975 to 2000 and 23 fish per year from 2006 to 2012 (USASAC 2012; Table 7).

Table 7. Adult Atlantic salmon returns by origin to the Kennebec River recorded from 1975 to 2012.

Year	Hatchery Origin				Wild Origin				
	1SW	**2SW**	**3SW**	**Repeat**	**1SW**	**2SW**	**3SW**	**Repeat**	**Total**
1975-2001	12	189	5	1	0	9	0	0	216
2006	4	6	0	0	3	2	0	0	15
2007	2	5	1	0	2	6	0	0	16
2008	6	15	0	0	0	0	0	0	21
2009	0	16	0	6	1	10	0	0	33
2010	0	2	0	0	1	2	0	0	5
2011	0	21	0	0	2	41	0	0	64
2012	0	1	0	0	0	4	0	0	5
Total	24	255	6	7	9	74	0	0	375

Source: USASAC 2012.

Following spawning in the fall, Atlantic salmon kelts may immediately return to the sea, or overwinter in freshwater habitat and migrate in the spring, typically April or May (Baum 1997). Spring flows resulting in spillage at the dams facilitate out-migration of adult salmon (Shepard 1988). The number of kelts in the Kennebec River is proportional to the number of adults entering the river each year to spawn. As such, the number of kelts in the Kennebec River is likely to be a few dozen annually.

The Kennebec River in the vicinity of the Lockwood, Shawmut, and Weston Projects serves as migration habitat for adults returning to freshwater to spawn and for smolts and kelts returning to the ocean. The nearest mapped rearing habitat upstream of the Projects is within the Sandy River located approximately 11 miles upstream of the upper most of these dams (Weston).

However, a GIS-based Atlantic salmon habitat model (Wright *et al.* 2008) shows that habitat exists in the mainstem of the Kennebec River downstream of the Shawmut, Hydro-Kennebec, and Lockwood Projects that could provide some juvenile rearing habitat for salmon. The model, which predicts the presence of juvenile rearing habitat approximately 75 percent of the time, indicates that there are 117, 1,779, and 2,085 units (one unit = 100 m^2) of rearing habitat downstream of the Shawmut, Hydro-Kennebec, and Lockwood Projects, which could potentially produce 62, 961, and 1,126 juvenile salmon per year, respectively (Wright *et al.* 2008). Despite this production potential, it is unlikely that much of this habitat is used as prespawn salmon are currently trucked to spawning and rearing habitat in the Sandy River well upstream of Lockwood. However, the 1,126 habitat units downstream of Lockwood is currently accessible to prespawn adults and could be used for spawning and rearing of juvenile salmon. Although the model does not identify habitat that is suitable for spawning, MDMR has conducted field surveys of mainstem habitat and certain tributaries in order to identify areas of suitable habitat for salmon spawning and rearing. These field efforts have identified suitable spawning habitat as close as 300 meters of the Lockwood Project. However, based on redd and electrofishing surveys of the habitat, MDMR has concluded that the habitat is rarely used for spawning (P. Christman, MDMR, Pers. Comm., 2013). Therefore, although spawning and rearing habitat is present, it is unlikely that juvenile salmon would be abundant downstream of the Project.

Generally, salmon smolts begin moving out of Maine rivers in mid-April to June. Atlantic salmon smolts originating in the Sandy River will migrate through the Weston, Shawmut, and Lockwood Projects as they migrate to the ocean. Most data concerning the emigration of smolts in Maine have been collected in the Penobscot, Sheepscot, and Narraguagus Rivers. Based on unpublished data from smolt-trapping studies that we conducted in 2000 – 2005, smolts migrate from the Penobscot between late April and early June. The majority of the smolt migration appears to take place over a three to five week period after water temperatures rise to 10°C. In the spring of 2012, a smolt-trapping study was conducted on the Sandy River by NextEra Energy. NextEra Energy installed a rotary screw trap (RST) in the lower reaches to sample outmigrating Atlantic salmon smolts. The Sandy River RST was operational from April 18, 2012 to May 30, 2012. A total of 52 smolts were captured during 29 days of sampling. The first smolt was captured on April 18 and the last smolt was captured on May 21. Peak capture of smolts occurred in the first week of May. Ambient water temperatures in the Sandy River during sampling ranged from 8° C to 19° C. While the annual abundance of smolts in the Kennebec River is presently unknown, MDMR estimates the current egg stocking and natural reproduction in the Sandy River may be producing over 10,000 smolts annually. Smolt abundance in the river is likely to remain stable or grow as restoration efforts in the river continue.

Androscoggin River

The Androscoggin River originates at Umbagog Lake near Errol, New Hampshire and flows roughly 260 kilometers to Merrymeeting Bay (MDEP 1999). The upper portions of the Androscoggin, like the Kennebec, are high gradient. The Androscoggin River drops over 305 meters from its headwaters to where it meets the sea, with an average gradient of 3.9 meters per kilometer. In the Androscoggin watershed, Rumford Falls was the upper extent of Atlantic salmon migration, while Lewiston Falls was believed to be the upper extent of alewife and shad migrations (Foster and Atkins 1867). The Little Androscoggin River is the largest major subbasin of the Androscoggin with historically important salmon habitat that was accessible as far up as Snow’s Falls located 3.2 kilometer outside of West Paris (Foster and Atkins 1867). Prior to its damming, the Androscoggin River provided access to a large and diverse aquatic habitat for great numbers of diadromous and resident fish species (Foster and Atkins 1867).

Historically, Atlantic salmon were reportedly abundant in the Androscoggin River, but adult returns have dwindled and native stocks of Atlantic salmon are considered extirpated south of the Androscoggin River watershed. Dams, pollution, and over-fishing have contributed to the decline of Atlantic salmon in the Androscoggin River. The returns of adult Atlantic salmon to the Androscoggin River in recent years have been small, and mostly comprised of stray, hatchery origin fish from active restoration programs on other rivers (Letter from MDMR to FERC dated March 25, 2010, Table 8).

Table 8. Adult Atlantic salmon returns by origin to the Androscoggin River recorded from 1983 to 2012 at the Brunswick Project (USASAC 2012).

	Hatchery Origin				**Wild Origin**				
	1SW	**2SW**	**3SW**	**Repeat**	**1SW**	**2SW**	**3SW**	**Repeat**	**Total**
1983-2000	26	507	6	2	6	83	0	1	**631**
2001	1	4	0	0	0	0	0	0	**5**
2002	0	2	0	0	0	0	0	0	**2**
2003	0	3	0	0	0	0	0	0	**3**
2004	3	7	0	0	0	1	0	0	**11**
2005	2	8	0	0	0	0	0	0	**10**
2006	5	1	0	0	0	0	0	0	**6**
2007	6	11	0	0	1	2	0	0	**20**
2008	8	5	0	0	2	1	0	0	**16**
2009	2	19	0	0	0	3	0	0	**24**
2010	2	5	0	0	0	2	0	0	**9**
2011	2	25	0	0	1	16	0	0	**44**
2012	0	0	0	0	0	0	0	0	**0**
Total	**57**	**597**	**6**	**2**	**10**	**108**	**0**	**1**	**737**

Prior to 2007, MDMR stated that there were no indications that the Androscoggin River had a reproducing population of Atlantic salmon (letter from MDMR to FERC dated March 25, 2010). Documented annual runs of returning adult salmon consisted primarily (98%) of fish originating as hatchery smolts released into Maine rivers. In 2007 and 2008 several returning adults captured at the Brunswick fishway were determined to be fry-stocked or naturally reared fish. As stocking efforts in other DPS rivers increase so does the amount of strays captured at the Brunswick Dam.

Adult Atlantic salmon are released above the Brunswick Dam to continue upstream migration after biological data (e.g., length) are collected. The mean fork length of returning adults was

603 mm in 2008 and 735 in 2009 (MDMR 2010). Several adult salmon have been captured at the Brunswick fishway with fin-clips or tags, indicating that these fish are strays or stocked landlocked salmon from other rivers (MDMR 2010). The Maine Atlantic Salmon Technical Advisory Committee (MASTAC) collects fin-clips for genetic samples in an attempt to identify the origin of returning salmon (MDMR 2010). The MASTAC plans to conduct future analyses to determine the origin of these and all other adult Atlantic salmon captured at the Brunswick fishway (MDMR 2010).

The next two dams encountered on the Androscoggin River upstream of the Brunswick Dam are the Pejepscot and Worumbo Dams. Both projects have anadromous upstream passage facilities. With passage at the first three dams on the river, Atlantic salmon have access up to Lewiston Falls (Fay *et al.* 2006, MDMR 2010). This available habitat represents approximately 27 miles of accessible water in the lower Androscoggin River from the Brunswick Project to Lewiston Falls. Atlantic salmon habitat is quantified in the GOM DPS by mapping Hydrologic Unit Codes 10 scale (HUC10) to define suitable Atlantic salmon habitat units (NMFS 2009a). Each habitat unit equals 100 square meters. The Androscoggin River consists of 97,598 historic HUC10 habitat units. An estimated 17% (16,978 units) of these historic habitat units within the Androscoggin River system are considered to be occupied and occur in the lower Androscoggin River drainage (NMFS 2009a). Atlantic salmon habitat quality is measured in HUC10s based on the suitability of several parameters using a scale from zero to three, which include temperature, biological communities, water quality, and substrate and cover. Low quality habitat scores have been assigned to the lower Androscoggin River, while high scores were determined in the upper inaccessible reaches of the river (NMFS 2009a).

Fay *et al.* (2006) report that "...practically all suitable rearing habitat in the Androscoggin River watershed is not currently accessible to Atlantic salmon." The availability of suitable spawning habitat is unknown; no documentation of successful spawning in the Androscoggin River exists although naturally reared fish have been documented to occur in the river (MDMR 2012). In 2011, HDR evaluated the spawning habitat in the Little River, 800 meters downriver of the Worumbo Project, and found numerous barriers and poor substrates. However, MDMR indicates that there is a significant amount of habitat in the Little River and that it could hold “tens of thousands of eggs” (MDMR 2012b). During the 2011 telemetry study, MDMR documented a radio tagged female Atlantic salmon moving throughout the Little River, and it is thought that it may have spawned in Gillespie Brook, one of its tributaries (MDMR 2012b). The mainstem Androscoggin River is expected to provide minimal spawning habitat due to the existing impoundments and/or unsuitable substrates. However, MDMR identified the Pejepscot (in the mainstem) and Lower Barker (in the Little Androscoggin) bypass reaches as containing suitable spawning habitat (MDMR 2012b). In addition, tributaries in the central reaches of the Androscoggin River contain abundant (-40,000 units) suitable Atlantic salmon spawning and rearing habitat that is presently inaccessible due to dams (NMFS 2009b). Above Worumbo Dam the only sizeable tributary other than the Little Androscoggin that might provide suitable spawning and rearing habitat would be the Sabattus River; however, Lower Dam (a.k.a. Farwell Mill Dam), which is located about three kilometers upstream in the mouth of the Sabattus River, blocks access to the majority of the habitat.

Atlantic salmon stocking practices are common in the region for the GOM DPS stock enhancement program, although the Androscoggin River has been stocked with fewer fish than any other river with a stocking program for anadromous Atlantic salmon. A total of 13,000 fry have been stocked in the Androscoggin River since stocking commenced in 2001 (USASAC 2012). Most recently, the total number of juvenile salmon stocked in the Androscoggin River (fry only) was 2,000 individuals in 2009 and 1,000 in 2010 and 1,000 in 2011 (USASAC 2010, 2011, 2012). These numbers are most likely estimates of the amount of fry stocked into the Little River by school groups participating in salmon outreach programs (MDMR 2010). In comparison, other major GOM rivers were stocked at the following levels in 2011 (number of juveniles indicated in parenthesis): the Penobscot (1.8 million), Machias (347,500), Dennys (539,000), and Kennebec (85,000) rivers (USASAC 2012).

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

The fact that only 10% (2 out of 21) of the tagged adult Atlantic salmon successfully migrated past all three of the lower dams in 2011 may indicate poor passage efficiencies at the Pejepscot and Worumbo Projects, but likely also suggests that the salmon are poorly motivated to seek out upstream habitat. This conclusion is further supported by the fact that nearly one third of the salmon dropped out of the river soon after release in the Brunswick headpond and did not return. Overall, this study appears to support the conclusion that the majority of Atlantic salmon that enter the Androscoggin are strays that were stocked in other GOM DPS rivers.

The Androscoggin River is considered within the same Ecological Drainage Unit (EDU) as the Penobscot and Kennebec Rivers (Fay *et al*. 2006), which was considered in the decision to expand the GOM DPS in 2009 (USFWS and NMFS 2009). While salmon migration and habitat use studies are limited in the Androscoggin River, a number of studies have been conducted in the Penobscot River that may be relevant to the Androscoggin River. Specifically, adult Atlantic salmon returns are most common in June on the Penobscot River (MDMR 2007, 2008), and have been tracked with telemetry and observed to stop migration and seek thermal refuge when temperatures exceed 22°C (Holbrook 2007). Adult salmon have also been observed falling back and out of the river during periods of very high water temperatures (Shepard 1995, Holbrook

2007). After spawning, kelts have been observed in the lower Penobscot River in November (USASAC 2007). Based on NMFS Penobscot River smolt trapping studies in 2000 - 2005, smolts migrate from the Penobscot between late April and early June with a peak in early May (Fay *et al.* 2006). These NMFS data also demonstrate that the majority of the smolt migration appears to take place over a two-week period after water temperatures rise to 10°C.

3.1.4. Factors Affecting Atlantic Salmon in the Action Area

3.1.4.1. Hydroelectric Facilities

Within the Merrymeeting Bay SHRU there are roughly 104 dams of which 15 are FERC licensed mainstem dams used for power generation or storage, resulting in over 59 kilometers of impounded river (MDEP 1999). Therefore, both the Kennebec and Androscoggin watersheds are heavily utilized for power production.

The Kennebec River Basin has been extensively developed for hydroelectric power production. There are currently 18 hydroelectric dams in the Kennebec watershed and 15 of these dams are impassable due to the lack of fishways. The Lockwood Project is the first impediment to upstream migration on the Kennebec River. There are nine facilities upstream of the Lockwood Project on the mainstem Kennebec River and an additional four on upstream tributaries. The vast majority of salmon habitat (nearly 90%) in the Kennebec River watershed is located above the Lockwood Project. Hydroelectric dams are known to impact Atlantic salmon through habitat alteration, fish passage delays, and entrainment and impingement.

On the Androscoggin below Rumford (the upper extent of the range of Atlantic salmon), major hydroelectric facilities include the upper and lower stations at the Rumford Falls project in Rumford; Riley/Jay/Livermore Projects in Jay, Riley and Livermore; Gulf Island/Deer Rips project in Lewiston-Auburn; Lewiston Falls project in Lewiston/Auburn; the Worumbo Project in Lisbon/Durham; Worumbo in Topsham/Brunswick; and the Brunswick project in Brunswick/Topsham. Today, the upper extent of fish passage in the Androscoggin River is Lewiston Falls, which is located 32 km (20 miles) upstream from Merrymeeting Bay.

Habitat Alteration

Dams have eliminated or degraded vast, but to date un-quantified, reaches of suitable rearing habitat in the Kennebec and Androscoggin River watersheds. The Kennebec River consists of 254,558 historic habitat units, with 44,402 units considered to be occupied. Similarly, the Androscoggin River consists of 97,598 historic habitat units, with 16,978 units considered to be occupied (NMFS 2009a). Impoundments created by these dams limit access to habitat, alter habitat, and degrade water quality through increased temperatures and lowered dissolved oxygen levels. Furthermore, because hydropower dams are typically constructed in reaches with moderate to high underlying gradients, significant areas of free-flowing habitat have been converted to impounded habitats in the Kennebec and Androscoggin River watersheds. Coincidently, these moderate to high gradient reaches, if free-flowing, would likely constitute the highest value as Atlantic salmon spawning, nursery, and adult resting habitat within the context of all potential salmon habitat within these reaches.

Compared to a natural hydrograph, the operation of dams in a store-and-release mode in the upper reaches of the two rivers results in reduced spring runoff flows, less severe flood events, and augmented summer and early fall flows. Such operations in turn reduce sediment flushing and transport and physical scouring of substrates, and increase surface area and volume of summer and early fall habitat in the main stem. The extent to which these streamflow modifications in the upper Kennebec and Androscoggin River watersheds impact salmon populations, habitat (including migratory corridors during applicable seasons), and restoration efforts is unknown. However, increased embeddedness of spawning and invertebrate colonization substrates, diminished flows during smolt and kelt outmigration, and enhanced habitat quantity and, potentially, "quality" for non-native predators such as smallmouth bass, are likely among the adverse impacts to salmon. Conversely, higher summer and early fall stream flows may provide some benefits to Atlantic salmon or their habitat within affected reaches, and may also help mitigate certain potential water quality impacts (e.g., dilution of harmful industrial and municipal discharges).

Habitat Connectivity

Smolts from the Kennebec and Androscoggin Rivers have to navigate through multiple dams on their migrations to the estuary every spring. While several studies have been conducted at hydroelectric dams in the lower Kennebec River to assess downstream passage effectiveness for smolts, survival of smolts migrating past dams is presently unknown. The route that a salmon smolt takes when passing a project is a major factor in its likelihood of survival. Fish that pass through a properly designed downstream bypass have a better chance of survival than a fish that goes over a spillway, which, in turn, has a better chance of survival than a fish swimming through the turbines. It can be assumed that close to 100% of smolts will survive when passing through a properly designed downstream bypass. Survival through turbines varies significantly based on numerous factors, but as described above can be significantly lower than the other two routes.

Although the survival of smolts migrating past dams in the Kennebec and Androscoggin Rivers is presently unknown, smolt studies conducted by Holbrook (2007) on the Penobscot River documented significant losses of smolts in the vicinity of mainstem dams. Of the tagged salmon smolts used in the study in 2005 and 2006, 43% and 60%, respectively, were lost in the vicinity of the West Enfield, Howland, and Milford Dams. Although these data do not definitively reveal sources of mortality, these losses are likely attributable to the direct and indirect effects of the dams (e.g., physical injury, predation). Alden Research Laboratory (Alden 2012) modeled the smolt survival rates of 15 hydroelectric dams in the Penobscot River. The average of the mean survival rates at the 15 projects (accounting for both direct and indirect mortality) was 89.5%, but survival at individual dams fell as low as 61.5%.

Atlantic salmon kelts move downstream after spawning in November or, alternatively, overwinter in freshwater and outmigrate early in the spring (mostly mid-April through late May). Lévesque *et al.* (1985) and Baum (1997) suggest that 80% of kelts overwinter in freshwater habitat prior to returning to the ocean. No kelt survival studies have been conducted on the Androscoggin River, however, downstream passage success at dams on the Penobscot has been studied. Kelt passage occurred during periods of spill at most dams, and a large portion of study fish used the spillage. Kelt attraction to, and use of, downstream passage facilities was highly variable depending on facility, year of study, and hydrological conditions (e.g., spill or not). Shepard (1989a) documented that kelts relied on spillage flows to migrate past the Milford and Veazie Dams on the Penobscot River during a study conducted in 1988. In fact, some kelts spent hours to days searching for spillway flows to complete their downstream migration during the 1988 study.

High quality spawning and rearing habitat is not presently accessible volitionally to Atlantic salmon in the Kennebec River. To access high quality spawning and rearing habitat, Atlantic salmon must be trapped at the Lockwood Project and transported by trucks to upstream areas. This is due to the lack of upstream fish passage facilities at mainstem dams including the Hydro Kennebec, Shawmut, and Weston Projects. While trap and truck fish passage can successfully move migrants to upstream areas, trap and truck operations to transport migratory fish species can result in adverse impacts including injury, disorientation, disease and mortality, delay in migration, and interruption of the homing instinct, which can lead to straying (OTA 1995). Other disadvantages to trap and truck passage include: holding and handling stress, reduced passage by other species that will not enter traps, and the need for long-term, guaranteed operational funding for dedicated biological staff, equipment, supplies, vehicles and tanks, etc.

Androscoggin River

In 1982, Central Maine Power Company (CMP) reconstructed the hydroelectric facility in Brunswick-Topsham (Brown *et al*. 2006) on the Androscoggin River. CMP installed a slot fishway with a trapping and sorting facility. At that time, the MDMR began the Anadromous Fish Restoration Program in the lower Androscoggin River main stem and tributaries below Lewiston Falls. In 1987, the Pejepscot Project, the second dam on the Androscoggin River, had upstream fish passage installed. In 1988, upstream passage facilities were installed at the Worumbo Project, the third upstream dam on the river. This provided an opportunity for anadromous species to migrate upstream as far as Lewiston Falls (Brown *et al.*2006).

No upstream passage studies for Atlantic salmon have been conducted at the dams on the Androscoggin River, although annual counts of pre-spawn migrating Atlantic salmon trapped at the Brunswick and Worumbo Dams have been made since 1983. Few Atlantic salmon are known to migrate upriver of all three passable dams in the lower Androscoggin River. Between zero and 44 Atlantic salmon per year (average of 15 fish) passed the Brunswick Dam between 2003 and 2012 (Table 9). Of these, an average of 13% (range between 0% and 56%) successfully passed the Worumbo Project. Similarly, in a radio telemetry study conducted in 2011, while the spillway rehabilitation was occurring, MDMR documented that fewer than 10% (2 out of 21) of tagged salmon passed at the Brunswick Project successfully migrated past the Worumbo Project. In the same study, MDMR documented that 43% (9 out of 21) of tagged salmon successfully passed the Pejepscot Project (MDMR 2012b). Individual Atlantic salmon may use existing habitat and tributaries between dams and may not attempt to pass the next upstream dam. Tributaries exist between the Brunswick Project and the Worumbo Project that may contain Atlantic salmon habitat (MDMR 2010). Individual Atlantic salmon may migrate to these tributaries to spawn or seek thermal refuge, instead of migrating further upstream past the Worumbo Project.

Table 9. The number of sea run Atlantic salmon passing the Brunswick and Worumbo Projects between 2003 and 2012, and the proportion that are known to pass all three of the lower-most dams in the Androscoggin River.

Year	Brunswick Project	Worumbo Project	Proportion that Pass the Worumbo Project
2003	3	1	33%
2004	12	1	8%
2005	10	0	0%
2006	6	2	33%
2007	21	7	33%
2008	18	2	11%
2009	24	1	4%
2010	9	5	56%
2011	44	3	7%
2012	0	0	
Average	**15**	**2**	**13%**

3.1.4.2. Delayed Effects of Downstream Passage

In addition to direct mortality sustained by Atlantic salmon at hydroelectric projects, Atlantic salmon in the Kennebec and Androscoggin Rivers will also sustain delayed mortality as a result of repeated passage events at multiple hydroelectric projects. Studies have investigated what is referred to as latent or delayed mortality, which occurs in the estuary or ocean environment and is associated with passage through one or more hydro projects (Budy *et al.* 2002, ISAB 2007, Schaller and Petrosky 2007, Haeseker *et al.* 2012). The concept describing this type of mortality is known as the hydrosystem-related, delayed-mortality hypothesis (Budy *et al.* 2002, Schaller and Petrosky 2007, Haeseker *et al.* 2012).

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

Some recent studies have corroborated the indirect evidence for hydrosystem delayed mortality presented by Budy *et al.* (2002) and provided data on the effects of in-river and marine environmental conditions (Schaller and Petrosky 2007, Haeseker *et al.* 2012). Based on an evaluation of historical tagging data describing spatial and temporal mortality patterns of downstream migrants, Schaller and Petrosky (2007) concluded that delayed mortality of Snake River chinook salmon was evident and that it did not diminish with more favorable oceanic and climatic conditions. Estimates of delayed mortality reported in this study ranged from 0.75 to 0.95 (mean = 0.81) for the study years of 1991-1998 and 0.06 to 0.98 (mean = 0.64) for the period of 1975-1990. Haeseker *et al.* (2012) assessed the effects of environmental conditions experienced in freshwater and the marine environment on delayed mortality of Snake River chinook salmon and steelhead trout. This study examined seasonal and life-stage-specific survival rates of both species and analyzed the influence of environmental factors (freshwater: river flow spilled and water transit time; marine: spring upwelling, Pacific Decadal Oscillation, sea surface temperatures). Haeseker *et al.* (2012) found that both the percentage of river flow spilled and water transit time influenced in-river and estuarine/marine survival rates, whereas the Pacific Decadal Oscillation index was the most important factor influencing variation in marine and cumulative smolt-to-adult survival of both species. Also, freshwater and marine survival rates were shown to be correlated, demonstrating a relation between hydrosystem experience on estuarine and marine survival. The studies described above clearly support the delayed-mortality hypothesis proposed by Budy *et al.* (2002). However, only one of the studies quantified delayed mortality, and the estimates varied considerably. Although Rechisky *et al*. (2012) found no evidence of hydrosystem related delayed mortality between juvenile Snake River and Yakima River Chinook salmon they acknowledged limitations within their study.

Although delayed mortality following passage through a hydrosystem has been demonstrated by the studies discussed above, effectively quantifying such losses remains difficult, mainly because of practical limitations in directly measuring mortality after fish have left a river system (i.e., during time spent in estuaries and the marine environment). Evaluations of delayed mortality have generally produced indirect evidence to support the link between hydrosystem experience and estuary and marine survival rates (and smolt-to-adult returns). In fact, in a review of delayed mortality experienced by Columbia River salmon, ISAB (2007) recommended that attempts should not be made to provide direct estimates of absolute delayed mortality, concluding that measuring such mortality relative to a damless reference was not possible. Alternatively, it was suggested that the focus should be on estimating total mortality of in-river fish, which was considered more critical to the recovery of listed salmonids. Consequently, it is difficult to draw absolute or quantifiable inferences from the Columbia River studies to other river systems beyond the simple conclusion that delayed mortality likely occurs for most anadromous salmonid populations. Additionally, although there is evidence of differential mortality between upper and lower river smolts in the Columbia River basin (Schaller and Petrosky 2007), data are not available for estimating a cumulative mortality rate based on the number of dams passed by downstream migrants.

Given the difficulty in estimating this type of mortality at the present time, we do not have sufficient data to specifically assess the effect of hydrosystem-related mortality in the Kennebec and Androscoggin Rivers. Thus, we have not attempted to quantify the delayed (or delayed) loss of smolts or kelts attributed to the licensee’s projects in this Opinion. Nevertheless, considering the multiple FERC licensed hydroelectric projects in the Kennebec and Androscoggin River watersheds, it can be assumed that practically all smolts and kelts in the river must pass at least two hydroelectric dams during the downstream migrations and the resulting loss of endangered Atlantic salmon could be significant. According to a model developed by NMFS (2012), even a small cumulative mortality rate (1-10%) could have a significant effect on the number of returning 2 SW female Atlantic salmon in the Penobscot River watershed.

3.1.4.3. Predation

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

Smallmouth bass and chain pickerel are each important predators of Atlantic salmon within the range of the GOM DPS (Fay *et al.* 2006). Smallmouth bass are a warm-water species whose range now extends through north-central Maine and well into New Brunswick (Jackson 2002). Smallmouth bass are very abundant in the Androscoggin and Kennebec Rivers, and they inhabit much of the main stem migratory corridor and areas containing juvenile Atlantic salmon. Smallmouth bass likely feed on fry and parr though little quantitative information exists regarding the extent of bass predation upon salmon fry and parr. Smallmouth bass are important predators of smolts in main stem habitats, although bioenergetics modeling indicates that bass predation is insignificant at 5°C and increases with increasing water temperature during the smolt migration (Van den Ende 1993).

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

Northern pike were illegally stocked in Maine, and their range now includes portions of the lower Androscoggin and Kennebec Rivers (MDIFW 2008). Northern pike are ambush predators that rely on vision and thus, predation upon smolts occurs primarily in daylight with the highest predation rates in low light conditions at dawn and dusk (Bakshtansky *et al.* 1982). Hatchery smolts experience higher rates of predation by fish than wild smolts, particularly from northern pike (Ruggles 1980, Bakshtansky *et al.* 1982).

Many species of birds prey upon Atlantic salmon throughout their life cycle (Fay *et al.* 2006). Blackwell *et al.* (1997) reported that salmon smolts were the most frequently occurring food items in cormorant sampled at main stem dam foraging sites. Common mergansers, belted kingfishers cormorants, and loons would likely prey upon Atlantic salmon in the Androscoggin and Kennebec River. The abundance of alternative prey resources such as upstream migrating alewife, likely minimizes the impacts of cormorant predation on the GOM DPS (Fay *et al.* 2006).

3.1.4.4. Contaminants and Water Quality

Pollutants discharged from point sources affect water quality within the action area of this consultation. Common point sources of pollutants include publicly operated waste treatment facilities, overboard discharges (OBD), a type of waste water treatment system), and industrial sites and discharges. The Maine Department of Environmental Protection (MDEP) issues permits under the National Pollutant Discharge Elimination System (NPDES) for licensed point source discharges. Conditions and license limits are set to maintain the existing water quality classification. Generally, the impacts of point source pollution are greater in the larger rivers of the GOM DPS.

Kennebec River

The DEP has a schedule for preparing a number of TMDLs for rivers and streams within the Kennebec River watershed. TMDLs allocate a waste load for a particular pollutant for impaired waterbodies. The main stem of the Kennebec River downstream of Augusta has restricted fish consumption due to the presence of dioxin from industrial point sources. Combined sewer overflows in Augusta and other communities along the river produce elevated bacteria levels, thus inhibiting recreation uses of the river (primary contact). The lower 22.7 miles of the Kennebec River downstream of its confluence with the Carrabassett River is impaired due to contamination of polychlorinated biphenyls. Other tributaries to the Kennebec River including the Sebasticook River area impaired due to contamination of mercury, PCBs, dioxin, and bacteria from industrial and municipal point sources.

Androscoggin River

Poor water quality within segments of the Androscoggin River is of particular concern for fisheries restoration. The U.S. Environmental Protection Agency (USEPA) noted that two segments of the Androscoggin, including the lower four miles of the Gulf Island dam impoundment and the Livermore Falls impoundment do not attain water quality standards for class C waters (USEPA 2005). The non-attainment status is caused by point source discharges upriver from the three paper mills located in Berlin, New Hampshire (Fraser Paper), Rumford, Maine (Mead WestVaco), and Jay, Maine (International Paper); five municipal point sources from locations in Berlin and Gorham, New Hampshire and Bethel, Rumford-Mexico, and Livermore Falls, Maine; and non-point source pollutant loads from land use activities, particularly that related to residential development, silviculture, and agriculture (USEPA 2005).

The MDEP has four standards for classification of freshwater which are not classified as “great ponds”. These are class AA, A, B, and C waters, in which class AA is the highest classification in which waters are considered to be “outstanding natural resources and which should be preserved because of their ecological, social, scenic or recreational importance”; and class C waters is the lowest classification in which class C waters “shall be of such quality that they are suitable for the designated uses of drinking water supply after treatment; fishing; recreation in and on the water; industrial process and cooling water supply; hydroelectric power generation, except as prohibited…, navigation, and as a habitat for fish and other aquatic life." (State of Maine, Title 38 *§ 465*).

The Gulf Island Dam impoundment does not meet the Class C standards for dissolved oxygen concentration in the summer at depths of 30 to 80 feet. In addition to the pollution sources upstream from the dam, the dam itself contributes to non-attainment of DO criteria and algae growth by creating an environment of low water movement and low vertical mixing with the deeper water column (USEPA 2005). The Livermore Falls impoundment does not attain the class C aquatic life criteria in which dissolved oxygen shall not fall below an instantaneous minimum of 5 ppm and 60 percent saturation, and a 30 day average long term minimum of 6.5 ppm (USEPA 2005).

3.1.5. Summary of Factors Affecting Recovery of Atlantic Salmon

There are a wide variety of factors that have and continue to affect the current status of the GOM DPS. The potential interactions among these factors are not well understood, nor are the reasons for the seemingly poor response of salmon populations to the many ongoing conservation efforts for this species.

Threats to the Species

The recovery plan for the previously designated GOM DPS (NMFS and USFWS 2005), the latest status review (Fay *et al.* 2006), and the 2009 listing rule all provide a comprehensive assessment of the many factors, including both threats and conservation actions, that are currently affecting the status and recovery of listed Atlantic salmon. The Services are writing a new recovery plan that will include the current, expanded GOM DPS and its designated critical habitat. The new recovery plan provides the most up to date list of significant threats affecting the GOM DPS. These are the following:

- Dams
- Inadequacy of existing regulatory mechanisms for dams
- Continued low marine survival rates for U.S. stocks of Atlantic salmon
- Lack of access to spawning and rearing habitat due to dams and road-stream crossings

In addition to these significant threats, there are a number of lesser stressors. These are the following:

- Degraded water quality
- Aquaculture practices, which pose ecological and genetic risks
- Climate change
- Depleted diadromous fish communities
- Incidental capture of adults and parr by recreational anglers
- Introduced fish species that compete or prey on Atlantic salmon
- Poaching of adults in DPS rivers
- Recovery hatchery program (potential for artificial selection/domestication)
- Sedimentation of spawning and rearing habitat

- Water extraction

Fay *et al.* (2006) examined each of the five statutory ESA listing factors and determined that each of the five listing factors is at least partly responsible for the present low abundance of the GOM DPS. The information presented in Fay *et al.* (2006) is reflected in and supplemented by the final listing rule for the new GOM DPS (74 FR 29344; June 19, 2009). The following gives a brief overview of the five listing factors as related to the GOM DPS.

1. **Present or threatened destruction, modification, or curtailment of its habitat or range –** Historically and, to a lesser extent currently, dams have adversely impacted Atlantic salmon by obstructing fish passage and degrading riverine habitat. Dams are considered to be one of the primary causes of both historic declines and the contemporary low abundance of the GOM DPS. Land use practices, including forestry and agriculture, have reduced habitat complexity (e.g., removal of large woody debris from rivers) and habitat connectivity (e.g., poorly designed road crossings) for Atlantic salmon. Water withdrawals, elevated sediment levels, and acid rain also degrade Atlantic salmon habitat.

2. **Overutilization for commercial, recreational, scientific, or educational purposes –** While most directed commercial fisheries for Atlantic salmon have ceased, the impacts from past fisheries are still important in explaining the present low abundance of the GOM DPS. Both poaching and by-catch in recreational and commercial fisheries for other species remain of concern, given critically low numbers of salmon.

3. **Predation and disease –** Natural predator-prey relationships in aquatic ecosystems in the GOM DPS have been substantially altered by introduction of non-native fishes (e.g., chain pickerel, smallmouth bass, and northern pike), declines of other native diadromous fishes, and alteration of habitat by impounding free-flowing rivers and removing instream structure (such as removal of boulders and woody debris during the log-driving era). The threat of predation on the GOM DPS is noteworthy because of the imbalance between the very low numbers of returning adults and the recent increase in populations of some native predators (e.g., double-crested cormorant), as well as non-native predators. Atlantic salmon are susceptible to a number of diseases and parasites, but mortality is primarily documented at conservation hatcheries and aquaculture facilities.

4. **Inadequacy of existing regulatory mechanisms –** The ineffectiveness of current federal and state regulations at requiring fish passage and minimizing or mitigating the aquatic habitat impacts of dams is a significant threat to the GOM DPS today. Furthermore, most dams in the GOM DPS do not require state or federal permits. Although the State of Maine has made substantial progress in regulating water withdrawals for agricultural use, threats still remain within the GOM DPS, including those from the effects of irrigation wells on salmon streams.

5. **Other natural or manmade factors –** Poor marine survival rates of Atlantic salmon are a significant threat, although the causes of these decreases are unknown. The role of ecosystem function among the freshwater, estuarine, and marine components of the Atlantic salmon's life history, including the relationship of other diadromous fish species in Maine (e.g., American shad, alewife, sea lamprey), is receiving increased scrutiny in

its contribution to the current status of the GOM DPS and its role in recovery of the Atlantic salmon. While current state and federal regulations pertaining to finfish aquaculture have reduced the risks to the GOM DPS (including eliminating the use of non-North American Atlantic salmon and improving containment protocols), risks from the spread of diseases or parasites and from farmed salmon escapees interbreeding with wild salmon still exist.

Efforts to Protect the GOM DPS of Atlantic salmon

Efforts aimed at protecting Atlantic salmon and their habitats in Maine have been underway for well over one hundred years. These efforts are supported by a number of federal, state, and local government agencies, as well as many private conservation organizations. The 2005 recovery plan for the originally-listed GOM DPS (NMFS and USFWS 2005) presented a strategy for recovering Atlantic salmon that focused on reducing the most severe threats to the species and immediately halting the decline of the species to prevent extinction. The 2005 recovery program included the following elements:

1. Protect and restore freshwater and estuarine habitats;
2. Minimize potential for take in freshwater, estuarine, and marine fisheries;
3. Reduce predation and competition for all life-stages of Atlantic salmon;
4. Reduce risks from commercial aquaculture operations;
5. Supplement wild populations with hatchery-reared DPS salmon;
6. Conserve the genetic integrity of the DPS;
7. Assess stock status of key life stages;
8. Promote salmon recovery through increased public and government awareness; and
9. Assess effectiveness of recovery actions and revise as appropriate.

A wide variety of activities have focused on protecting Atlantic salmon and restoring the GOM DPS, including (but not limited to) hatchery supplementation; removing dams or providing fish passage; improving road crossings that block passage or degrade stream habitat; protecting riparian corridors along rivers; reducing the impact of irrigation water withdrawals; limiting effects of recreational and commercial fishing; reducing the effects of finfish aquaculture; outreach and education activities; and research focused on better understanding the threats to Atlantic salmon and developing effective restoration strategies. In light of the 2009 GOM DPS listing and designation of critical habitat, the Services are producing a new recovery plan for the expanded GOM DPS of Atlantic salmon.

3.2. Critical Habitat for Atlantic Salmon in the GOM DPS

Coincident with the June 19, 2009 endangered listing, we designated critical habitat for the GOM DPS of Atlantic salmon (74 FR 29300; June 19, 2009) (Figure 3). The final rule was revised on August 10, 2009. In this revision, designated critical habitat for the expanded GOM DPS of Atlantic salmon was reduced to exclude trust and fee holdings of the Penobscot Indian Nation and a table was corrected (74 FR 39003; August 10, 2009).

Primary Constituent Elements of Atlantic Salmon Critical Habitat

Designation of critical habitat is focused on the known primary constituent elements (PCEs), within the occupied areas of a listed species that are deemed essential to the conservation of the species. Within the GOM DPS, the PCEs for Atlantic salmon are: 1) sites for spawning and rearing, and 2) sites for migration (excluding marine migration[1]). We chose not to separate spawning and rearing habitat into distinct PCEs, although each habitat does have distinct features, because of the GIS-based habitat prediction model approach that was used to designate critical habitat (74 FR 29300; June 19, 2009). This model cannot consistently distinguish between spawning and rearing habitat across the entire range of the GOM DPS.

1 Although successful marine migration is essential to Atlantic salmon, NMFS was not able to identify the essential features of marine migration and feeding habitat or their specific locations at the time critical habitat was designated.2 For purposes of this consultation, Northern rivers are considered to include tributaries of the Chesapeake Bay northward to the St. John River in Canada. Southern rivers are those south of the Chesapeake Bay.

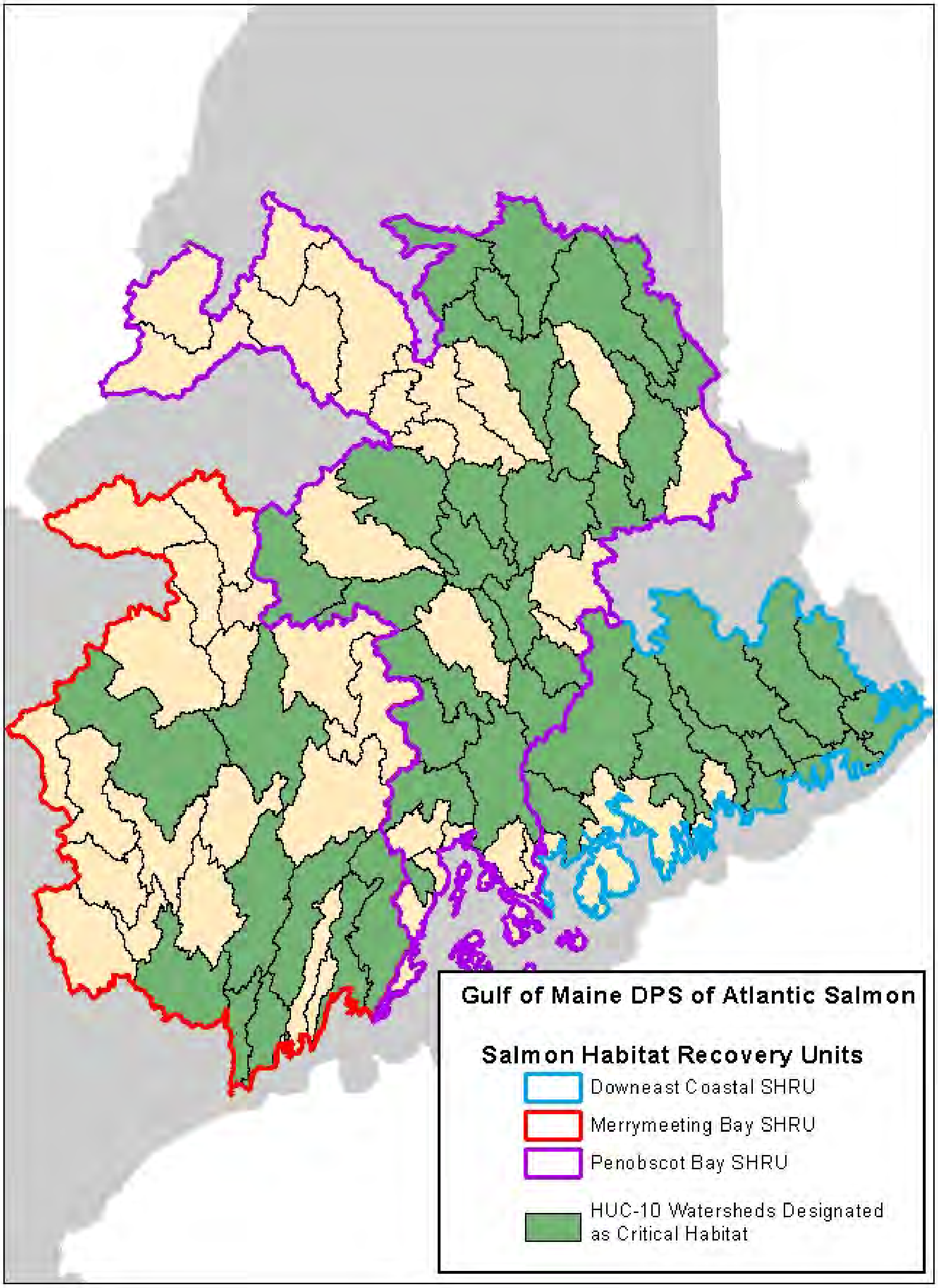

Figure 3. HUC-10 Watersheds Designated as Atlantic Salmon Critical Habitat within the GOM DPS.

The physical and biological features of the two PCEs for Atlantic salmon critical habitat are as follows:

Physical and Biological Features of the Spawning and Rearing PCE

1. Deep, oxygenated pools and cover (*e.g.*, boulders, woody debris, vegetation, etc.), near freshwater spawning sites, necessary to support adult migrants during the summer while they await spawning in the fall.
2. Freshwater spawning sites that contain clean, permeable gravel and cobble substrate with oxygenated water and cool water temperatures to support spawning activity, egg incubation, and larval development.
3. Freshwater spawning and rearing sites with clean, permeable gravel and cobble substrate with oxygenated water and cool water temperatures to support emergence, territorial development and feeding activities of Atlantic salmon fry.
4. Freshwater rearing sites with space to accommodate growth and survival of Atlantic salmon parr.
5. Freshwater rearing sites with a combination of river, stream, and lake habitats that accommodate parr's ability to occupy many niches and maximize parr production.
6. Freshwater rearing sites with cool, oxygenated water to support growth and survival of Atlantic salmon parr.
7. Freshwater rearing sites with diverse food resources to support growth and survival of Atlantic salmon parr.

Physical and Biological Features of the Migration PCE

1. Freshwater and estuary migratory sites free from physical and biological barriers that delay or prevent access of adult salmon seeking spawning grounds needed to support recovered populations.
2. Freshwater and estuary migration sites with pool, lake, and instream habitat that provide cool, oxygenated water and cover items (*e.g.*, boulders, woody debris, and vegetation) to serve as temporary holding and resting areas during upstream migration of adult salmon.
3. Freshwater and estuary migration sites with abundant, diverse native fish communities to serve as a protective buffer against predation.
4. Freshwater and estuary migration sites free from physical and biological barriers that delay or prevent emigration of smolts to the marine environment.
5. Freshwater and estuary migration sites with sufficiently cool water temperatures and water flows that coincide with diurnal cues to stimulate smolt migration.
6. Freshwater migration sites with water chemistry needed to support sea water adaptation of smolts.

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

For an area containing PCEs to meet the definition of critical habitat, the ESA also requires that the physical and biological features essential to the conservation of Atlantic salmon in that area "may require special management considerations or protections." Activities within the GOM DPS that were identified as potentially affecting the physical and biological features of salmon habitat and, therefore, requiring special management considerations or protections include agriculture, forestry, changing land-use and development, hatcheries and stocking, roads and road-stream crossings, mining, dams, dredging, and aquaculture.

Salmon Habitat Recovery Units within Critical Habitat for the GOM DPS

In describing critical habitat for the GOM DPS, we divided the DPS into three Salmon Habitat Recovery Units or SHRUs. The three SHRUs include the Downeast Coastal, Penobscot Bay, and Merrymeeting Bay. The SHRU delineations were designed 1) to ensure that a recovered Atlantic salmon population has widespread geographic distribution to help maintain genetic variability and 2) to 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, as will be needed to achieve recovery of the GOM DPS.

Areas designated as critical habitat within each SHRU are described in terms of habitat units. One habitat unit represents 100 m^2 of salmon spawning or rearing habitat. The quantity of habitat units within the GOM DPS was estimated through the use of a GIS-based salmon habitat model (Wright *et al.* 2008). For each SHRU, we determined that there were sufficient habitat units available within the currently occupied habitat to achieve recovery objectives in the future; therefore, no unoccupied habitat (at the HUC-10 watershed scale) was designated as critical habitat. A brief historical description for each SHRU, as well as contemporary critical habitat designations and special management considerations, are provided below.

Downeast Coastal SHRU

The Downeast Coastal SHRU encompasses fourteen HUC-10 watersheds covering approximately 747,737 hectares (1,847,698 acres) within Washington and Hancock counties. In this SHRU there are approximately 59,066 units of spawning and rearing habitat for Atlantic salmon among approximately 6,039 kilometers of rivers, lakes and streams. Of the 59,066 units of spawning and rearing habitat, approximately 53,400 units of habitat in eleven HUC-10 watersheds are considered to be currently occupied. The Downeast SHRU has enough habitat units available within the occupied range that, in a restored state (*e.g.* improved fish passage or improved habitat quality), the Downeast SHRU could satisfy recovery objectives as described in the final rule for critical habitat (74 FR 29300; June 19, 2009). Certain tribal and military lands within the Downeast Coastal SHRU are excluded from critical habitat designation.

Penobscot Bay SHRU

The Penobscot Bay SHRU, which drains approximately 22,234,522 hectares (54,942,705 acres), contains approximately 315,574 units of spawning and rearing habitat for Atlantic salmon among approximately 17,440 kilometers of rivers, lakes and streams. Of the 315,574 units of spawning and rearing habitat (within 46 HUC-10 watersheds), approximately 211,000 units of habitat are considered to be currently occupied (within 28 HUC-10 watersheds). Three HUC-10 watersheds (Molunkus Stream, Passadumkeag River, and Belfast Bay) are excluded from critical habitat designation due to economic impact. Certain tribal lands within the Penobscot Bay SHRU are also excluded from critical habitat designation.

Merrymeeting Bay SHRU

The Merrymeeting Bay SHRU drains approximately 2,691,814 hectares of land (6,651,620 acres) and contains approximately 339,182 units of spawning and rearing habitat for Atlantic salmon located among approximately 5,950 kilometers of historically accessible rivers, lakes and streams. Of the 339,182 units of spawning and rearing habitat, approximately 136,000 units of habitat are considered to be currently occupied. There are forty-five HUC-10 watersheds in this SHRU, but only nine are considered currently occupied. Lands controlled by the Department of Defense within the Little Androscoggin HUC-10 and the Sandy River HUC-10 are excluded as critical habitat.

In conclusion, the June 19, 2009 final critical habitat designation for the GOM DPS (as revised on August 10, 2009) includes 45 specific areas occupied by Atlantic salmon that comprise approximately 19,571 km of perennial river, stream, and estuary habitat and 799 km^2 of lake habitat within the range of the GOM DPS and on which are found those physical and biological features essential to the conservation of the species. Within the occupied range of the GOM DPS, approximately 1,256 km of river, stream, and estuary habitat and 100 $km^2$of lake habitat have been excluded from critical habitat pursuant to section 4(b)(2) of the ESA.

3.2.1. Status of Atlantic Salmon Critical Habitat in the Action Area

The environmental baseline of this Opinion describes the status of salmonid habitat, which is important for two reasons: a) because it affects the viability of the listed species within the action area at the time of the consultation; and b) because those habitat areas designated "critical" provide PCEs essential for the conservation (i.e., recovery) of the species. The environmental baseline also describes the status of critical habitat over the duration of the proposed action because it includes the persistent effects of past actions and the future effects of Federal actions that have not taken place but have already undergone section 7 consultation.

The complex life cycles exhibited by Atlantic salmon give rise to complex habitat needs, particularly during the freshwater phase (Fay *et al.* 2006). Spawning gravels must be a certain size and free of sediment to allow successful incubation of the eggs. Eggs also require cool, clean, and well-oxygenated waters for proper development. Juveniles need abundant food sources, including insects, crustaceans, and other small fish. They need places to hide from predators (mostly birds and bigger fish), such as under logs, root wads, and boulders in the stream, as well as beneath overhanging vegetation. They also need places to seek refuge from periodic high flows (side channels and off-channel areas) and from warm summer water temperatures (coldwater springs and deep pools). Returning adults generally do not feed in fresh water but instead rely on limited energy stores to migrate, mature, and spawn. Like juveniles, they also require cool water and places to rest and hide from predators. During all life stages, Atlantic salmon require cool water that is free of contaminants. They also need migratory corridors with adequate passage conditions (timing, water quality, and water quantity) to allow access to the various habitats required to complete their life cycle.

As discussed previously, critical habitat for Atlantic salmon has been designated in the Kennebec and Androscoggin Rivers. Both PCEs for Atlantic salmon (sites for spawning and rearing and sites for migration) are present in the action area as it was described in Section 2.6 of this Opinion (the entirety of the Kennebec and Androscoggin River watersheds). PCEs consist of the physical and biological elements identified as essential to the conservation of the species in the documents designating critical habitat. These PCEs include sites essential to support one or more life stages of Atlantic salmon (sites for spawning, rearing, and migration) and contain physical or biological features essential to the conservation of the species, for example, spawning gravels, water quality and quantity, unobstructed passage, and forage.

To facilitate and standardize determinations of effect for section 7 consultations involving Atlantic salmon critical habitat, we developed the "Matrix of PCEs and Essential Features for Designated Atlantic Salmon Critical Habitat in the GOM DPS" (Table 10). The matrix lists the PCEs, physical and biological features (essential features) of each PCE, and the potential conservation status of critical habitat within an action area. The two PCEs in the matrix (spawning and rearing, and migration) are described in regards to five distinct Atlantic salmon life stages: (1) adult spawning; (2) embryo and fry development; (3) parr development; (4) adult migration; and, (5) smolt migration. The conservation status of the essential features may exist in varying degrees of functional capacity within the action area. The three degrees of functional capacity used in the matrix are described in ascending order: (1) fully functioning; (2) limited function; and (3) not properly functioning. Using this matrix along with information presented in FERC's BA and site-specific knowledge of each project, we have determined that several essential features to Atlantic salmon in the action area have limited function or are not properly functioning currently (Table 11).

Table 10. Matrix of Primary Constituent Elements (PCEs) and essential features for assessing the environmental baseline of the action area.

		Conservation Status Baseline		
PCE	Essential Features	Fully Functioning	Limited Function	Not Properly Functioning
A) Adult Spawning: (October 1st - December 14th)				
	Substrate	highly permeable course gravel and cobble between 1.2 to 10 cm in diameter	40- 60% cobble (22.5-256 mm dia.) 40-50% gravel (2.2 – 22.2 mm dia.); 10-15% course sand (0.5 -2.2 mm dia.), and <3% fine sand (0.06-0.05mm dia.)	more than 20% sand (particle size 0.06 to 2.2 mm), no gravel or cobble
	Depth	17-30 cm	30 - 76 cm	< 17 cm or > 76 cm
	Velocity	31 to 46 cm/sec.	8 to 31cm/sec. or 46 to 83 cm/sec.	< 5-8 cm/sec. or > 83cm/sec.
	Temperature	7^{o} to 10^{o}C	often between 7^{o} to 10^{o}C	always < 7^{o} or > 10^{o}C
	pH	> 5.5	between 5.0 and 5.5	< 5.0
	Cover	Abundance of pools 1.8-3.6 meters deep (McLaughlin and Knight 1987). Large boulders or rocks, over hanging trees, logs, woody debris, submerged vegetation or undercut banks	Limited availability of pools 1.8-3.6 meters deep (McLaughlin and Knight 1987). Large boulders or rocks, over hanging trees, logs, woody debris, submerged vegetation or undercut banks	Absence of pools 1.8-3.6 meters deep (McLaughlin and Knight 1987). Large boulders or rocks, over hanging trees, logs, woody debris, submerged vegetation or undercut banks
	Fisheries Interactions	Abundant diverse populations of indigenous fish species	Abundant diverse populations of indigenous fish species, low quantities of non-native species present	Limited abundance and diversity of indigenous fish species, abundant populations of non-native species
B) Embryo and Fry Development: (October 1st - April 14th)				
	Temperature	0.5^{o}C and 7.2^{o}C, averages nearly 6oC from fertilization to eye pigmentation	averages < 4oC, or 8 to 10^{o}C from fertilization to eye pigmentation	>10^{o}C from fertilization to eye pigmentation
	D.O.	at saturation	7-8 mg/L	< 7 mg/L
	pH	> 6.0	6 - 4.5	< 4.5
	Depth	5.3-15cm	NA	<5.3 or >15cm
	Velocity	4 – 15cm/sec.	NA	<4 or > 15cm/sec.
	Fisheries Interactions	Abundant diverse populations of indigenous fish species	Abundant diverse populations of indigenous fish species, low quantities of non-native species present	Limited abundance and diversity of indigenous fish species, abundant populations of non-native species

TABLE 10 continued…

PCE	Essential Features	Conservation Status Baseline Fully Functioning	Limited Function	Not Properly Functioning
C) Parr Development: (All year)				
	Substrate	gravel between 1.6 and 6.4 cm in diameter and boulders between 30 and 51.2 cm in diameter. May contain rooted aquatic macrophytes	gravel < 1.2cm and/or boulders > 51.2. May contain rooted aquatic macrophytes	no gravel, boulders, or rooted aquatic macrophytes present
	Depth	10cm to 30cm	NA	<10cm or >30cm
	Velocity	7 to 20 cm/sec.	< 7cm/sec. or > 20 cm/sec.	velocity exceeds 120 cm/sec.
	Temperature	15^{o} to 19^{o}C	generally between 7-22.5oC, but does not exceed 29oC at any time	stream temperatures are continuously <7oC or known to exceed 29oC
	D.O.	> 6 mg/l	2.9 - 6 mg/l	< 2.9 mg/l
	Food	Abundance of larvae of mayflies, stoneflies, chironomids, caddisflies, blackflies, aquatic annelids, and mollusks as well as numerous terrestrial invertebrates and small fish such as alewives, dace or minnows	Presence of larvae of mayflies, stoneflies, chironomids, caddisflies, blackflies, aquatic annelids, and mollusks as well as numerous terrestrial invertebrates and small fish such as alewives, dace or minnows	Absence of larvae of mayflies, stoneflies, chironomids, caddisflies, blackflies, aquatic annelids, and mollusks as well as numerous terrestrial invertebrates and small fish such as alewives, dace or minnows
	Passage	No anthropogenic causes that inhibit or delay movement	Presence of anthropogenic causes that result in limited inhibition of movement	barriers to migration known to cause direct inhibition of movement
	Fisheries Interactions	Abundant diverse populations of indigenous fish species	Abundant diverse populations of indigenous fish species, low quantities of non-native species present	Limited abundance and diversity of indigenous fish species, abundant populations of non-native species

TABLE 10 continued…

PCE	Essential Features	Conservation Status Baseline: Fully Functioning	Limited Function	Not Properly Functioning
D) Adult migration: (April 15th- December 14th)				
	Velocity	30 cm/sec to 125 cm/sec	In areas where water velocity exceeds 125 cm/sec adult salmon require resting areas with a velocity of < 61 cm/s	sustained speeds > 61 cm/sec and maximum speed > 667 cm/sec
	D.O.	> 5mg/L	4.5-5.0 mg/l	< 4.5mg/L
	Temperature	14 – 20^{o}C	temperatures sometimes exceed 20oC but remain below 23^{o}C.	> 23^{o}C
	Passage	No anthropogenic causes that delay migration	Presence of anthropogenic causes that result in limited delays in migration	barriers to migration known to cause direct or indirect mortality of smolts
	Fisheries Interactions	Abundant diverse populations of indigenous fish species	Abundant diverse populations of indigenous fish species, low quantities of non-native species present	Limited abundance and diversity of indigenous fish species, abundant populations of non-native species
E) Juvenile Migration: (April 15th - June 14th)				
	Temperature	8 - 11oC	5 - 11^{o}C.	< 5oC or > 11oC
	pH	> 6	5.5 - 6.0	< 5.5
	Passage	No anthropogenic causes that delay migration	Presence of anthropogenic causes that result in limited delays in migration	barriers to migration known to cause direct or indirect mortality of smolts

Table 11. Current conditions of essential features of Atlantic salmon critical habitat having limited function or not properly functioning in the action area.

Pathway/Indicator	Life Stages Affected	PCEs Affected	Effect	Population Viability Attributes Affected
Passage/Access to Historical Habitat	Adult, juvenile, smolt	Freshwater migration	Upstream passage delays and inefficiencies limit access to spawning habitat. Poor downstream passage causes direct and delayed mortality of smolts and kelts.	Adult abundance and productivity,
Habitat Elements, Channel Dynamics, Watershed Condition	Adult, incubating eggs, juvenile, smolt	Freshwater migration, spawning, and rearing	Impoundments degrade spawning and rearing habitat, increase predation, limit productivity, and delay migrations.	Adult abundance and productivity Juvenile growth rate
Water Quality	Adult, juvenile, incubating eggs	Freshwater spawning and rearing	Impoundments degrade spawning and rearing habitat.	Adult abundance and productivity Juvenile growth rate

3.2.2. Factors affecting Atlantic Salmon Critical Habitat in the Action Area

In Section 3.1.4, we present the factors affecting the GOM DPS of Atlantic salmon within the Kennebec and Androscoggin River watersheds. To the extent that these same factors (hydroelectric operations, predation, and water quality) affect the essential features of rearing, spawning and migration habitat in the Kennebec and Androscoggin River watersheds, they are also affecting Atlantic salmon critical habitat.

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

Today, dams are the greatest impediment, outside of marine survival, to the recovery of salmon in the Penobscot, Kennebec and Androscoggin river basins (Fay *et al.* 2006). Hydropower dams in the Kennebec and Androscoggin Rivers significantly impede the migration of Atlantic salmon and other diadromous fish and either reduce or eliminate access to roughly 330,000 units of historically accessible spawning and rearing habitat. In addition to hydropower dams, agriculture and urban development largely affect the lower third of the Merrymeeting Bay SHRU by reducing substrate and cover, reducing water quality, and elevating water temperatures. Additionally, smallmouth bass and brown trout introductions, along with other non-indigenous species, significantly degrade habitat quality throughout the Merrymeeting Bay SHRU by altering natural predator/prey relationships.

3.3. Shortnose sturgeon

3.3.1. Species Description

Shortnose sturgeon are benthic fish that mainly occupy the deep channel sections of large rivers. They feed on a variety of benthic and epibenthic invertebrates including mollusks, crustaceans (amphipods, chironomids, isopods), and oligochaete worms (Vladykov and Greeley 1963, Dadswell 1979 *in* NMFS 1998). Shortnose sturgeon have similar lengths at maturity (45-55 cm fork length) throughout their range, but, because sturgeon in southern rivers grow faster than those in northern rivers, southern sturgeon mature at younger ages (Dadswell *et al.* 1984). Shortnose sturgeon are long-lived (30-40 years) and, particularly in the northern extent of their range, mature at late ages. In the north, males reach maturity at five to ten years, while females mature between seven and thirteen years. Based on limited data, females spawn every three to five years while males spawn approximately every two years. The spawning period is estimated to last from a few days to several weeks. Spawning begins from late winter/early spring (southern rivers) to mid to late spring (northern rivers)[2] when the freshwater temperatures increase to 8-9ºC. Several published reports have presented the problems facing long-lived species that delay sexual maturity (Crouse *et al.* 1987, Crowder *et al.* 1994, Crouse 1999). In general, these reports concluded that animals that delay sexual maturity and reproduction must have high annual survival as juveniles through adults to ensure that enough juveniles survive to reproductive maturity and then reproduce enough times to maintain stable population sizes.

Total instantaneous mortality rates (Z) are available for the Saint John River (0.12 - 0.15; ages 14-55; Dadswell 1979), Upper Connecticut River (0.12; Taubert 1980), and Pee Dee-Winyah River (0.08-0.12; Dadswell *et al.* 1984). Total instantaneous natural mortality (M) for shortnose sturgeon in the lower Connecticut River was estimated to be 0.13 (T. Savoy, Connecticut Department of Environmental Protection, personal communication). There is no recruitment information available for shortnose sturgeon because there are no commercial fisheries for the species. Estimates of annual egg production for this species are difficult to calculate because females do not spawn every year (Dadswell *et al.* 1984). Further, females may abort spawning attempts, possibly due to interrupted migrations or unsuitable environmental conditions (NMFS 1998). Thus, annual egg production is likely to vary greatly in this species. Fecundity estimates have been made and range from 27,000 to 208,000 eggs/female (Dadswell *et al.* 1984).

At hatching, shortnose sturgeon are blackish-colored, 7-11mm long and resemble tadpoles (Buckley and Kynard 1981). In 9-12 days, the yolk sac is absorbed and the sturgeon develops into larvae which are about 15mm total length (TL; Buckley and Kynard 1981). Sturgeon larvae are believed to begin downstream migrations at about 20mm TL. Laboratory studies suggest that young sturgeon move downstream in a 2-step migration; a 2- to 3-day migration by larvae followed by a residency period by young of the year (YOY), then a resumption of migration by yearlings in the second summer of life (Kynard 1997). Juvenile shortnose sturgeon (between 3-10 years of age) reside in the interface between saltwater and freshwater in most rivers (NMFS

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2 For purposes of this consultation, Northern rivers are considered to include tributaries of the Chesapeake Bay northward to the St. John River in Canada. Southern rivers are those south of the Chesapeake Bay.

1998).

In populations that have free access to the total length of a river (e.g., no dams within the species' range in a river: Saint John, Kennebec, Altamaha, Savannah and Delaware Rivers), spawning areas are located at the farthest upstream reach of the river (NMFS 1998). In the northern extent of their range, shortnose sturgeon exhibit three distinct movement patterns. These migratory movements are associated with spawning, feeding, and overwintering activities. In spring, as water temperatures rise above 8ºC, pre-spawning shortnose sturgeon move from overwintering grounds to spawning areas. Spawning occurs from mid/late March to mid/late May depending upon location and water temperature. Sturgeon spawn in upper, freshwater areas and feed and overwinter in both fresh and saline habitats. Shortnose sturgeon spawning migrations are characterized by rapid, directed and often extensive upstream movement (NMFS 1998).

Shortnose sturgeon are believed to spawn at discrete sites within their natal river (Kieffer and Kynard 1996). In the Merrimack River, males returned to only one reach during a four year telemetry study (Kieffer and Kynard 1996). Squires *et al.* (1982) found that during the three years of the study in the Androscoggin River, adults returned to a 1-km reach below the Brunswick Dam and Kieffer and Kynard (1996) found that adults spawned within a 2-km reach in the Connecticut River for three consecutive years. Spawning occurs over channel habitats containing gravel, rubble, or rock-cobble substrates (Dadswell *et al.* 1984, NMFS 1998). Additional environmental conditions associated with spawning activity include decreasing river discharge following the peak spring freshet, water temperatures ranging from 8 - 12º, and bottom water velocities of 0.4 to 0.7 m/sec (Dadswell *et al.* 1984, NMFS 1998). For northern shortnose sturgeon, the temperature range for spawning is 6.5-18.0ºC (Kieffer and Kynard in press). Eggs are separate when spawned but become adhesive within approximately 20 minutes of fertilization (Dadswell *et al.* 1984). Between 8° and 12°C, eggs generally hatch after approximately 13 days. The larvae are photonegative, remaining on the bottom for several days. Buckley and Kynard (1981) found week old larvae to be photonegative and form aggregations with other larvae in concealment.

Adult shortnose sturgeon typically leave the spawning grounds soon after spawning. Non-spawning movements include rapid, directed post-spawning movements to downstream feeding areas in spring and localized, wandering movements in summer and winter (Dadswell *et al.* 1984, Buckley and Kynard 1985, O'Herron *et al.* 1993). Kieffer and Kynard (1993) reported that post-spawning migrations were correlated with increasing spring water temperature and river discharge. Young-of-the-year shortnose sturgeon are believed to move downstream after hatching (Dovel 1981) but remain within freshwater habitats. Older juveniles tend to move downstream in fall and winter as water temperatures decline and the salt wedge recedes. Juveniles move upstream in spring and feed mostly in freshwater reaches during summer.

Juvenile shortnose sturgeon generally move upstream in spring and summer and move back downstream in fall and winter; however, these movements usually occur in the region above the saltwater/freshwater interface (Dadswell *et al.* 1984, Hall *et al.* 1991). Adult sturgeon occurring in freshwater or freshwater/tidal reaches of rivers in summer and winter often occupy only a few short reaches of the total length (Buckley and Kynard 1985). Summer concentration areas in southern rivers are cool, deep, thermal refugia, where adult and juvenile shortnose sturgeon congregate (Flournoy *et al.* 1992, Rogers *et al.* 1994, Rogers and Weber 1995, Weber 1996).

The temperature preference for shortnose sturgeon is not known (Dadswell *et al.* 1984) but shortnose sturgeon have been found in waters with temperatures as low as 2-3ºC (Dadswell *et al.* 1984) and as high as 34ºC (Heidt and Gilbert 1978). However, temperatures above 28ºC are thought to adversely affect shortnose sturgeon. In the Altamaha River, temperatures of 28-30ºC during summer months create unsuitable conditions and shortnose sturgeon are found in deep cool water refuges.

Shortnose sturgeon are known to occur at a wide range of depths. A minimum depth of 0.6 meters is necessary for the unimpeded swimming by adults. Shortnose sturgeon are known to occur at depths of up to 30 meters but are generally found in waters less than 20 meters (Dadswell *et al.* 1984, Dadswell 1979). Shortnose sturgeon have also demonstrated tolerance to a wide range of salinities. Shortnose sturgeon have been documented in freshwater (Taubert 1980, Taubert and Dadswell 1980) and in waters with salinity of 30 parts-per-thousand (ppt) (Holland and Yeverton 1973). McCleave *et al.* (1977) reported adults moving freely through a wide range of salinities, crossing waters with differences of up to 10ppt within a two hour period. The tolerance of shortnose sturgeon to increasing salinity is thought to increase with age (Kynard 1996). Shortnose sturgeon typically occur in the deepest parts of rivers or estuaries where suitable oxygen and salinity values are present (Gilbert 1989). Shortnose sturgeon were listed as endangered on March 11, 1967 (32 FR 4001), and the species remained on the endangered species list with the enactment of the ESA in 1973.

Although the original listing notice did not cite reasons for listing the species, a 1973 Resource Publication, issued by the U.S. Department of the Interior, stated that shortnose sturgeon were "in peril…gone in most of the rivers of its former range [but] probably not as yet extinct" (USDOI 1973). Pollution and overfishing, including bycatch in the shad fishery, were listed as principal reasons for the species' decline. In the late nineteenth and early twentieth centuries, shortnose sturgeon commonly were taken in a commercial fishery for the closely related and commercially valuable Atlantic sturgeon (*Acipenser oxyrinchus*). More than a century of extensive fishing for sturgeon contributed to the decline of shortnose sturgeon along the east coast. Heavy industrial development during the twentieth century in rivers inhabited by sturgeon impaired water quality and impeded these species' recovery; possibly resulting in substantially reduced abundance of shortnose sturgeon populations within portions of the species' ranges (e.g., southernmost rivers of the species range: Santilla, St. Marys and St. Johns Rivers). A shortnose sturgeon recovery plan was published in December 1998 to promote the conservation and recovery of the species (see NMFS 1998). Shortnose sturgeon are listed as "vulnerable" on the IUCN Red List.

Although shortnose sturgeon are listed as endangered range-wide, in the final recovery plan we recognized 19 separate populations occurring throughout the range of the species. These populations are in New Brunswick Canada (1); Maine (2); Massachusetts (1); Connecticut (1); New York (1); New Jersey/Delaware (1); Maryland and Virginia (1); North Carolina (1); South Carolina (4); Georgia (4); and Florida (2). We have not formally recognized distinct population segments (DPS)[3] of shortnose sturgeon under the ESA. The 1998 Recovery Plan indicates that while genetic information may reveal that interbreeding does not occur between rivers that drain into a common estuary, at this time, such river systems are considered a single population compromised of breeding subpopulations (NMFS 1998).

Studies conducted since the issuance of the Recovery Plan have provided evidence that suggests that years of isolation between populations of shortnose sturgeon have led to morphological and genetic variation. Walsh *et al.* (2001) examined morphological and genetic variation of shortnose sturgeon in three rivers (Kennebec, Androscoggin, and Hudson). The study found that the Hudson River shortnose sturgeon population differed markedly from the other two rivers for most morphological features (total length, fork length, head and snout length, mouth width, interorbital width and dorsal scute count, left lateral scute count, right ventral scute count). Significant differences were found between fish from Androscoggin and Kennebec rivers for interorbital width and lateral scute counts which suggests that even though the Androscoggin and Kennebec rivers drain into a common estuary, these rivers support largely discrete populations of shortnose sturgeon. The study also found significant genetic differences among all three populations indicating substantial reproductive isolation among them and that the observed morphological differences may be partly or wholly genetic.

Grunwald *et al.* (2002) examined mitochondrial DNA (mtDNA) from shortnose sturgeon in eleven river populations. The analysis demonstrated that all shortnose sturgeon populations examined showed moderate to high levels of genetic diversity as measured by haplotypic diversity indices. The limited sharing of haplotypes and the high number of private haplotypes are indicative of high homing fidelity and low gene flow. The researchers determined that glaciation in the Pleistocene Era was likely the most significant factor in shaping the phylogeographic pattern of mtDNA diversity and population structure of shortnose sturgeon. The Northern glaciated region extended south to the Hudson River while the southern non-glaciated region begins with the Delaware River. There is a high prevalence of haplotypes restricted to either of these two regions and relatively few are shared; this represents a historical subdivision that is tied to an important geological phenomenon that reflects historical isolation. Analyses of haplotype frequencies at the level of individual rivers showed significant differences among all systems in which reproduction is known to occur. This implies that although higher level genetic stock relationships exist (i.e., southern vs. northern and other regional subdivisions), shortnose sturgeon appear to be discrete stocks, and low gene flow exists between the majority of populations.

Waldman *et al.* (2002) also conducted mtDNA analysis on shortnose sturgeon from 11 river systems and identified 29 haplotypes. Of these haplotypes, 11 were unique to northern, glaciated systems and 13 were unique to the southern non-glaciated systems. Only five were shared between them. This analysis suggests that shortnose sturgeon show high structuring and

3 The definition of species under the ESA includes any subspecies of fish, wildlife, or plants, and any distinct population segment of any species of vertebrate fish or wildlife which interbreeds when mature. To be considered a DPS, a population segment must meet two criteria under NMFS policy. First, it must be discrete, or separated, from other populations of its species or subspecies. Second, it must be significant, or essential, to the long-term conservation status of its species or subspecies. This formal legal procedure to designate DPSs for shortnose sturgeon has not been undertaken.

discreteness and that low gene flow rates indicated strong homing fidelity.

Wirgin *et al.* (2005) also conducted mtDNA analysis on shortnose sturgeon from 12 rivers (St. John, Kennebec, Androscoggin, Upper Connecticut, Lower Connecticut, Hudson, Delaware, Chesapeake Bay, Cooper, Peedee, Savannah, Ogeechee and Altamaha). This analysis suggested that most population segments are independent and that genetic variation among groups was high.

In 2007, we initiated a five-year status review to assess the status of shortnose sturgeon range-wide. The status review team was specifically charged with analyzing new genetic data to inform the current understanding of shortnose sturgeon genetics range-wide. Although these analyses are not yet available, life history studies indicate that shortnose sturgeon populations from different river systems are substantially reproductively isolated (Kynard 1997).

The best available information demonstrates differences in life history and habitat preferences between northern and southern river systems and given the species' anadromous breeding habits, the rare occurrence of migration between river systems, and the documented genetic differences between river populations, it is unlikely that populations in adjacent river systems interbreed with any regularity. This behavior likely accounts for the failure of shortnose sturgeon to repopulate river systems from which they have been extirpated, despite the geographic closeness of persisting populations. This particular characteristic of shortnose sturgeon also complicates recovery and persistence of this species in the future because, if a river population is extirpated in the future, it is unlikely that this river will be recolonized. Consequently, this Opinion will treat the nineteen separate populations of shortnose sturgeon as subpopulations (one of which occurs in the action area) for the purposes of this analysis.

3.3.2. Status and Trends of Shortnose Sturgeon Rangewide

Historically, shortnose sturgeon are believed to have inhabited nearly all major rivers and estuaries along nearly the entire east coast of North America. The range extended from the Saint John River in New Brunswick, Canada to the Indian River in Florida. Today, only 19 populations remain ranging from the St. Johns River, Florida (possibly extirpated from this system) to the Saint John River in New Brunswick, Canada. Shortnose sturgeon are large, long lived fish species. The present range of shortnose sturgeon is disjunct, with northern populations separated from southern populations by a distance of about 400 kilometers. The species is anadromous in the southern portion of its range (i.e., south of Chesapeake Bay), while northern populations are amphidromous (NMFS 1998). Population sizes vary across the species' range. From available estimates, the smallest populations occur in the Cape Fear (~8 adults; Moser and Ross 1995) and Merrimack Rivers (~100 adults; M. Kieffer, United States Geological Survey, personal communication), while the largest populations are found in the Saint John (~100,000; Dadswell 1979) and Hudson Rivers (~61,000; Bain *et al.* 1998). As indicated in Kynard (1996), adult abundance is less than the minimum estimated viable population abundance of 1000 adults for five of 11 surveyed northern populations and all natural southern populations. Kynard (1996) indicates that all aspects of the species' life history indicate that shortnose sturgeon should be abundant in most rivers. As such, the expected abundance of adults in northern and north-central populations should be thousands to tens of thousands of adults. Expected abundance in southern rivers is uncertain, but large rivers should likely have thousands of adults. The only river systems likely supporting populations of these sizes are the Saint John, Hudson and possibly the Delaware and the Kennebec, making the continued success of shortnose sturgeon in these rivers critical to the species as a whole. While no reliable estimate of the size of either the total species or the shortnose sturgeon population in the northeastern United States exists, it is clearly below the size that could be supported if the threats to shortnose sturgeon were removed; however, overall the species trend is considered to be stable.

3.3.3. Status and Distribution of Shortnose Sturgeon in the Action Area

Historic Distribution and Abundance

The Kennebec system includes the Kennebec, Androscoggin, and Sheepscot rivers. The Kennebec River, at its mouth, drains an area of 24,667 square kms encompassing the drainage area of the Androscoggin River and the smaller tributaries of Merrymeeting Bay. The Kennebec River estuary below Chops Point (outlet of Merrymeeting Bay) forms a complex with that of the Sheepscot River estuary. Atkins (1887) confirmed the presence of sturgeon in Maine rivers though he believed that they were common sturgeon (*Acipenser sturio*). Fried and McCleave (1973) first noted shortnose sturgeon within Montsweag Bay in the Sheepscot River in 1971, the first reported occurrence in all of Maine. Shortnose sturgeon were subsequently found in the Kennebec River by MDMR in 1977 (Squiers and Smith 1979).

Current Distribution and Abundance

MDMR has conducted studies in the past to determine the distribution and abundance of shortnose sturgeon in the estuarine complex of the Kennebec, Androscoggin and Sheepscot rivers (Squiers and Smith 1979, Squiers *et al.* 1982). Additional studies were conducted to determine the timing of the spawning run and the location of spawning areas in the tidal section of the Androscoggin River (Squiers 1982, Squiers *et al.* 1993). The estimated size of the adult population (>50 centimeters TL), based on a tagging and recapture study conducted between 1977 and1981, was 7,200 (95% CI = 5,000 - 10,800; Squiers *et al.* 1982). A Schnabel estimate using tagging and recapture data from 1998, 1999 and 2000 indicates a population estimate of 9,488 (95% CI, 6,942 to 13,358) for the estuarine complex (Squires 2003). The average density of adult shortnose sturgeon per 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).

3.3.3.1. Spawning

Suspected spawning areas on both the Androscoggin and Kennebec rivers were identified in gillnet studies conducted from 1977 through 1981 (Squiers *et al*. 1981, Squiers *et al*. 1982).

Androscoggin River

Large catches of shortnose sturgeon have been documented on the Androscoggin River about 500 meters downstream of the Brunswick Project between late April and mid-May. This site is approximately 44 kilometers upriver from the mouth of the Kennebec River and water temperatures ranged between 8.5°C and 14.5°C. Many of the males captured were freely expressing milt. During 1983, a few female sturgeon were so ripe that eggs were extruded as they were retrieved from the nets. The substrate at the sampling site graduated from ledge, boulders, cobbles, pebbles, and gravel on the Brunswick shore to sand in the middle to silt on the Topsham shore. The maximum depth at low tide was 6.7 meters, with an average depth of three meters. Water velocities measured along a transect from the Brunswick shore to the Topsham shore on October 14, 1983, during an outgoing tide ranged from 32cm/sec. to 60cm/sec.

Ages were determined for 58 shortnose sturgeon collected on the spawning run in the Androscoggin River in 1981; sex was not determined. Average age of the shortnose sturgeon collected on the spawning run was 12 with a median of 10 years. Length ranged between 52.5 centimeters FL to 90.0 centimeters FL with the average of 68.9 centimeters FL.

A follow-up study conducted in 1993 using radio telemetry, artificial substrate, and bottom-set plankton nets once again found ripe shortnose sturgeon concentrated about 500 meters below the Brunswick Project. Shortnose sturgeon eggs were collected in this area using artificial substrate and plankton nets. Spawning migration extended from the end of April to the last week in May with spawning occurring from May 7-19 based on eggs collected on artificial substrate. Temperatures ranged between 7°C and 17°C during this time. Gillnet catches and radio telemetry indicated that the peak spawning occurred from May 8 to May 10 at a water temperature of 14°C.

Kennebec River

Spawning site(s) on the Kennebec River are not as well delineated as the site(s) on the Androscoggin River. Squiers *et al.* (1982) suspected a spawning area occurred 11 kilometers below the former Edwards Dam (rkm 60) as males extruding milt were collected in 1980 and 1981. Additional samples were obtained on May 11, 1999 approximately 10 kilometers below the former Edwards Dam (rkm 60) when 135 adults were captured in an overnight set at 14°C. It is assumed that these sturgeon were on the spawning run.

MDMR conducted an ichthyoplankton survey from 1997 through 2001 to monitor the recolonization of the habitat above the Edwards Dam which was removed in 1999. Sampling sites located both above and below the dam location were surveyed via surface tows with one-meter plankton nets (800 microns) or stationary sets of one-half meter D-shaped plankton nets (1600 microns). A small number of shortnose sturgeon eggs and/or larvae were collected at sites located in the first nine kilometers below the former Edwards Dam (rkm 61-70) annually. No shortnose sturgeon eggs or larvae were collected above the former Edwards Dam site in 2000 or 2001(Wippelhauser 2003). It is likely that the primary spawning area for shortnose sturgeon in the Kennebec River is located in the first 11 kilometers below the former Edwards Dam site (rkms 59-70). While there have not been any directed studies to determine if shortnose sturgeon are utilizing the habitat above the former Edwards Dam, shortnose sturgeon have been captured upstream about 27 kilometers in Waterville, approximately a kilometer downstream of the Lockwood Project, and one was discovered stranded in the ledges downstream of the Project in 2003.

3.3.3.2. Foraging

Tracking data and gillnet studies indicate that the majority of shortnose sturgeon feed in the Bath region of the Kennebec River (rkm 16 to rkm 29) from mid-April through late November and early December. Sturgeon then migrate upriver to overwinter in Merrymeeting Bay. Although the major concentration of shortnose sturgeon is found in the Bath region which includes the Sasanoa River, shortnose sturgeon are also found in Montsweag Bay in the lower Sheepscot River and in Merrymeeting Bay (rkm 29 to rkm 42) located upriver of Bath. Based on limited gillnetting data and telemetry data it appears that shortnose sturgeon occasionally make forays upriver to the Augusta/Gardiner (rkm 59-70) area during the summer months.

The salinities in the main foraging area in the Bath Region range from 0 to 21 ppt from May through November. There is very little stratification during most of this time period and the difference in salinities from the surface to the bottom are usually less than 1 ppt. Water temperature ranges from 4°C in April to over 24°C in July, to around 5°C in late November. DO levels are almost always near 100% saturation.

Some shortnose sturgeon also utilize Montsweag Bay, which is part of the Sheepscot River, as a foraging area. The Sheepscot River is interconnected with the Kennebec River through the Sasanoa River and Hockomock Bay. Salinities ranged from 12 to 28 ppt and temperatures ranged from 12 to 22°C in June and July in Montsweag Bay during an ultrasonic telemetry study (McCleave *et al.* 1977).

A few shortnose sturgeon stomachs, captured in Montsweag Bay, were examined by McCleave *et al.* (1977). The most common prey items found were crangon shrimp (*Crangon septemspinosous*); clams (*Mya arenaria*); and small winter flounder (*Pseudopleuronectes americanus*). No food habit studies have been conducted for shortnose sturgeon in the Kennebec River. Tracking studies indicate that shortnose sturgeon make use of two large marshes in the Bath area: Hanson Bay (Pleasant Cove; rkm 21) in the Sasanoa River, and Winnegance Cove (rkm 17) in the Kennebec River. A Wetland Functional Assessment was conducted by Bath Iron Works (BIW) as part of the assessment of impacts of the proposed expansion of the shipyard into wetlands habitat (Normandeau Associates 1998) and included a quantitative assessment of the benthic community in Winnegance Creek. The benthic assemblage in Winnegance Creek (rkm 17) contained no mollusks, the preferred food of adult shortnose sturgeon in the Saint John River, New Brunswick (Dadswell 1979, Dadswell *et al.* 1984). One of the dominant species in Winnegance Creek was the sabellid polychaete (*Maranzariella viridis*) which was found in stomachs of shortnose sturgeon from the Saint John River but was not identified as a preferred food item.

No sampling for epibenthic invertebrates was done in the BIW Wetland Functional Assessment. On numerous occasions, gammarid amphipods were observed on the nets when sampling for sturgeon in the summer foraging area. In an earlier study on the food habits of smelt in the lower reaches of the Kennebec River, it was found that the dominant food item was gammarids, particularly *Gammarus oceanicus* (Flagg 1974). Shortnose sturgeon consumed gammarid amphipods and polychaete worms in the estuary of the Connecticut River (Savoy and Benway 2004). Shortnose sturgeon also fed heavily on gammarid amphipods in the Hudson River (Haley 1999).

3.3.3.3. Overwintering/Resting

No studies had been done to locate the overwintering sites of adult shortnose sturgeon in the Kennebec River prior to 1996. Based on catch per unit effort from gillnet sets in the lower Kennebec River, it was thought that the most likely overwintering sites were in the deep saline region of the lower river (below Bluff Head at rkm 15) and possibly in the adjacent estuary of the Sheepscot River (Squiers *et al.* 1982). Some shortnose sturgeon overwinter in the tidal freshwater sections of the Eastern and Cathance Rivers; which are tributaries to Merrymeeting Bay (Squiers *et al*. 1982).

MDMR attempted to identify shortnose sturgeon overwintering sites in the Kennebec River in 1996. A total of fifteen shortnose sturgeon were tagged in October and November, 1996 to track them to their overwintering habitat. Initial capture locations of the sturgeon varied within the Kennebec System: eight were captured, tagged and released in Pleasant Cove (rkm 21) on the Sasanoa River which joins the Kennebec River in Bath just a short distance downriver of the Sagadahoc bridge; five were captured, tagged and released in Winnegance Cove (rkm 17), which is located approximately 2700 meters below the Sagadahoc Bridge on the Kennebec River; and two were captured in Merrymeeting Bay (rkm 38) and released at the Richmond town landing in channel west of Swan Island (rkm 40.5).

The eight shortnose sturgeon captured in Pleasant Cove and the five captured in Winnegance Cove were all later relocated: 11 of these 13 fish were relocated in Merrymeeting Bay. The first two sturgeon tagged in Pleasant Cove (code #338 and 356) were never found in Merrymeeting Bay. Sturgeon #338 did move from Pleasant Cove to Winnegance Cove and back and sturgeon #356 moved to Days Ferry (rkm 24) and back. Both sturgeon #338 and #356 were last found in Pleasant Cove (rkm 21) on November 13, 1996. After November 13, 1996, sturgeon with transmitters were only found in upper Merrymeeting Bay on the east side of Swan Island (rkm 38). Because 11 sturgeon were in the area it became impossible to separate signals as the sturgeon grouped together. Multiple signals were always found at the suspected overwintering site near Swan Island in Merrymeeting Bay. It was difficult to survey large areas of Merrymeeting Bay due to poor ice so it is possible other sturgeon were in the area and other overwintering areas exist.

In 1997, five additional shortnose sturgeon captured in the immediate vicinity of BIW were tagged: two were later captured by Normandeau Associates in an otter trawl, and three were captured by MDMR in gillnets. These tagged sturgeon remained in the lower Kennebec River in the Bath area until late November. One was later located in the area on December 2, 1997, but no others have been detected since.

In 1998, 17 shortnose sturgeon were captured by Normandeau Associates under contract to BIW and tagged. Fourteen receiver/data loggers were deployed: nine around BIW and five upstream and downstream BIW. The majority of shortnose sturgeon moved out of the Bath area by the end of November although three remained in the Bath area in early December. Ten shortnose and one
Atlantic were at the overwintering site upriver in Merrymeeting Bay on December 15, 1998.

Additional manual tracking did not occur during this period due to weather conditions.
Five pre-spawning adult shortnose sturgeon originally captured and tagged in the Bangor/Brewer overwintering area of the Penobscot River in late September 2007 were later relocated in October and November of 2007 (Fernandes 2008, Fernandes *et al.* 2010). Four individuals were subsequently located at the Kennebec River overwintering area (Merrymeeting Bay) near rkm 38 in February 2008. These sturgeon were located between rkm 37.25 and 39.25 in a tidally influenced area in depths are approximately 4.5 to 6.0 meters in predominantly sandy substrate.

3.3.3.4. Migration

Recent data collected by University of Maine (UM) and MDMR indicate that migration between river systems is more extensive than was previously reported (Dadswell *et al*.1984, NMFS 1998). Sonic transmitters were implanted in a total of 39 shortnose sturgeon from June 14, 2006 through September 27, 2007 in the Penobscot River; however some tags were expelled and some individuals may have suffered mortality (Fernandes 2008, Fernandes *et al.* 2010). Eleven of these sturgeon have been subsequently detected in the Kennebec River by MDMR via the passive receiver array. The distance between the mouth of the Kennebec River and the mouth of the Penobscot River is about 70 kilometers. One tracked individual traveled 230 kilometers from its tagging site in Bangor on the Penobscot River to upper Kennebec River (Fernandes 2008, Fernandes *et al.* 2010). Movement from the Kennebec to the Penobscot was documented when two shortnose sturgeon PIT tagged by MDMR in the Kennebec River in 1998 and 1999 were recaptured in the Penobscot River in 2006 by UM researchers.

Ultrasonic transmitters were implanted in five pre-spawning adult shortnose sturgeon in late September 2007 in the Bangor/Brewer overwintering area on the Penobscot River (Fernandes 2008, Fernandes *et al.* 2010). The intent was to track these individuals the following spring to locate the spawning area(s) in the Penobscot River. MDMR subsequently detected four of these prespawning adults with its passive receiver array in the Kennebec River during October and November 2007. Four of the five sturgeon were subsequently located in the Kennebec River overwintering area near rkm 38 in February 2008. These sturgeon were located between rkm 37.25 and 39.25. The fifth shortnose sturgeon implanted with a transmitter during the same time period and area was located in the Kennebec River overwintering area.

MDMR deployed its passive receiver array in early April 2008. Four of the five Penobscot shortnose sturgeon located in the Kennebec River overwintering grounds in February 2008 were detected. These four were females with late stage eggs. One migrated upriver to the Farmingdale/Hallowell (rkm 61) reach in the Kennebec River that had been previously identified by MDMR as a spawning area. Another migrated to the Lockwood Project in Waterville (rkm 97), which is the upstream limit of sturgeon habitat and was made accessible with the removal of the Edwards Dam in 1999. A third fish migrated to the known spawning area on the Androscoggin River near Brunswick, ME (rkm 44). Collectively these three fish moved rapidly downriver after a few days and are presumed to have left the Kennebec River system. The fourth sturgeon with late stage eggs migrated to the mouth of the Androscoggin and was last located in Merrymeeting Bay on May 12, 2008. Its signal was not picked up on any of the downriver receivers.

In addition to the Penobscot females with late stage eggs, an additional three Penobscot River shortnose sturgeon outfitted with acoustic transmitters in 2006 were located in the Kennebec River in the spring of 2008. One fish arrived at Townsend Gut on May 10, 2008 and migrated through the Sasanoa River to the Kennebec River and on May 20 arrived in the Farmingdale/Hallowell reach. Another fish was located in the Merrymeeting Bay overwintering area in the Kennebec River on April 16, 2008 and migrated to the Eastern River arriving on April 19, 2008 arriving in the Sasanoa River on April 25, 2008 and moving to the Phippsburg area from April 25 to May 19, 2008. Subsequently the individual migrated upriver to the Farmingdale/Hallowell reach of the Kennebec River on May 21, 2008, remained for two days and was subsequently picked up in Phippsburg on May 24, 2008 and was last recorded on May 28, 2008. The third tagged fish was recorded at Townsend Gut on May 12, 2008 and was never subsequently picked up on any of the Kennebec River receivers.

3.3.4. Factors Affecting Shortnose Sturgeon in the Action Area

Dams and Hydroelectric Facilities

Historically, the upstream migration of sturgeon on the Kennebec River was limited to Waterville at Ticonic Falls (rkm 98) (NMFS and USFWS 1998), approximately the location of the Lockwood Project. Ticonic Falls is located 65 rkm downstream of the fall line (based on reference points provided by Oakley 2005). The construction of Edwards Dam at rkm 71 in 1837 denied sturgeon access to historical habitat in the Kennebec River until 1999 when it was removed. Since its removal, almost 100% of historic habitat is now accessible. Since the removal of the Edwards Dam, shortnose sturgeon have been documented at the Lockwood Dam (rkm 98) indicating that this habitat is being utilized to some extent. One shortnose sturgeon was stranded below the Lockwood Dam spillway in 2003 as result of flow manipulation to allow the installation of flashboards. During the re-licensing of the Lockwood Hydroelectric Project, FERC requested ESA section 7 formal consultation; a Biological Opinion was issued by us on January 12, 2005, where we concluded the proposed re-licensing was likely to adversely affect but not likely to jeopardize the continued existence of shortnose sturgeon. The Opinion included an Incidental Take Statement (ITS), Reasonable and Prudent Measures, and Terms and Conditions designed to minimize and monitor future effects of the project, including strandings. No additional strandings of shortnose sturgeon have been reported. There is a fish lift at the Lockwood project, but to date, no shortnose sturgeon have been documented in the lift. The FERC license for this project includes a requirement that any shortnose sturgeon observed in the lift be removed and returned downstream of the project. This is consistent with the terms of the Opinion's ITS. Additionally, the Project's shortnose sturgeon handling plan is updated annually by the licensee.

In the Androscoggin River, the Brunswick Hydroelectric Project (rkm 44) is located at the head-of-tide at the site of a natural falls. This facility was licensed by FERC in 1979 and the license is set to expire in 2029. The limited storage capacity of the Brunswick Dam restricts its ability to influence river flows; therefore, during the FERC licensing process, a minimum flow requirement was deemed not necessary. The location of historical spawning grounds on the Androscoggin River is unknown, but it is unlikely that sturgeon could navigate the natural falls located at Brunswick Dam (NMFS and USFWS 1998).

Dredging and Blasting

There is an authorized Federal Navigation Channel in the Kennebec River extending from the mouth of the river to Augusta. This channel is maintained by the ACOE. Historically, the Kennebec River has been dredged along Swan Island in Merrymeeting Bay (~ rkm 36), at Gardiner (~ rkms 59) and from Hallowell to Augusta (~ rkm 65-69). The upriver dredging projects are all located in tidal freshwater habitat. No channel maintenance dredging above Bath, where spawning habitat used to be located prior to the removal of Edwards Dam, has been conducted since 1963. On average, shoaled areas at Doubling Point and Popham Beach are dredged every three years. Maintenance dredging was last conducted in October 2003. The primary user of the deepwater channel in the lower Kennebec River is the U.S. Navy that routinely moves ship to and from the BIW facility in Bath, ME. ESA section 7 consultation between the ACOE and NMFS has been completed on the effects of the maintenance dredging of this channel. Interactions with shortnose sturgeon have been recorded during hopper dredging activities in this river including the entrainment of five shortnose sturgeon at Doubling Point over three days in October 2003 when three shortnose sturgeon were killed and the other two suffered serious injuries. In April 2003, a shortnose sturgeon was killed in a bucket dredge (NMFS, Biological Opinion 2004) operating in the BIW sinking basin. More recently, a live shortnose sturgeon was recorded in dredging operations in the BIW sinking basin on June 1, 2009 and later released alive (M. Bowen, Normandeau Associates, pers. comm. 2009).

There are no Federal navigation projects in the Androscoggin River or Sheepscot Rivers, however, private dredging activities occur throughout the estuarine complex.

Water quality and Contaminants

During the late 1960s and early 1970s, dissolved oxygen (DO) levels reached zero parts per million in the Kennebec and Androscoggin Rivers from the head-of-tide to the mid-estuary during the summer months. The drop in oxygen levels commonly caused fish kills. DO levels improved significantly in the late 1970s and 1980s, coincident with improved point source treatment of municipal and industrial waste. Although DO was at severely low levels until the late 1970s, a population of shortnose sturgeon managed to persist in the system during this time period. The substrate in the upper freshwater section of both the Kennebec and Androscoggin rivers was severely degraded by wood chips, sawdust, and organic debris until the late 1970s. This accumulation was quickly flushed from the river systems after the cessation of log drives and the construction of water treatment plants.

Dioxin, likely generated from wastewater discharges from pulp and paper mills and municipal wastewater treatment plants, has been found in fish tissue samples collected in the Kennebec and Androscoggin Rivers (MDEP 2005). The concentrations of dioxins in fishes collected from Maine rivers have decreased significantly over time. Concentrations of dioxins in fishes collected from Maine rivers were in the 2 to 30 parts-per-thousand (ppt) range in the mid 1980s while today levels are much more commonly seen in the less than 1 to 2 ppt range. The Androscoggin River has had the highest dioxin levels for fishes in the state of Maine. Levels of tetrachlorodibenzo-p-dioxin (2,3,7,8-TCDD) were as high as 20 - 30 pg/g (parts-per-trillion) in fishes sampled from the Androscoggin and Kennebec Rivers during 1984-1986, before dropping to 0.1 pg/g in 2004 (ME DEP 2005). MDEP has conducted limited testing for heavy metals, PCBs, and organochlorine pesticides in the tidal waters of the Kennebec River.

The Maine Center for Disease Control issues fish consumption advisories for segments of the Kennebec and Androscoggin Rivers. As of July, 2013 they advise no consumption of fish between Augusta and Chops Point (~ rkm 69) and 6 to 12 meals a year in the tidal section of the Androscoggin River. The consumption advisory for the Kennebec River from Augusta to the Shawmut Project in Fairfield is 5 meals of trout a year and 1 to 2 bass meals a month. Contaminant analysis of muscle, liver, and ovarian tissue has been performed for a shortnose sturgeon killed in May 2003 during dredging operations at BIW on the Kennebec River (see above). Fourteen metals, one semivolatile compound, one PCB Aroclor, PCDDs, and PCDFs were detected in one or more of the tissue samples. Of these chemicals, cadmium and zinc were detected at concentrations above an adverse effect concentration reported for fishes in the literature (Brundage 2003).

Despite water quality degradation in the past, the Kennebec estuarial complex has continued to support sturgeon. Improvements in habitat quality from the 1980s to the present should facilitate recovery of the shortnose sturgeon in this estuary.

3.3.5. Summary of Factors affecting Recovery of Shortnose Sturgeon

The Shortnose Sturgeon Recovery Plan (NMFS 1998) identifies habitat degradation or loss (resulting, for example, from dams, bridge construction, channel dredging, and pollutant discharges) and mortality (resulting, for example, from impingement on cooling water intake screens, dredging and incidental capture in other fisheries) as principal threats to the species' survival.

Several natural and anthropogenic factors continue to threaten the recovery of shortnose sturgeon range-wide. Shortnose sturgeon continue to be taken incidentally in fisheries along the east coast and are probably targeted by poachers throughout their range (Dadswell 1979, Dovel *et al.* 1992, Collins *et al.* 1996). Bridge construction and demolition projects may interfere with normal shortnose sturgeon migratory movements and disturb sturgeon concentration areas. Unless appropriate precautions are taken, internal damage and/or death may result from blasting projects with powerful explosives. Hydroelectric dams may affect shortnose sturgeon by restricting habitat, altering river flows or temperatures necessary for successful spawning and/or migration and causing mortalities to fish that become entrained in turbines. Maintenance dredging of Federal navigation channels and other areas can adversely affect or jeopardize shortnose sturgeon populations. Hydraulic dredges can lethally take sturgeon by entraining sturgeon in dredge dragarms and impeller pumps. Mechanical dredges have also been documented to lethally take shortnose sturgeon. In addition to direct effects, dredging operations may also impact shortnose sturgeon by destroying benthic feeding areas, disrupting spawning migrations, and filling spawning habitat with re-suspended fine sediments. Shortnose sturgeon are susceptible to impingement on cooling water intake screens at power plants. Electric power and nuclear power generating plants can affect sturgeon by impinging larger fish on cooling water intake screens and entraining larval fish. The operation of power plants can have unforeseen and extremely detrimental impacts to water quality which can affect shortnose sturgeon. For example, the St. Stephen Power Plant near Lake Moultrie, South Carolina was shut down for several days in June 1991 when large mats of aquatic plants entered the plant's intake canal and clogged the cooling water intake gates. Decomposing plant material in the tailrace canal coupled with the turbine shut down (allowing no flow of water) triggered a low dissolved oxygen water condition downstream and a subsequent fish kill. The South Carolina Wildlife and Marine Resources Department reported that twenty shortnose sturgeon were killed during this low dissolved oxygen event.

Contaminants, including toxic metals, polychlorinated aromatic hydrocarbons (PAHs), pesticides, and polychlorinated biphenyls (PCBs) can have substantial deleterious effects on aquatic life including production of acute lesions, growth retardation, and reproductive impairment (Cooper 1989, Sinderman 1994). Ultimately, toxins introduced to the water column become associated with the benthos and can be particularly harmful to benthic organisms (Varanasi 1992) like sturgeon. Heavy metals and organochlorine compounds are known to accumulate in fat tissues of sturgeon, but their long term effects are not yet known (Ruelle and Henry 1992, Ruelle and Kennlyne 1993). Available data suggests that early life stages of fish are more susceptible to environmental and pollutant stress than older life stages (Rosenthal and Alderdice 1976).

Although there is little information available comparing the levels of contaminants in shortnose sturgeon tissues rangewide, some research on other related species indicates that concern about the effects of contaminants on the health of sturgeon populations is warranted. Detectible levels of chlordane, DDE (1,1-dichloro-2, 2-bis(p-chlorophenyl)ethylene), DDT (dichlorodiphenyl-trichloroethane), and dieldrin, and elevated levels of PCBs, cadmium, mercury, and selenium were found in pallid sturgeon tissue from the Missouri River (Ruelle and Henry 1994). These compounds were found in high enough levels to suggest they may be causing reproductive failure and/or increased physiological stress (Ruelle and Henry 1994). In addition to compiling data on contaminant levels, Ruelle and Henry also determined that heavy metals and organochlorine compounds (i.e., PCBs) accumulate in fat tissues. Although the long term effects of the accumulation of contaminants in fat tissues is not yet known, some speculate that lipophilic toxins could be transferred to eggs and potentially inhibit egg viability. In other fish species, reproductive impairment, reduced egg viability, and reduced survival of larval fish are associated with elevated levels of environmental contaminants including chlorinated hydrocarbons. A strong correlation that has been made between fish weight, fish fork length, and DDE concentration in pallid sturgeon livers indicates that DDE increases proportionally with fish size (NMFS 1998).

Contaminant analysis was conducted on two shortnose sturgeon from the Delaware River in the fall of 2002. Muscle, liver, and gonad tissue were analyzed for contaminants (ERC 2003). Sixteen metals, two semivolatile compounds, three organochlorine pesticides, one PCB Aroclor, as well as polychlorinated dibenzo-p-dioxins (PCDDs), and polychlorinated dibenzofurans (PCDFs) were detected in one or more of the tissue samples. Levels of aluminum, cadmium, PCDDs, PCDFs, PCBs, DDE (an organochlorine pesticide) were detected in the "adverse affect" range. It is of particular concern that of the above chemicals, PCDDs, DDE, PCBs and cadmium, were detected as these have been identified as endocrine disrupting chemicals.

Contaminant analysis conducted in 2003 on tissues from a shortnose sturgeon from the Kennebec River revealed the presence of fourteen metals, one semivolatile compound, one PCB Aroclor, PCDDs and PCDFs in one or more of the tissue samples. Of these chemicals, cadmium and zinc were detected at concentrations above an adverse effect concentration reported for fish in the literature (ERC 2003). While no directed studies of chemical contamination in shortnose sturgeon have been undertaken, it is evident that the heavy industrialization of the rivers where shortnose sturgeon are found is likely adversely affecting this species.

During summer months, especially in southern areas, shortnose sturgeon must cope with the physiological stress of water temperatures that may exceed 28ºC. Flournoy *et al.* (1992) suspected that, during these periods, shortnose sturgeon congregate in river regions which support conditions that relieve physiological stress (i.e., in cool deep thermal refuges). In southern rivers where sturgeon movements have been tracked, sturgeon refrain from moving during warm water conditions and are often captured at release locations during these periods (Flournoy *et al.*,1992, Rogers and Weber 1995, Weber 1996). The loss and/or manipulation of these discrete refuge habitats may limit or be limiting population survival, especially in southern river systems.

Pulp mill, silvicultural, agricultural, and sewer discharges, as well as a combination of non-point source discharges, which contain elevated temperatures or high biological demand, can reduce dissolved oxygen levels. Shortnose sturgeon are known to be adversely affected by dissolved oxygen levels below five milligrams per liter. Shortnose sturgeon may be less tolerant of low dissolved oxygen levels in high ambient water temperatures and show signs of stress in water temperatures higher than 28ºC (Flournoy *et al.* 1992). At these temperatures, concomitant low levels of dissolved oxygen may be lethal.

3.4. Atlantic Sturgeon

3.4.1. Species Description

The section below describes the Atlantic sturgeon listing, provides life history information that is relevant to all DPSs of Atlantic sturgeon, and provides information specific to the status of each DPS of Atlantic sturgeon. Below, we also provide a description of the Atlantic sturgeon DPSs likely to occur in the action area and their use of the action area.

The Atlantic sturgeon (*Acipenser oxyrinchus oxyrinchus*) is a subspecies of sturgeon distributed along the eastern coast of North America from Hamilton Inlet, Labrador, Canada to Cape Canaveral, FL (Scott and Scott 1988; ASSRT 2007;). We have divided U.S. populations of Atlantic sturgeon into five DPSs[4] (77 FR 5880 and 77 FR 5914). These are: the Gulf of Maine, New York Bight, Chesapeake Bay, Carolina, and South Atlantic DPSs (Figure 4).

The results of genetic studies suggest that natal origin influences the distribution of Atlantic

4 To be considered for listing under the ESA, a group of organisms must constitute a “species.” A “species” is defined in section 3 of the ESA to include “any subspecies of fish or wildlife or plants, and any distinct population segment of any species of vertebrate fish or wildlife which interbreeds when mature.”

sturgeon in the marine environment (Wirgin and King 2011). However, genetic data, as well as tracking and tagging data, demonstrate that sturgeon from each DPS and Canada occur throughout the full range of the subspecies. Therefore, sturgeon originating from any of the five DPSs can be affected by threats in the marine, estuarine, and riverine environment that occur far from natal spawning rivers.

On February 6, 2012, we published notice in the *Federal Register* that we were listing the New York Bight, Chesapeake Bay, Carolina, and South Atlantic DPSs as "endangered," and the Gulf of Maine DPS as "threatened" (77 FR 5880 and 77 FR 5914). The effective date of the listings is April 6, 2012. The DPSs do not include Atlantic sturgeon spawned in Canadian rivers. Therefore, fish that originated in Canada are not included in the listings. As described below, individuals originating from all five listed DPSs may occur in the action area. Information general to all Atlantic sturgeon, as well as information specific to each of the DPSs, is provided below.

Atlantic Sturgeon Life History

Atlantic sturgeon are long-lived (approximately 60 years), late maturing, estuarine dependent, anadromous[5] fish (Bigelow and Schroeder 1953, Vladykov and Greeley 1963, Mangin 1964, Pikitch *et al.* 2005, Dadswell 2006, ASSRT 2007). They are a relatively large fish, even among sturgeon species (Pikitch *et al.* 2005) and can grow to over 14 feet weighing 800 pounds. Atlantic sturgeon are bottom feeders that suck food into a ventral protruding mouth (Bigelow and Schroeder 1953). Four barbels in front of the mouth assist the sturgeon in locating prey (Bigelow and Schroeder 1953). Diets of adult and migrant subadult Atlantic sturgeon include mollusks, gastropods, amphipods, annelids, decapods, isopods, and fish such as sand lance (Bigelow and Schroeder 1953, ASSRT 2007, Guilbard *et al.* 2007, Savoy 2007). Juvenile Atlantic sturgeon feed on aquatic insects, insect larvae, and other invertebrates (Bigelow and Schroeder 1953, ASSRT 2007, Guilbard *et al.* 2007).

5 Anadromous refers to a fish that is born in freshwater, spends most of its life in the sea, and returns to freshwater to spawn (NEFSC FAQs, available at http://www.nefsc.noaa.gov/faq/fishfaq1a.html, modified June 16, 2011)

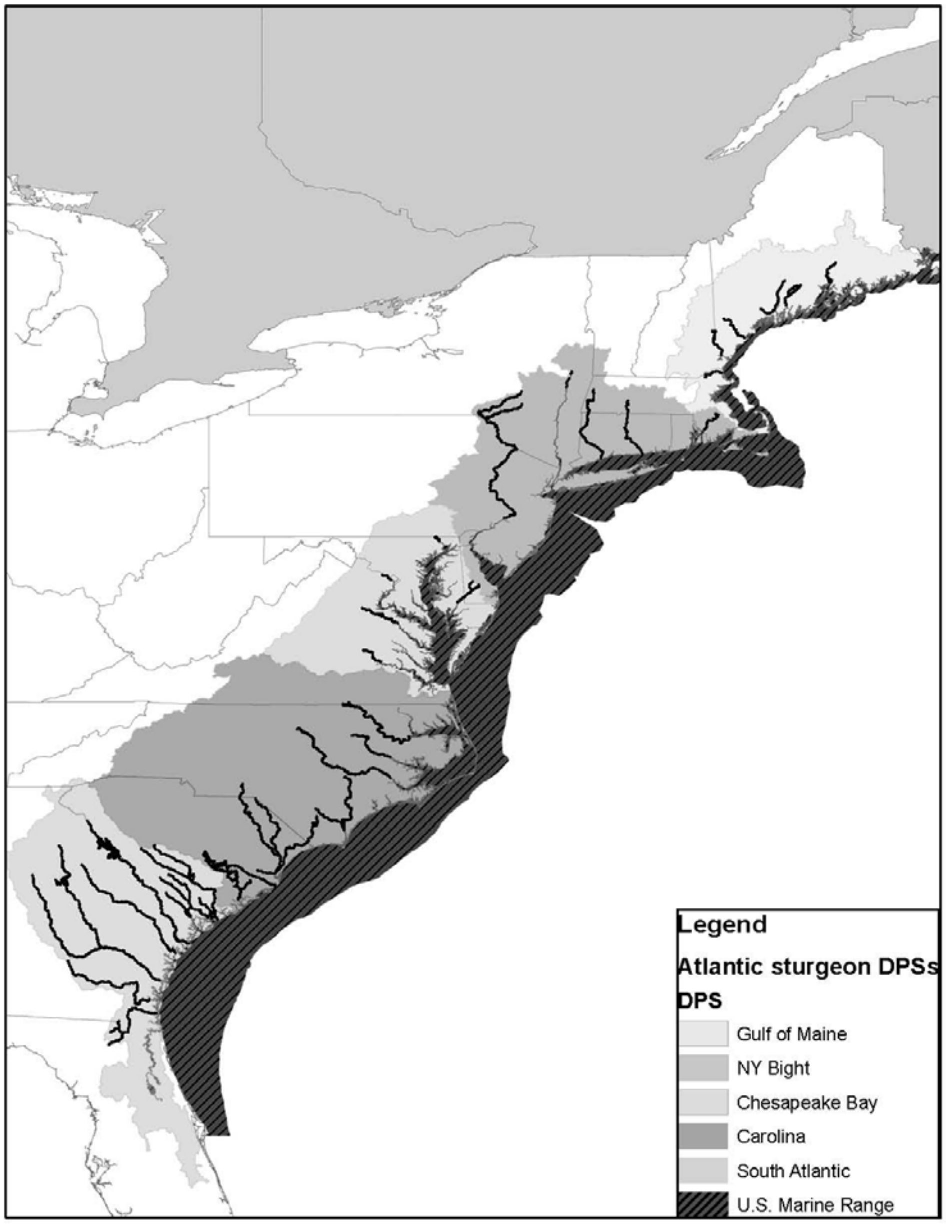

Figure 4 Geographic Locations for the Five ESA-listed DPSs of Atlantic Sturgeon

Rate of maturation is affected by water temperature and gender. In general: (1) Atlantic sturgeon that originate from southern systems grow faster and mature sooner than Atlantic sturgeon that originate from more northern systems; (2) males grow faster than females; (3) fully mature females attain a larger size (i.e. length) than fully mature males. The largest recorded Atlantic sturgeon was a female captured in 1924 that measured approximately 4.26 meters (Vladykov and Greeley 1963). Dadswell (2006) reported seeing seven fish of comparable size in the St. John River estuary from 1973 to 1995. Observations of large-sized sturgeon are particularly important given that egg production is correlated with age and body size (Smith *et al.* 1982, Van Eenennaam *et al.* 1996, Van Eenennaam and Doroshov 1998, Dadswell 2006). The lengths of Atlantic sturgeon caught since the mid-late 20^{th} century have typically been less than three meters (Smith *et al.* 1982, Smith and Dingley 1984, Smith 1985, Scott and Scott 1988, Young *et al.* 1998, Collins *et al.* 2000, Caron *et al.* 2002, Dadswell 2006, ASSRT 2007, Kahnle *et al.* 2007, DFO 2011). While females are prolific, with egg production ranging from 400,000 to 4 million eggs per spawning year, females spawn at intervals of two to five years (Vladykov and Greeley 1963, Smith *et al.* 1982, Van Eenennaam *et al.* 1996, Van Eenennaam and Doroshov 1998, Stevenson and Secor 1999, Dadswell 2006). Given spawning periodicity and a female's relatively late age to maturity, the age at which 50% of the maximum lifetime egg production is achieved is estimated to be 29 years (Boreman 1997). Males exhibit spawning periodicity of one to five years (Smith 1985, Collins *et al.* 2000, Caron *et al.* 2002). While long-lived, Atlantic sturgeon are exposed to a multitude of threats prior to achieving maturation and have a limited number of spawning opportunities once mature.

Water temperature plays a primary role in triggering the timing of spawning migrations (ASMFC 2009). Spawning migrations generally occur during February-March in southern systems, April-May in Mid-Atlantic systems, and May-July in Canadian systems (Murawski and Pacheco 1977; Smith 1985; Bain 1997; Smith and Clugston 1997; Caron *et al.* 2002). Male sturgeon begin upstream spawning migrations when waters reach approximately 6°C (43° F) (Smith *et al.* 1982; Dovel and Berggren 1983; Smith 1985; ASMFC 2009), and remain on the spawning grounds throughout the spawning season (Bain 1997). Females begin spawning migrations when temperatures are closer to 12°to 13°C (54° to 55°F) (Dovel and Berggren 1983; Smith 1985; Collins *et al.* 2000), make rapid spawning migrations upstream, and quickly depart following spawning (Bain 1997).

The spawning areas in most U.S. rivers have not been well defined. However, the habitat characteristics of spawning areas have been identified based on historical accounts of where fisheries occurred, tracking and tagging studies of spawning sturgeon, and physiological needs of early life stages. Spawning is believed to occur in flowing water between the salt front of estuaries and the fall line of large rivers, when and where optimal flows are 46-76 centimeters per second and depths are 3-27 meters (Borodin 1925, Dees 1961, Leland 1968, Scott and Crossman 1973, Crance 1987, Shirey *et al.* 1999, Bain *et al.* 2000, Collins *et al.* 2000, Caron *et al.* 2002, Hatin *et al.* 2002, ASMFC 2009). Sturgeon eggs are deposited on hard bottom substrate such as cobble, coarse sand, and bedrock (Dees 1961, Scott and Crossman 1973, Gilbert 1989, Smith and Clugston 1997, Bain *et al.* 2000, Collins *et al.* 2000, Caron *et al.* 2002, Hatin *et al.* 2002, Mohler 2003, ASMFC 2009), and become adhesive shortly after fertilization (Murawski and Pacheco 1977, Van den Avyle 1984, Mohler 2003). Incubation time for the eggs increases as water temperature decreases (Mohler 2003). At temperatures of 20° and 18° C, hatching occurs approximately 94 and 140 hours, respectively, after egg deposition (ASSRT 2007).

Larval Atlantic sturgeon (i.e. less than four weeks old, with total lengths (TL) less than 30 millimeters; Van Eenennaam *et al.* 1996) are assumed to mostly live on or near the bottom and inhabit the same riverine or estuarine areas where they were spawned (Smith *et al.* 1980, Bain *et al.* 2000, Kynard and Horgan 2002, ASMFC 2009). 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 (Haley 1999, Hatin *et al.* 2007, McCord *et al.* 2007, Munro *et al.* 2007) while older fish are more salt-tolerant and occur in both high salinity and low salinity waters (Collins *et al.* 2000). Atlantic sturgeon remain in the natal estuary for months to years before emigrating to open ocean as subadults (Holland and Yelverton 1973, Dovel and Berggen 1983, Waldman *et al.* 1996, Dadswell 2006, ASSRT 2007).

After emigration from the natal estuary, subadults and adults travel within the marine environment, typically in waters less than 50 meters in depth, using coastal bays, sounds, and ocean waters (Vladykov and Greeley 1963, Murawski and Pacheco 1977, Dovel and Berggren 1983, Smith 1985, Collins and Smith 1997, Welsh *et al.* 2002, Savoy and Pacileo 2003, Stein *et al.* 2004, Laney *et al.* 2007, Dunton *et al.* 2010, Erickson *et al.* 2011, Wirgin and King 2011). Tracking and tagging studies reveal seasonal movements of Atlantic sturgeon along the coast. Satellite-tagged adult sturgeon from the Hudson River concentrated in the southern part of the Mid-Atlantic Bight at depths greater than 20 meters during winter and spring, and in the northern portion of the Mid-Atlantic Bight at depths less than 20 meters in summer and fall (Erickson *et al.* 2011). Shirey (Delaware Department of Fish and Wildlife, unpublished data reviewed in ASMFC 2009) found a similar movement pattern for juvenile Atlantic sturgeon based on recaptures of fish originally tagged in the Delaware River. After leaving the Delaware River estuary during the fall, juvenile Atlantic sturgeon were recaptured by commercial fishermen in nearshore waters along the Atlantic coast as far south as Cape Hatteras, NC from November through early March. In the spring, a portion of the tagged fish re-entered the Delaware River estuary. However, many fish continued a northerly coastal migration through the Mid-Atlantic as well as into southern New England waters, where they were recovered throughout the summer months. Movements as far north as Maine were documented. A southerly coastal migration was apparent from tag returns reported in the fall, with the majority of these tag returns from relatively shallow nearshore fisheries, with few fish reported from waters in excess of 25 meters (C. Shirey, Delaware Department of Fish and Wildlife, unpublished data reviewed in ASMFC 2009). Areas where migratory Atlantic sturgeon commonly aggregate include the Bay of Fundy (e.g., Minas and Cumberland Basins), Massachusetts Bay, Connecticut River estuary, Long Island Sound, New York Bight, Delaware Bay, Chesapeake Bay, and waters off of North Carolina from the Virginia/North Carolina border to Cape Hatteras at depths up to 24 meters (Dovel and Berggren 1983, Dadswell *et al.* 1984, Johnson *et al.* 1997, Rochard *et al.* 1997, Kynard *et al.* 2000, Eyler *et al.* 2004, Stein *et al.* 2004, Wehrell 2005, Dadswell 2006, ASSRT 2007, Laney *et al.* 2007). These sites may be used as foraging sites and/or thermal refuge.

3.4.2. 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. We have considered the best available information to determine from which DPSs individuals in the action area are likely to have originated. We have determined that Atlantic sturgeon in the action area are likely to originate from two of the five ESA listed DPSs (NYB and GOM) as well as from the St. John River in Canada. Fish originating from the St. John River are not listed under the ESA. Currently, if the fish does not have an identifying tag, the only way to tell the river (or DPS) of origin for a particular individual is by genetic sampling. The distribution of Atlantic sturgeon is influenced by geography, with Atlantic sturgeon from a particular DPS becoming less common the further you are from the river of origin. Areas that are geographically close are expected to have a similar composition of individuals.

Based on the analysis of genetic data, it was determined that 92% of the fish in the spawning region of the Hudson River originated from the NYB DPS while 8% originated from the GOM DPS. Given the lack of data specific to the Kennebec river spawning region, we determined that using these ratios for the Kennebec River represented the best available information for this spawning river. Based on the above percentages, some percentage of fish on the spawning grounds in the Kennebec River could be from the St. John while a more limited percentage could be from the NYB DPS. However, the most significant percentage would be expected to be from the GOM DPS. Thus, we used the breakdown of 92% of the fish being from the GOM DPS while the remaining 8% are from either the NYB DPS or the St. John. Since more fish in this area are attributed to the St. John River, a higher proportion of the 8% are attributed to this population. Therefore, in the action area, we expect Atlantic sturgeon to occur at the following frequencies: GOM DPS 92%, St. John River (Canada) 7%, and NYB DPS 1%. The genetic assignments have a plus/minus 5% confidence interval; however, for purposes of section 7 consultation, we have selected the reported values above, which approximate the mid-point of the range, as a reasonable indication of the likely genetic makeup of Atlantic sturgeon in the action area. These assignments and the data from which they are derived are described in detail in Damon-Randall *et al.* (2013).

3.4.3. Status and Trends of Atlantic Sturgeon Range-wide

Distribution and Abundance

Atlantic sturgeon underwent significant range-wide declines from historical abundance levels due to overfishing in the mid to late 19th century when a caviar market was established (Scott and Crossman 1973, Taub 1990, Kennebec River Resource Management Plan 1993, Smith and Clugston 1997, Dadswell 2006, ASSRT 2007). Abundance of spawning-aged females prior to this period of exploitation was predicted to be greater than 100,000 for the Delaware River, and at least 10,000 females for other spawning stocks (Secor and Waldman 1999, Secor 2002). Historical records suggest that Atlantic sturgeon spawned in at least 35 rivers prior to this period. Currently, only 17 U.S. rivers are known to support spawning (i.e., presence of young-of-year or gravid Atlantic sturgeon documented within the past 15 years) (ASSRT 2007). While there may be other rivers supporting spawning for which definitive evidence has not been obtained (e.g., in the Penobscot and York Rivers), the number of rivers supporting spawning of Atlantic sturgeon are approximately half of what they were historically. In addition, only five rivers (Kennebec, Androscoggin, Hudson, Delaware, James) are known to currently support spawning from Maine through Virginia, where historical records show that there used to be 15 spawning rivers (ASSRT 2007). Thus, there are substantial gaps between Atlantic sturgeon spawning rivers among northern and Mid-Atlantic states which could make recolonization of extirpated populations more difficult.

At the time of the listing, there were no current, published population abundance estimates for any of the currently known spawning stocks or for any of the five DPSs of Atlantic sturgeon. An estimate of 863 mature adults per year (596 males and 267 females) was calculated for the

Hudson River based on fishery-dependent data collected from 1985 to 1995 (Kahnle *et al.* 2007). An estimate of 343 spawning adults per year is available for the Altamaha River, GA, based on fishery-independent data collected in 2004 and 2005 (Schueller and Peterson 2006). Using the data collected from the Hudson and Altamaha Rivers to estimate the total number of Atlantic sturgeon in either subpopulation is not possible, since mature Atlantic sturgeon may not spawn every year (Vladykov and Greeley 1963, Smith 1985, Van Eenennaam *et al.* 1996, Stevenson and Secor 1999, Collins *et al.* 2000, Caron *et al.* 2002), the age structure of these populations is not well understood, and stage-to-stage survival is unknown. In other words, the information that would allow us to take an estimate of annual spawning adults and expand that estimate to an estimate of the total number of individuals (*e.g.*, yearlings, subadults, and adults) in a population is lacking. The ASSRT presumed that the Hudson and Altamaha rivers had the most robust of the remaining U.S. Atlantic sturgeon spawning populations (ASSRT 2007).

Lacking complete estimates of population abundance across the distribution of Atlantic sturgeon, the NEFSC developed a virtual population analysis model with the goal of estimating bounds of Atlantic sturgeon ocean abundance (Kocik *et al.* 2013). The Atlantic Sturgeon Production Index (ASPI) provides a general abundance metric to assess risk for actions that may affect Atlantic sturgeon in the ocean; however, it is not a comprehensive population estimate (Table 12).

In additional to the ASPI, a population estimate was derived from the Northeast Area Monitoring and Assessment Program (NEAMAP) (Table 12). NEAMAP trawl surveys are conducted from Cape Cod, Massachusetts to Cape Hatteras, North Carolina in nearshore waters at depths up to 18.3 meters (60 feet) during the fall since 2007 and spring since 2008. Each survey employs a spatially stratified random design with a total of 35 strata and 150 stations. The ASMFC has initiated a new stock assessment with the goal of completing it by the end of 2014. NOAA Fisheries will be partnering with them to conduct the stock assessment, and the ocean population abundance estimates produced by the NEFSC will be shared with the stock assessment committee for consideration in the stock assessment.

Table 12 Description of the ASPI model and NEAMAP survey based area estimate method.

Model Name	Model Description
A. ASPI	Uses tag-based estimates of recapture probabilities from 1999 to 2009. Natural mortality based on Kahnle *et al.* (2007) rather than estimates derived from tagging model. Tag recaptures from commercial fisheries are adjusted for non reporting based on recaptures from observers and researchers. Tag loss assumed to be zero.
B. NEAMAP Swept Area	Uses NEAMAP survey-based swept area estimates of abundance and assumed estimates of gear efficiency. Estimates based on average of ten surveys from fall 2007 to spring 2012.

Table 13 Modeled Results

Model Run	Model Years	95% low	Mean	95% high
A. ASPI	1999-2009	165,381	417,934	744,597

B.1 NEAMAP Survey, swept area assuming 100% efficiency	2007-2012	8,921	33,888	58,856
B.2 NEAMAP Survey, swept area assuming 50% efficiency	2007-2012	13,962	67,776	105,984
B.3 NEAMAP Survey, swept area assuming 10% efficiency	2007-2012	89,206	338,882	588,558

As illustrated by Table 13 above, the ASPI model currently projects a mean population size of 417,934 Atlantic sturgeon, and the NEAMAP Survey projects mean population sizes ranging from 33,888 to 338,882 depending on the assumption made regarding efficiency of that survey. The NEAMAP estimate, in contrast to the ASPI, is more empirically derived and does not depend on as many assumptions. For the purposes of this Opinion, while the ASPI model will be considered as part of the ASMFC stock assessment, we consider the NEAMAP estimate as the best available information on population size of Atlantic sturgeon in the ocean. Assuming a 50% catchability (defined as 1) the product of the probability of capture given encounter (i.e. net efficiency), and 2) the fraction of the population within the sampling domain), the ocean estimate for Atlantic sturgeon is 67,776. Currently, there are no comprehensive population estimates for any of spawning populations that will be affected by this action. Thus, we have presented the only available information on population sizes.

Table 15 Summary of calculated population estimates based upon the NEAMAP Survey swept area assuming 50% efficiency

DPS	Estimated Ocean Population Abundance
GOM (11%)	7,455
NYB (51%)	34,566
CB (13%)	8,811
Carolina (2%)	1,356
SA (22%)	14,911
Canada (1%)	678

3.4.4. Threats Faced by Atlantic sturgeon throughout their range

Atlantic sturgeon are susceptible to over-exploitation given their life history characteristics (e.g., late maturity and dependence on a wide variety of habitats). Similar to other sturgeon species (Vladykov and Greeley 1963, Pikitch *et al.* 2005), Atlantic sturgeon experienced range-wide declines from historical abundance levels due to overfishing (for caviar and meat) and impacts to habitat in the 19th and 20th centuries (Taub 1990, Smith and Clugston 1997, Secor and Waldman 1999).

Because a DPS is a group of populations, the stability, viability, and persistence of individual populations affects the persistence and viability of the larger DPS. The loss of any population within a DPS could result in: (1) a long-term gap in the range of the DPS that is unlikely to be recolonized; (2) loss of reproducing individuals; (3) loss of genetic biodiversity; (4) loss of unique haplotypes; (5) loss of adaptive traits; and (6) reduction in total number. The loss of a population will negatively impact the persistence and viability of the DPS as a whole, as fewer than two individuals per generation spawn outside their natal rivers (Secor and Waldman 1999). The persistence of individual populations, and in turn the DPS, depends on successful spawning and rearing within the freshwater habitat, emigration to marine habitats to grow, and return of adults to natal rivers to spawn.

Based on the best available information, NMFS has concluded that unintended catch in fisheries, vessel strikes, poor water quality, fresh water availability, dams, lack of regulatory mechanisms for protecting the fish, and dredging are the most significant threats to Atlantic sturgeon (77 FR 5880 and 77 FR 5914; February 6, 2012). While all the threats are not necessarily present in the same area at the same time, given that Atlantic sturgeon subadults and adults use ocean waters from Labrador, Canada to Cape Canaveral, FL, as well as estuaries of large rivers along the U.S. East Coast, activities affecting these water bodies are likely to impact more than one Atlantic sturgeon DPS. In addition, because Atlantic sturgeon depend on a variety of habitats, every life stage is likely affected by one or more of the identified threats.

Atlantic sturgeon are particularly sensitive to bycatch mortality because they are a long-lived species, have an older age at maturity, have lower maximum fecundity values, and a large percentage of egg production occurs later in life. Based on these life history traits, Boreman (1997) calculated that Atlantic sturgeon can only withstand the annual loss of up to 5% of their population to bycatch mortality without suffering population declines. Mortality rates of Atlantic sturgeon taken as bycatch in various types of fishing gear range between 0 and 51%, with the greatest mortality occurring in sturgeon caught by sink gillnets. Atlantic sturgeon are particularly vulnerable to being caught in sink gillnets; therefore, fisheries using this type of gear account for a high percentage of Atlantic sturgeon bycatch. Fisheries known to incidentally catch Atlantic sturgeon occur throughout the marine range of the species and in some riverine waters as well. Because Atlantic sturgeon mix extensively in marine waters and may access multiple river systems, they are subject to being caught in multiple fisheries throughout their range. In addition, stress or injury to Atlantic sturgeon taken as bycatch but released alive may result in increased susceptibility to other threats, such as poor water quality (e.g., exposure to toxins and low DO). This may result in reduced ability to perform major life functions, such as foraging and spawning, or even post-capture mortality.

As a wide-ranging anadromous species, Atlantic sturgeon are subject to numerous federal (U.S. and Canadian), state and provincial, and inter-jurisdictional laws, regulations, and agency activities. While these mechanisms, including the prohibition on possession, have addressed impacts to Atlantic sturgeon through directed fisheries, the listing determination concluded that the mechanisms in place to address the risk posed to Atlantic sturgeon from commercial bycatch were insufficient.

An ASMFC interstate fishery management plan for sturgeon (Sturgeon FMP) was developed and implemented in 1990 (Taub 1990). In 1998, the remaining Atlantic sturgeon fisheries in U.S. state waters were closed per Amendment 1 to the Sturgeon FMP. Complementary regulations were implemented by NMFS in 1999 that prohibit fishing for, harvesting, possessing, or retaining Atlantic sturgeon or their parts in or from the EEZ in the course of a commercial fishing activity.

Commercial fisheries for Atlantic sturgeon still exist in Canadian waters (DFO 2011). Sturgeon belonging to one or more of the DPSs may be harvested in the Canadian fisheries. In particular, the Bay of Fundy fishery in the Saint John estuary may capture sturgeon of U.S. origin given that sturgeon from the Gulf of Maine and the New York Bight DPSs have been incidentally captured in other Bay of Fundy fisheries (DFO 2010, Wirgin and King 2011). Because Atlantic sturgeon are listed under Appendix II of the Convention on International Trade in Endangered Species (CITES), the U.S. and Canada are currently working on a conservation strategy to address the potential for captures of U.S. fish in Canadian-directed Atlantic sturgeon fisheries and of Canadian fish incidentally captured in U.S. commercial fisheries. At this time, there are no estimates of the number of individuals from any of the DPSs that are captured or killed in Canadian fisheries each year.

Based on geographic distribution, most U.S. Atlantic sturgeon that are intercepted in Canadian fisheries are likely to originate from the Gulf of Maine DPS, with a smaller percentage from the New York Bight DPS.

Bycatch in U.S. waters is one of the primary threats faced by all five DPSs. At this time, we have an estimate of the number of Atlantic sturgeon captured and killed in sink gillnet and otter trawl fisheries authorized by federal FMPs (NMFS NEFSC 2011) in the Northeast Region but do not have a similar estimate for southeast fisheries. We also do not have an estimate of the number of Atlantic sturgeon captured or killed in state fisheries. At this time, we are not able to quantify the effects of other significant threats (e.g., vessel strikes, poor water quality, water availability, dams, and dredging) in terms of habitat impacts or loss of individuals. While we have some information on the number of mortalities that have occurred in the past in association with certain activities (e.g., mortalities in the Delaware and James Rivers that are thought to be due to vessel strikes), we are not able to use those numbers to extrapolate effects throughout one or more DPSs. This is because of (1) the small number of data points and, (2) the lack of information on the percent of incidents that the observed mortalities represent.

As noted above, the NEFSC prepared an estimate of the number of encounters of Atlantic sturgeon in fisheries authorized by Northeast FMPs (NMFS NEFSC 2011). The analysis estimates that from 2006 through 2010, there were averages of 1,548 and 1,569 encounters per year in observed gillnet and trawl fisheries, respectively, with an average of 3,118 encounters combined annually. Mortality rates in gillnet gear were approximately 20%. Mortality rates in otter trawl gear are generally lower, at approximately 5%.

Global climate change may affect all DPSs of Atlantic sturgeon in the future; however, effects of increased water temperature and decreased water availability are most likely to affect the South Atlantic and Carolina DPSs. Implications of climate change to the Atlantic sturgeon DPSs have been speculated, yet no scientific data are available on past trends related to climate effects on this species, and current scientific methods are not able to reliably predict the future magnitude of climate change and associated impacts or the adaptive capacity of these species. Impacts of climate change on Atlantic sturgeon are uncertain at this time, and cannot be quantified. Any prediction of effects is made more difficult by a lack of information on the rate of expected change in conditions and a lack of information on the adaptive capacity of the species (i.e., its ability to evolve to cope with a changing environment). For analysis on the potential effects of climate change on Atlantic sturgeon, see Section 5 below.

3.4.5. Gulf of Maine DPS of Atlantic sturgeon

The GOM DPS includes the following: all anadromous Atlantic sturgeon that spawn or are spawned in the watersheds from the Maine/Canadian border and, extending southward, all watersheds draining into the GOM as far south as Chatham, MA. The marine range of Atlantic sturgeon from the GOM DPS extends from Hamilton Inlet, Labrador, Canada, to Cape Canaveral, FL. The riverine range of the GOM DPS and the adjacent portion of the marine range are shown in Figure1. Within this range, Atlantic sturgeon historically spawned in the Androscoggin, Kennebec, Merrimack, Penobscot, and Sheepscot Rivers (ASSRT 2007). Spawning still occurs in the Kennebec and Androscoggin Rivers, and it is possible that it still occurs in the Penobscot River as well. Spawning in the Androscoggin River was just recently confirmed by the Maine Department of Marine Resources when they captured a larval Atlantic sturgeon during the 2011 spawning season below the Brunswick Dam. There is no evidence of recent spawning in the remaining rivers. In the 1800s, construction of the Essex Dam on the Merrimack River at river kilometer (rkm) 49 blocked access to 58% of Atlantic sturgeon habitat in the river (Oakley 2003, ASSRT 2007). However, the accessible portions of the Merrimack seem to be suitable habitat for Atlantic sturgeon spawning and rearing (i.e., nursery habitat) (Keiffer and Kynard 1993). Therefore, the availability of spawning habitat does not appear to be the reason for the lack of observed spawning in the Merrimack River. Studies are ongoing to determine whether Atlantic sturgeon are spawning in the Penobscot and Saco Rivers. Atlantic sturgeon that are spawned elsewhere continue to use habitats within these rivers as part of their overall marine range (ASSRT 2007).

At its mouth, the Kennebec River drains an area of 24,667 square kilometers, and is part of a large estuarine system that includes the Androscoggin and Sheepscot Rivers (ASMFC 1998a, NMFS and USFWS 1998d, Squiers 1998). The Kennebec and Androscoggin Rivers flow into Merrymeeting Bay, a tidal freshwater bay, and exit as a combined river system through a narrow channel, flowing approximately 32 kilometers (20 miles) to the Atlantic Ocean as the tidal segment of the Kennebec River (Squiers 1998). This lower tidal segment of the Kennebec River forms a complex with the Sheepscot River estuary (ASMFC 1998a, Squiers 1998).

Substrate type in the Kennebec estuary is largely sand and bedrock (Fenster and Fitzgerald 1996, Moore and Reblin 2010). Main channel depths at low tide typically range from 17 meters (58 feet) near the mouth to less than 10 meters (33 feet) in the Kennebec River above Merrymeeting Bay (Moore and Reblin 2010). Salinities range from 31 parts per thousand at Parker Head (5 kilometers from the mouth) to 18 parts per thousand at Doubling Point during summer low flows (ASMFC 1998a). The 14-kilometer river segment above Doubling Point to Chops Point (the outlet of Merrymeeting Bay) is an area of transition (mid estuary) (ASMFC 1998a). The salinities in this section vary both seasonally and over a tidal cycle. During spring freshets this section is entirely fresh water but during summer low flows, salinities can range from 2 to 3 parts per thousand at Chops Point to 18 parts per thousand at Doubling Point (ASMFC 1998a). The river is essentially tidal freshwater from the outlet of Merrymeeting Bay upriver to the site of the former Edwards Dam (ASMFC 1998a). Mean tidal amplitude ranges from 2.56 meters at the mouth of the Kennebec River estuary to 1.25 meters in Augusta near the head of tide on the Kennebec River (in the vicinity of the former Edwards Dam) and 1.16 meters at Brunswick on the Androscoggin River (ASMFC 1998a).

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 (Squiers *et al.*1981, SMFC 1998a, NMFS and USFWS 1998d). 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 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; and, (3) capture of nine adults during a gillnet survey conducted from 1977 to 1981, the majority of which were captured in July in the area from Merrymeeting Bay and upriver as far as Gardiner, ME (NMFS and USFWS 1998d, ASMFC 2007). The low salinity of waters above Merrymeeting Bay are consistent with values found in other rivers where successful Atlantic sturgeon spawning is known to occur.

Age to maturity for GOM DPS Atlantic sturgeon is unknown. However, Atlantic sturgeon riverine populations exhibit clinal variation with faster growth and earlier age to maturity for those that originate from southern waters, and slower growth and later age to maturity for those that originate from northern waters (75 FR 61872; October 6, 2010). Age at maturity is 11 to 21 years for Atlantic sturgeon originating from the Hudson River (Young *et al.*1998), and 22 to 34 years for Atlantic sturgeon that originate from the Saint Lawrence River (Scott and Crossman1973). Therefore, age at maturity for Atlantic sturgeon of the GOM DPS likely falls within these values. Of the 18 sturgeon examined from the commercial fishery that occurred in the Kennebec River in 1980, all of which were considered mature, age estimates for the 15 males ranged from 17-40 years, and from 25-40 years old for the three females (Squiers *et al.*1981).

Several threats play a role in shaping the current status of GOM 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 *et al.*1979). In 1849, 160 tons of sturgeon were caught in the Kennebec River by local fishermen (Squiers *et al.* 1979). After the collapse of sturgeon stock in the 1880s, the sturgeon fishery was almost non-existent. 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 in state and federal waters still occur. In the marine range, GOM DPS Atlantic sturgeon are incidentally captured in federal and state-managed fisheries, reducing survivorship of subadult and adult Atlantic sturgeon (Stein *et al.* 2004, ASMFC 2007). As explained above, we have estimates of the number of subadults and adults that are killed as a result of bycatch in fisheries authorized under Northeast FMPs. At this time, we are not able to quantify the impacts from other threats or estimate the number of individuals killed as a result of other anthropogenic threats. Habitat disturbance and direct mortality from anthropogenic sources are the primary concerns.

Riverine habitat may be affected by dredging and other in-water activities, disturbing spawning habitat and also altering the benthic forage base. Many rivers in the GOM DPS have navigation channels that are maintained by dredging. Dredging outside of federal channels and in-water construction occurs throughout the GOM 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. 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, and are also not able to quantify any effects to habitat. Connectivity is disrupted by the presence of dams on several 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 historical natural falls and likely represent the maximum upstream extent of sturgeon occurrence even if the dams were not present. Because no Atlantic sturgeon 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. The extent that Atlantic sturgeon are affected by operations of dams in the Gulf of Maine region is currently unknown; however, the documentation of an Atlantic sturgeon larvae downstream of the Brunswick Dam in the Androscoggin River suggests that Atlantic sturgeon spawning may be occurring in the vicinity of that project and therefore, may be affected by project operations. The range of Atlantic sturgeon in the Penobscot River is limited by the presence of the Veazie Dam, which prevents Atlantic sturgeon from accessing approximately 29 kilometers of habitat, including the presumed historical spawning habitat located downstream of Milford Falls, the site of the Milford Dam. The removal of the Veazie Dam this year will restore access to the entirety of the species' historical range in the Penobscot River. Atlantic sturgeon are known to occur in the Penobscot River, but it is unknown whether spawning is currently occurring or whether the presence of the Veazie Dam affects the likelihood of spawning occurring in this river. The Essex Dam on the Merrimack River blocks access to approximately 58% of historically accessible habitat in this river. Atlantic sturgeon occur in the Merrimack River but spawning has not been documented. As with the Penobscot, it is unknown how the Essex Dam affects the likelihood of spawning in this river.

GOM 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 (Lichter *et al.* 2006, EPA 2008). Many rivers in Maine, including the Androscoggin River, were heavily polluted in the past from pulp and paper mills' industrial discharges. 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.

There are no direct in-river abundance estimates for the GOM DPS. The Atlantic Sturgeon Status Review Team (ASSRT) (2007) presumed that the GOM DPS was comprised of less than 300 spawning adults per year, based on extrapolated abundance estimates from the Hudson and Altamaha riverine populations of Atlantic sturgeon. Surveys of the Kennebec River over two time periods, 1977-1981 and 1998-2000, resulted in the capture of nine adult Atlantic sturgeon (Squiers 2004). However, since the surveys were primarily directed at capture of shortnose sturgeon, the capture gear used may not have been selective for the larger-sized adult Atlantic sturgeon; several hundred subadult Atlantic sturgeon were caught in the Kennebec River during these studies. As described earlier, we have estimated that there are a minimum of 7,455 GOM DPS adult and subadult Atlantic sturgeon of size vulnerable to capture in federal marine fisheries. We note further that this estimate is predicated on the assumption that fish in the GOM DPS would be available for capture in the NEAMAP survey which extends from Block Island Sound (RI) southward.

Summary of the Gulf of Maine DPS

Spawning for the GOM DPS is known to occur in two rivers (Kennebec and Androscoggin). Spawning may be occurring in other rivers, such as the Sheepscot, Merrimack, and Penobscot, but has not been confirmed. There are indications of potential increasing abundance of Atlantic sturgeon belonging to the GOM DPS. 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). These observations suggest that abundance of the GOM DPS of Atlantic sturgeon is sufficient such that recolonization to rivers historically suitable for spawning may be occurring. However, despite some positive signs, there is not enough information to establish a trend for this DPS.

Some of the impacts from the threats that contributed to the decline of the GOM 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). In Maine state waters, there are strict regulations on the use of fishing gear that incidentally catches sturgeon. In addition, in the last several years there have been reductions in fishing effort in state and federal waters, which most likely would result in a reduction in bycatch mortality of Atlantic sturgeon. A significant amount of fishing in the Gulf of Maine is conducted using trawl gear, which is known to have a much lower mortality rate for Atlantic sturgeon caught in the gear compared to sink gillnet gear (ASMFC 2007). Atlantic sturgeon from the GOM DPS are not commonly taken as bycatch in areas south of Chatham, MA, with only 8% (e.g., 7 of 84 fish) of interactions observed south of Chatham being assigned to the GOM DPS (Wirgin and King 2011). Tagging results also indicate that GOM DPS fish tend to remain within the waters of the Gulf of Maine and only occasionally venture to points south.

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 % originated from the GOM 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. As noted previously, studies have shown that in order to rebuild, Atlantic sturgeon can only sustain low levels of bycatch and other anthropogenic mortality (Boreman 1997, ASMFC 2007, Kahnle *et al.* 2007, Brown and Murphy 2010). We have determined that the GOM 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.

3.4.6. New York Bight DPS of Atlantic sturgeon

The NYB DPS includes the following: all anadromous Atlantic sturgeon spawned in the watersheds that drain into coastal waters from Chatham, MA to the Delaware-Maryland border on Fenwick Island. Within this range, Atlantic sturgeon historically spawned in the Connecticut, Delaware, Hudson, and Taunton Rivers (Murawski and Pacheco 1977, Secor 2002, ASSRT 2007). Spawning still occurs in the Delaware and Hudson Rivers, but there is no recent evidence (within the last 15 years) of spawning in the Connecticut and Taunton Rivers (ASSRT 2007). Atlantic sturgeon that are spawned elsewhere continue to use habitats within the Connecticut and Taunton Rivers as part of their overall marine range (ASSRT 2007, Savoy 2007, Wirgin and King 2011).

The Hudson River and Estuary extend 504 kilometers from the Atlantic Ocean to Lake Tear of-the-Clouds in the Adirondack Mountains (Dovel and Berggren 1983). The estuary is 246 km long, beginning at the southern tip of Manhattan Island (rkm 0) and running north to the Troy Dam (rkm 246) near Albany (Sweka *et al.* 2007). All Atlantic sturgeon habitats are believed to occur below the dam. Therefore, presence of the dam on the river does not restrict access of Atlantic sturgeon to necessary habitats (e.g., for spawning, rearing, foraging, over wintering) (NMFS and USFWS 1998, ASSRT 2007).

Use of the river by Atlantic sturgeon has been described by several authors. Briefly, spawning likely occurs in multiple sites within the river from approximately rkm 56 to rkm 182 (Dovel and Berggren 1983, Van Eenennaam *et al.* 1996, Kahnle *et al.* 1998, Bain *et al.* 2000). Selection of sites in a given year may be influenced by the position of the salt wedge (Dovel and Berggren 1983, Van Eenennaam *et al.* 1996, Kahnle *et al.* 1998). The area around Hyde Park (approximately rkm134) has consistently been identified as a spawning area through scientific studies and historical records of the Hudson River sturgeon fishery (Dovel and Berggren 1983, Van Eenennaam *et al.* 1996, Kahnle *et al.* 1998, Bain *et al.* 2000). Habitat conditions at the Hyde Park site are described as freshwater year round with bedrock, silt and clay substrates and waters depths of 12-24 m (Bain *et al.* 2000). Bain *et al.* (2000) also identified a spawning site at rkm 112 based on tracking data. The rkm 112 site, located to one side of the river, has clay, silt and sand substrates, and is approximately 21-27 m deep (Bain *et al.* 2000).

Young-of-year (YOY) have been recorded in the Hudson River between rkm 60 and rkm 148, which includes some brackish waters; however, larvae must remain upstream of the salt wedge because of their low salinity tolerance (Dovel and Berggren 1983, Kahnle *et al.* 1998, Bain *et al.* 2000). Catches of immature sturgeon (age 1 and older) suggest that juveniles utilize the estuary from the Tappan Zee Bridge through Kingston (rkm 43- rkm 148) (Dovel and Berggren 1983, Bain *et al.* 2000). Seasonal movements are apparent with juveniles occupying waters from rkm 60 to rkm 107 during summer months and then moving downstream as water temperatures decline in the fall, primarily occupying waters from rkm 19 to rkm 74 (Dovel and Berggren 1983, Bain *et al.* 2000). Based on river-bottom sediment maps (Coch 1986) most juvenile sturgeon habitats in the Hudson River have clay, sand, and silt substrates (Bain *et al.* 2000). Newburgh and Haverstraw Bays in the Hudson River are areas of known juvenile sturgeon concentrations (Sweka *et al.* 2007). Sampling in spring and fall revealed that highest catches of juvenile Atlantic sturgeon occurred during spring in soft-deep areas of Haverstraw Bay even though this habitat type comprised only 25% of the available habitat in the Bay (Sweka *et al.* 2007). Overall, 90% of the total 562 individual juvenile Atlantic sturgeon captured during the course of this study (14 were captured more than once) came from Haverstraw Bay (Sweka *et al.* 2007). At around three years of age, Hudson River juveniles exceeding 70 cm total length begin to migrate to marine waters (Bain *et al.* 2000).

In general, Hudson River Atlantic sturgeon mature at approximately 11 to 21 years of age (Dovel and Berggren 1983, ASMFC 1998, Young *et al. 1*998). A sample of 94 pre-spawning adult Atlantic sturgeon from the Hudson River was comprised of males 12 to 19 years old, and females that were 14 to 36 years old (Van Eenennaam *et al.* 1996). The majority of males were 13 to 16 years old while the majority of females were 16 to 20 years old (Van Eenennaam *et al.* 1996). These data are consistent with the findings of Stevenson and Secor (1999) who noted that, amongst a sample of Atlantic sturgeon collected from the Hudson River fishery from 1992-1995, growth patterns indicated males grew faster and, thus, matured earlier than females. The spawning season for Hudson River Atlantic sturgeon extends from late spring to early summer (Dovel and Berggren 1983, Van Eenennaam *et al.* 1996).

The abundance of the Hudson River Atlantic sturgeon riverine population prior to the onset of expanded exploitation in the 1800's is unknown but, has been conservatively estimated at 10,000 adult females (Secor 2002). Current abundance is likely at least one order of magnitude smaller than historical levels (Secor 2002, ASSRT 2007, Kahnle *et al.* 2007). As described above, an estimate of the mean annual number of mature adults (863 total; 596 males and 267 females) was calculated for the Hudson River riverine population based on fishery-dependent data collected from 1985-1995 (Kahnle *et al.* 2007). Kahnle *et al.* (1998, 2007) also showed that the level of fishing mortality from the Hudson River Atlantic sturgeon fishery during the period of 1985-1995 exceeded the estimated sustainable level of fishing mortality for the riverine population and may have led to reduced recruitment. All available data on abundance of juvenile Atlantic sturgeon in the Hudson River Estuary indicate a substantial drop in production of young since the mid 1970's (Kahnle *et al.* 1998). A decline appeared to occur in the mid to late 1970's followed by a secondary drop in the late 1980's (Kahnle *et al.* 1998, Sweka *et al.* 2007, ASMFC 2010). Catch-per-unit-effort data suggest that recruitment has remained depressed relative to catches of juvenile Atlantic sturgeon in the estuary during the mid-late 1980's (Sweka *et al.* 2007, ASMFC 2010). In examining the CPUE data from 1985-2007, there are significant fluctuations during this time. There appears to be a decline in the number of juveniles between the late 1980s and early 1990s and while the CPUE is generally higher in the 2000s as compared to the 1990s, given the significant annual fluctuation it is difficult to discern any trend. Despite the CPUEs from 2000-2007 being generally higher than those from 1990-1999, they are low compared to the late 1980s.

In the Delaware River and Estuary, Atlantic sturgeon occur from the mouth of the Delaware Bay to the fall line near Trenton, NJ, a distance of 220 km (NMFS and USFWS 1998, Simpson 2008). As is the case in the Hudson River, all historical Atlantic sturgeon habitats appear to be accessible in the Delaware (NMFS and USFWS 1998, ASSRT 2007). Recent multi-year studies have provided new information on the use of habitats by Atlantic sturgeon within the Delaware River and Estuary (Simpson 2008, Brundage and O'Herron 2009, Calvo *et al.* 2010, Fox and Breece 2010).

Historical records from the 1830's indicate Atlantic sturgeon may have spawned as far north as Bordentown, just below Trenton, NJ (Pennsylvania Commission of Fisheries 1897). Cobb (1899) and Borodin (1925) reported spawning occurring between rkm 77 and 130 (Delaware City, DE to Chester City, PA). Based on recent tagging and tracking studies carried out from 2009-2011, Breece (2011) reports likely spawning locations at rkm 120-150 and rkm 170-190. Mature adults have been tracked in these areas at the time of year when spawning is expected to occur and movements have been consistent with what would be expected from spawning adults. Based on tagging and tracking studies, Simpson (2008) suggested that spawning habitat also exists from Tinicum Island (rkm 136) to the fall line in Trenton, NJ (rkm 211). To date, eggs and larvae have not been documented to confirm that actual spawning is occurring in these areas. However, as noted below, the presence of young of the year in the Delaware River provides confirmation that spawning is still occurring in this river.

Sampling in 2009 that targeted YOY resulted in the capture of more than 60 YOY in the Marcus Hook anchorage (rkm 127) area during late October-late November 2009 (Fisher 2009, Calvo *et al.* 2010). Twenty of the YOY from one study and six from the second study received acoustic tags that provided information on habitat use by this early life stage (Calvo *et al.* 2010, Fisher 2011). YOY used several areas from Deepwater (rkm 105) to Roebling (rkm 199) during late fall to early spring. Some remained in the Marcus Hook area while others moved upstream, exhibiting migrations in and out of the area during winter months (Calvo *et al.* 2010, Fisher 2011). At least one YOY spent some time downstream of Marcus Hook (Calvo *et al.* 2010, Fisher 2011). Downstream detections from May to August between Philadelphia (rkm 150) and New Castle (rkm 100) suggest non-use of the upriver locations during the summer months (Fisher 2011). By September 2010, only three of 20 individuals tagged by DE DNREC persisted with active tags (Fisher 2011). One of these migrated upstream to the Newbold Island and Roebling area (rkm 195), but was back down in the lower tidal area within three weeks and was last detected at Tinicum Island (rkm 141) when the transmitter expired in October (Fisher 2011). The other two remained in the Cherry Island Flats (rkm 113) and Marcus Hook Anchorage area (rkm130) until their tags transmissions also ended in October (Fisher 2011).

The Delaware Estuary is known to be a congregation area for sturgeon from multiple DPSs. Generally, non-natal late stage juveniles (sometimes also referred to as subadults) immigrate into the estuary in spring, establish home range in the summer months in the river, and emigrate from the estuary in the fall (Fisher 2011). Subadults tagged and tracked by Simpson (2008) entered the lower Delaware Estuary as early as mid-March but, more typically, from mid-April through May. Tracked sturgeon remained in the Delaware Estuary through the late fall departing in November (Simpson 2008). Previous studies have found a similar movement pattern of upstream movement in the spring-summer and downstream movement to overwintering areas in the lower estuary or nearshore ocean in the fall-winter (Brundage and Meadows 1982, Shirey *et al.* 1997, 1999, Brundage and O'Herron 2009, Brundage and O'Herron in Calvo *et al.* 2010).

Brundage and O'Herron (in Calvo *et al.* 2010) tagged 26 juvenile Atlantic sturgeon, including six young of the year. For non YOY fish, most detections occurred in the lower tidal Delaware River from the middle Liston Range (rkm 70) to Tinicum Island (rkm 141). For non YOY fish, these researchers also detected a relationship between the size of individuals and the movement pattern of the fish in the fall. The fork length of fish that made defined movements to the lower bay and ocean averaged 815 mm (range 651-970 mm) while those that moved towards the bay but were not detected below Liston Range averaged 716 mm (range 505-947 mm), and those that appear to have remained in the tidal river into the winter averaged 524 mm (range 485-566 mm) (Calvo *et al.* 2010). During the summer months, concentrations of Atlantic sturgeon have been located in the Marcus Hook (rkm 123-129) and Cherry Island Flats (rkm 112-118) regions of the river (Simpson 2008, Calvo *et al.* 2010) as well as near Artificial Island (Simpson 2008). Sturgeon have also been detected using the Chesapeake and Delaware Canal (Brundage 2007, Simpson 2008).

Adult Atlantic sturgeon captured in marine waters off of Delaware Bay in the spring were tracked in an attempt to locate spawning areas in the Delaware River, (Fox and Breece 2010). Over the period of two sampling seasons (2009-2010) four of the tagged sturgeon were detected in the Delaware River. The earliest detection was in mid-April while the latest departure occurred in mid-June (Fox and Breece 2010). The sturgeon spent relatively little time in the river each year, generally about four weeks, and used the area from New Castle, DE (rkm 100) to Marcus Hook (rkm 130) (Fox and Breece 2010). A fifth sturgeon tagged in a separate study was also tracked and followed a similar timing pattern but traveled farther upstream (to rkm 165) before exiting the river in early June (Fox and Breece 2010).

There is no abundance estimate for the Delaware River population of Atlantic sturgeon. Harvest records from the 1800's indicate that this was historically a large population with an estimated 180,000 adult females prior to 1890 (Secor and Waldman 1999, Secor 2002). Sampling in 2009 to target young-of- the year (YOY) Atlantic sturgeon in the Delaware River (i.e., natal sturgeon) resulted in the capture of 34 YOY, ranging in size from 178 to 349 mm TL (Fisher 2009) and the collection of 32 YOY Atlantic sturgeon in a separate study (Brundage and O'Herron in Calvo *et al.* 2010). Genetics information collected from 33 of the 2009 year class YOY indicates that at least three females successfully contributed to the 2009 year class (Fisher 2011). Therefore, while the capture of YOY in 2009 provides evidence that successful spawning is still occurring in the Delaware River, the relatively low numbers suggest the existing riverine population is limited in size.

Several threats play a role in shaping the current status and trends observed in the Delaware River and Estuary. In-river threats include habitat disturbance from dredging, and impacts from historical pollution and impaired water quality. A dredged navigation channel extends from Trenton seaward through the tidal river (Brundage and O'Herron 2009), and the river receives significant shipping traffic. Vessel strikes have been identified as a threat in the Delaware River; however, at this time we do not have information to quantify this threat or its impact to the population or the NYB DPS. Similar to the Hudson River, there is currently not enough information to determine a trend for the Delaware River population.

Summary of the New York Bight DPS

Atlantic sturgeon originating from the NYB DPS spawn in the Hudson and Delaware rivers. While genetic testing can differentiate between individuals originating from the Hudson or Delaware river the available information suggests that the straying rate is high between these rivers. There are no indications of increasing abundance for the NYB DPS (ASSRT 2009 & 2010). Some of the impact from the threats that contributed to the decline of the NYB DPS have been removed (e.g., directed fishing) or reduced as a result of improvements in water quality since passage of the Clean Water Act (CWA). In addition, there have been reductions in fishing effort in state and federal waters, which may result in a reduction in bycatch mortality of Atlantic sturgeon. Nevertheless, areas with persistent, degraded water quality, habitat impacts from dredging, continued bycatch in state and federally-managed fisheries, and vessel strikes remain significant threats to the NYB DPS.

In the marine range, NYB DPS Atlantic sturgeon are incidentally captured in federal and state managed fisheries, reducing survivorship of subadult and adult Atlantic sturgeon (Stein *et al.* 2004, ASMFC 2007). Based on mixed stock analysis results presented by Wirgin and King (2011), over 40 percent of the Atlantic sturgeon bycatch interactions in the Mid Atlantic Bight region were sturgeon from the NYB DPS. Individual-based assignment and mixed stock analysis of samples collected from sturgeon captured in Canadian fisheries in the Bay of Fundy indicated that approximately 1-2% were from the NYB DPS. At this time, we are not able to quantify the impacts from other threats or estimate the number of individuals killed as a result of other anthropogenic threats.

Riverine habitat may be impacted by dredging and other in-water activities, disturbing spawning habitat and also altering the benthic forage base. Both the Hudson and Delaware rivers have navigation channels that are maintained by dredging. Dredging is also used to maintain channels in the nearshore marine environment. Dredging outside of Federal channels and in-water construction occurs throughout the New York Bight region. While some dredging projects operate with observers present to document fish mortalities, many do not. We have reports of one Atlantic sturgeon entrained during hopper dredging operations in Ambrose Channel, New Jersey. 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 and, additionally, are unable to quantify any effects to habitat.

In the Hudson and Delaware Rivers, dams do not block access to historical habitat. The Holyoke Dam on the Connecticut River blocks further upstream passage; however, the extent that Atlantic sturgeon would historically have used habitat upstream of Holyoke is unknown. Connectivity may be disrupted by the presence of dams on several smaller rivers in the New York Bight region. Because no Atlantic sturgeon occur upstream of any hydroelectric projects in the New York Bight region, passage over hydroelectric dams or through hydroelectric turbines is not a source of injury or mortality in this area. The extent that Atlantic sturgeon are affected by operations of dams in the New York Bight region is currently unknown.

NYB DPS Atlantic sturgeon may also be affected by degraded water quality. In general, water quality has improved in the Hudson and Delaware over the past decades (Lichter *et al.* 2006, USEPA 2008). Both the Hudson and Delaware rivers, as well as other rivers in the New York

Bight region, were heavily polluted in the past from industrial and sanitary sewer discharges. 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.

Vessel strikes occur in the Delaware River. Twenty-nine mortalities believed to be the result of vessel strikes were documented in the Delaware River from 2004 to 2008, and at least 13 of these fish were large adults. Given the time of year in which the fish were observed (predominantly May through July, with two in August), it is likely that many of the adults were migrating through the river to the spawning grounds. Because we do not know the percent of total vessel strikes that the observed mortalities represent, we are not able to quantify the number of individuals likely killed as a result of vessel strikes in the NYB DPS.

Studies have shown that to rebuild, Atlantic sturgeon can only sustain low levels of anthropogenic mortality (Boreman 1997, ASMFC 2007, Kahnle *et al.* 2007, Brown and Murphy 2010). There are no empirical abundance estimates of the number of Atlantic sturgeon in the NYB DPS. We have determined that the NYB DPS is currently at risk of extinction due to: (1) precipitous declines in population sizes and the protracted period in 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 population recovery.

3.4.7. Factors Affecting Atlantic Sturgeon in Action Area

3.4.7.1. Dams and Hydroelectric Facilities

Historically, the upstream migration of Atlantic sturgeon on the Kennebec River was limited to Waterville at Ticonic Falls (rkm 98) (NMFS and USFWS 1998), approximately the location of the Lockwood Project. Ticonic Falls is located 65 rkm downstream of the fall line (based on reference points provided by Oakley 2005). The construction of Edwards Dam at rkm 71 in 1837 denied sturgeon access to historical habitat in the Kennebec River until 1999 when it was removed. Since its removal, almost 100% of historic habitat is now accessible.

In the Androscoggin River, the Brunswick Hydroelectric Project (rkm 44) is located at the head-of-tide at the site of a natural falls. This facility was licensed by FERC in 1979 and the license is set to expire in 2029. The limited storage capacity of the Brunswick Dam restricts its ability to influence river flows; therefore, during the FERC licensing process, a minimum flow requirement was deemed not necessary. The location of historical spawning grounds on the Androscoggin River is unknown, but it is unlikely that sturgeon could navigate the natural falls located at Brunswick Dam (NMFS and USFWS 1998).

As Atlantic sturgeon do not occur upstream of any hydroelectric projects in the Kennebec or Androscoggin Rivers, passage over hydroelectric dams or through hydroelectric turbines is not a source of injury or mortality in the action area. The extent that Atlantic sturgeon are affected by operations of hydroelectric facilities in these Rivers is currently unknown.

3.4.7.2. Contaminants and Water Quality

Atlantic sturgeon are vulnerable to effects from contaminants and water quality over their entire life history. In addition, their long life span increases the potential for environmental contaminants to build up in the tissue which may affect the development of the individual or its gametes. Point source discharges (i.e., municipal wastewater, paper mill effluent, industrial or power plant cooling water or waste water) and compounds associated with discharges (i.e., metals, dioxins, dissolved solids, phenols, and hydrocarbons) contribute to poor water quality that may also impact the health of individual sturgeon. The compounds associated with discharges can alter the chemistry and temperature of receiving waters, which may lead to mortality, changes in fish behavior, deformations, and reduced egg production and survival. Contaminants including heavy metals, polychlorinated aromatic hydrocarbons (PAHs), pesticides, and polychlorinated biphenyls (PCBs), can have serious, deleterious effects on aquatic life and are associated with the production of acute lesions, growth retardation, and reproductive impairment (Ruelle and Keenlyne 1993). Contaminants introduced into the water column or through the food chain eventually become associated with the benthos where bottom dwelling species like Atlantic sturgeon are particularly vulnerable.

4. ENVIRONMENTAL BASELINE OF THE ACTION AREA

Environmental baselines for biological opinions include the past and present impacts of all state, federal or private actions and other human activities in the action area, 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 that are contemporaneous with the consultation in process (50 CFR 402.02). The environmental baseline for this Opinion includes the effects of several activities that may affect the survival and recovery of the listed species and may affect critical habitat in the action area.

4.1. Formal or Early Section 7 Consultations

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

On September 17, 2012, September 19, 2012, and October 18, 2012 we issued Opinions to the FERC on the impacts to listed species from ISPPs being proposed by Brookfield Renewable Power for the Hydro-Kennebec Project, Topsham Hydro Partners for the Pejepscot Project, and Miller Hydro Group for the Worumbo Project. The purpose of these ISPPs is to collect information on passage efficiency and survival of Atlantic salmon adults and smolts attempting to migrate past the Projects. The incidental take statements authorize take for proposed studies, fishway improvements, and ongoing operation of these projects for five year interim periods (2012-2016). At the end of this period, Brookfield, Topsham Hydro, and Miller Hydro will develop final SPPs that contain additional protection measures for listed fish, if necessary, and FERC will reinitiate formal consultation in order to obtain take authorization for the remainder of each projects' license term. We concluded that the proposed actions were not likely to jeopardize the continued existence of listed Atlantic salmon.

The ITSs accompanying the Opinions exempted the incidental take of Atlantic salmon smolts, adults, and kelts due to injury and harassment associated with the upstream and downstream passage studies (Table 16). We also authorized take for the operation of the projects over the term of the ISPPs. These authorizations expire at the end of the proposed ISPP (2016).

Table 16. Take of Atlantic salmon authorized for ISPPs for project operation and fish passage studies at the Pejepscot, Worumbo, and Hydro-Kennebec Projects

			Operations		**Monitoring**	
Project	**Duration**	**Lifestage**	**Harass**	**Kill**	**Harm and Harass**	**Kill***
Pejepscot	2012-2016	Adults	24.75%	0.25%	40/year	11 total
		Smolts		8.40%	172/year	
		Kelts		28%	20/year	
Worumbo	2012-2016	Adults		1 fish		12 total
		Smolts		8.40%	172/year	
		Kelts		10 fish	20/year	
Hydro Kennebec	2012-2016	Smolts		7.9%	200/year	
		Kelts		28%	20/year	

*Number anticipated to be killed due to handling and tagging only.

We also completed two formal consultations for activities in Bond Brook, a tributary to the Kennebec River in Augusta, Maine. The first project involved coal tar remediation in the brook. The second project involved upgrades to a combined sewer overflow in Bond Brook. We exempted the non-lethal take of two adult Atlantic salmon for each project.

4.2. Kennebec Hydro Developers Group Agreement

In 1987, the owners of several hydropower projects on the Kennebec and Sebasticook Rivers, including the owners of the Projects addressed under this ISPP, reached an agreement with state and federal fishery agencies on anadromous fish passage initiatives that dam owners would undertake. The agreement, known as the Kennebec Hydro Developer Group Agreement (KHDG Agreement), was designed to facilitate the restoration of American shad, river herring, and Atlantic salmon in the Kennebec River basin. The 1998 KHDG Agreement, modified the original Agreement to include provisions for supporting the removal of Edwards dam and for providing fish passage for Atlantic salmon, American shad, river herring and American eel at the Lockwood, Shawmut and Weston projects, as well as other hydroelectric projects located on the mainstem Kennebec and Sebasticook rivers. Under KHDG, the hydro owners directly funded restoration efforts, including dam removals at Edwards and Fort Halifax.

The 1998 KHDG Agreement established triggers that, if reached, would initiate a sequential process of upstream and downstream fishway construction at the Lockwood, Hydro-Kennebec, Shawmut, and Weston Projects on the Kennebec River, and the Burnham and Benton Falls Projects in the Sebasticook River. The KHDG Agreement indicates that permanent downstream passage facilities will be operational at the time that the upstream fishways become operational.

The Agreement lays out two potential triggers for the construction of fishways: 1) a threshold number of shad trapped at the existing fish trap at the Lockwood Project, or 2) "a biological trigger initiated for Atlantic salmon, alewife or blueback herring." The number of shad trapped at the Lockwood Project has been consistently low since the implementation of the Agreement. Between 2006 and 2012, an average of 11 shad have been trapped at the Project per year (Brookfield Renewable Energy Group 2013), significantly below the 8,000 required to trigger the construction of permanent upstream fishways. In regards to the "biological trigger," the KHDG agreement states that "Should the growth of salmon or river herring runs make it necessary to adopt an alternative approach for triggering fishway installation…the resource agencies will meet with the licensees(s) to attempt to reach consensus on the need, timing and design of permanent upstream fish passage facilities…" The Agreement further states that if neither of the triggers have been met prior to December 2014, "the parties will meet to assess the progress in restoring" diadromous fish species in the Kennebec River. As neither of the triggers has been met, it is anticipated that discussions will be occurring in the near future to determine what modifications to the KHDG Agreement may be necessary to restore diadromous fish to the Kennebec River.

The licensee's proposed ISPP does not supersede their obligations under the KHDG Agreement. The provisions of the Agreement have been incorporated into the Projects' licenses and FERC has not proposed to remove those provisions. In their ISPP, the licensee proposes date-certain upstream fishway installation for Atlantic salmon at the Lockwood, Shawmut and Weston Projects, although the triggers as defined in the Agreement have yet to be met. It is expected that the licensee will meet the other provisions of the Agreement such as the requirements that 1) downstream passage studies be conducted prior to the date that permanent downstream passage facilities are to be operational, 2) that permanent downstream passage facilities are operational at the same time as permanent upstream passage facilities, and 3) that efficiency and survival studies will be conducted after the construction of any interim or permanent upstream or downstream fish passage facilities.

4.3. Scientific Studies

Atlantic salmon

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

We are also a sub-permittee under USFWS' ESA section 10 endangered species blanket permit. Research authorized under this permit is currently ongoing regarding Atlantic salmon populations in the Merrymeeting Bay SHRU. Although these activities will result in some take of Atlantic salmon, adverse impacts are expected to be minor and such take is authorized by an existing ESA permit. The information gained from these activities will be used to further salmon conservation actions in the GOM DPS.

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

Shortnose sturgeon

Research activities for shortnose sturgeon conducted by University of Maine investigators are authorized through scientific research permits issued by NMFS. Permit number 16306 was recently issued (May 2012), and will extend until 2017. The research team consists of scientists from MDMR, USGS, UM, and the University of Southern Maine. Their research objectives are to: 1) use mark-recapture techniques to generate population estimates and to define stock structure and distribution, 2) determine the degree of demographic correspondence and connectivity of local in-river sturgeon populations, and 3) identify habitat use, movement patterns, and life history characteristics of shortnose sturgeon in Maine waters. The treatments would include weighing, measuring, photographing, anesthetize, inserting PIT tag, Floy/T-bar tag insertion, tissue sample, blood sample, boroscope, gastric lavage, fin ray section, apical spine sample, and external satellite tagging. Not all specimens sampled would receive all treatments. The research sites include the Penobscot, Kennebec, Saco, and Merrimack Rivers. Additionally, several smaller coastal rivers in Maine and New Hampshire will also be surveyed. The Section 10 permit allows the directed non-lethal take of 7,205 shortnose sturgeon of various life stages over the duration of the permit, with 200 deliberate mortalities of early life stage (ELS) occurring annually. The Biological Opinion issued as a result of section 7 consultation on the effects of the directed take authorized under Permit 16306, concluded that this take is not likely to jeopardize the continued existence of any ESA-listed species under NMFS jurisdiction

Atlantic sturgeon

The MDMR, in collaboration with scientists at UM and others, are conducting studies on the Atlantic sturgeon population in the GOM DPS. The research proposed to be conducted through a scientific research permit (NMFS No. 16526) would include determining movement patterns and rate of exchange between coastal river systems, characterizing the population structure (i.e., sex ratios and aging), and generating estimates of population abundance. The proposed action would involve several major river systems in Maine, including the Penobscot, Kennebec, Androscoggin and Sheepscot rivers. Smaller coastal rivers throughout Maine would also be targeted. The applicant would use gill nets to capture up to 975 juvenile and adult Atlantic sturgeon, and D-nets to sample 200 early life stage (ELS) annually. Atlantic sturgeon captured by gill nets, trammel nets, trawls, and beach seines would be measured, weighed, photographed, PIT tagged, Floy/T-bar tagged, tissue sampled, boroscoped, apical spine sampled, blood sampled, anesthetized, fin ray sectioned, and implanted with an acoustic telemetry tag. The applicant would use MS-222 as an anesthetic or on occasion, electronarcosis; see the application for further details. Not all Atlantic sturgeon would undergo all procedures. In total, up to 200 ELS, plus two annual incidental mortalities of juvenile Atlantic sturgeon and up to one adult Atlantic sturgeon over the life of the permit would be anticipated as the result of research. Research conducted prior to issuance of this permit has demonstrated a low mortality rate using similar gear types; approximately 120 Atlantic sturgeon were captured over a five year study with four incidental mortalities occurring to juvenile fish.

4.3. Other Federally Authorized Activities in the Action Area

We have completed several informal consultations on effects of in-water construction activities in the Kennebec and Androscoggin Rivers permitted by the ACOE. This includes several dock, pier, and bank stabilization and dredging projects.   No interactions with Atlantic salmon, shortnose or Atlantic sturgeon have been reported in association with any of these projects.

4.4. State or Private Activities in the Action Area

Information on the number of sturgeon captured or killed in state fisheries is extremely limited and as such, efforts are currently underway to obtain more information on the numbers of sturgeon captured and killed in state water fisheries.   We are currently working with the Atlantic States Marine Fisheries Commission (ASMFC) and the coastal states to assess the impacts of state authorized fisheries on sturgeon. We anticipate that some states are likely to apply for ESA section 10(a)(1)(B) Incidental Take Permits to cover their fisheries; however, to date, no applications have been submitted.

In 2007, the MDMR authorized a limited catch-and-release fall fishery (September 15 to October 15) for Atlantic salmon in the Penobscot River upstream of the former Bangor Dam. The fishery was closed prior to the 2009 season. There is no indication that the fishery will be reinstated in the future.

4.5. Impacts of Other Human Activities in the Action Area

Other human activities that may affect listed species and critical habitat include direct and indirect modification of habitat due to hydroelectric facilities and the introduction of pollutants from paper mills, sewers, and other industrial sources. Pollution has been a major problem for these river systems, which continues to receive discharges from sewer treatment facilities and paper production facilities (metals, dioxin, dissolved solids, phenols, and hydrocarbons).

Hydroelectric facilities can alter the river’s natural flow pattern and temperatures.   In addition, the release of silt and other fine river sediments during dam maintenance can be deposited in sensitive spawning habitat nearby. These facilities also act as barriers to normal upstream and downstream movements, and block access to important habitats. Passage through these facilities may result in the mortality of downstream migrants.

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. 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. Consideration of effects of the proposed action in light of predicted changes in environmental conditions due to anticipated climate change are included in the Effects of the Action section below (Section 6.0).

5.1. Background Information on Global climate change

The global mean temperature has risen 0.76ºC (1.36°F) over the last 150 years, and the linear trend over the last 50 years is nearly twice that for the last 100 years (IPCC 2007) and precipitation has increased nationally by 5%-10%, mostly due to an increase in heavy downpours (NAST 2000). 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 other 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 are most apparent over the past few decades. Information on future impacts of climate change in the action area is discussed below.

Climate model projections exhibit a wide range of plausible scenarios for both temperature and precipitation over the next century. Both of the principal climate models used by the National Assessment Synthesis Team (NAST) project warming in the southeast by the 2090s, but at different rates (NAST 2000): the Canadian model scenario shows the southeast U.S. experiencing a high degree of warming, which translates into lower soil moisture as higher temperatures increase evaporation; the Hadley model scenario projects less warming and a significant increase in precipitation (about 20%). The scenarios examined, which assume no major interventions to reduce continued growth of world greenhouse gases (GHG), indicate that temperatures in the U.S. will rise by about 3^{o}-5^{o}C (5^{o}-9^{o}F) on average in the next 100 years which is more than the projected global increase (NAST 2000). A warming of about 0.2^{o}C (0.4°F) per decade is projected for the next two decades over a range of emission scenarios (IPCC 2007). This temperature increase will very likely be associated with more extreme precipitation and faster evaporation of water, leading to greater frequency of both very wet and very dry conditions. Climate warming has resulted in increased precipitation, river discharge, and glacial and sea-ice melting (Greene *et al.* 2008).

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 2006). 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 2006). The NAO impacts climate variability throughout the northern hemisphere (IPCC 2006). Data from the 1960s through the present show that the NAO index has increased from minimum values in the 1960s to strongly positive index values in the 1990s and somewhat declined since (IPCC 2006). This warming extends over 1000m (0.62 miles) deep and is deeper than anywhere in the world oceans and is particularly evident under the Gulf Stream/ North Atlantic Current system (IPCC 2006). 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 (Greene *et al.* 2008, IPCC 2006). There is evidence that the NADW has already freshened significantly (IPCC 2006). 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 whole earth system (Greene *et al.* 2008).

While predictions are available regarding potential effects of climate change globally, it is more difficult to assess the potential effects of climate change over the next few decades on coastal and marine resources on smaller geographic scales, such as the Penobscot River, 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. Warming is very likely to continue in the U.S. over the next 25 to 50 years regardless of reduction in GHGs, due to emissions that have already occurred (NAST 2000). It is very likely that the magnitude and frequency of ecosystem changes will continue to increase in the next 25 to 50 years, and it is possible that the rate of change will accelerate. Climate change can cause or exacerbate direct stress on ecosystems through high temperatures, a reduction in water availability, and altered frequency of extreme events and severe storms. Water temperatures in streams and rivers are likely to increase as the climate warms and are very likely to have both direct and indirect effects on aquatic ecosystems. Changes in temperature will be most evident during low flow periods when they are of greatest concern (NAST 2000). In some marine and freshwater systems, shifts in geographic ranges and changes in algal, plankton, and fish abundance are associated with high confidence with rising water temperatures, as well as related changes in ice cover, salinity, oxygen levels and circulation (IPCC 2007).

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

While debated, researchers anticipate: 1) the frequency and intensity of droughts and floods will change across the nation; 2) a warming of about 0.2^{o}C (0.4°F) per decade; and 3) a rise in sea level (NAST 2000). A warmer and drier climate will reduce stream flows and increase water temperature resulting in a decrease of DO and an increase in the concentration of nutrients and toxic chemicals due to reduced flushing. Sea level is expected to continue rising: during the 20th century global sea level has increased 15 to 20 cm (6-8 inches).

5.2. Species Specific Information on Climate Change Effects

5.2.1. Effects to Atlantic Salmon and Critical Habitat

Atlantic salmon may be especially vulnerable to the effects of climate change in New England, since the areas surrounding many river catchments where salmon are found are heavily populated and have already been affected by a range of stresses associated with agriculture, industrialization, and urbanization (Elliot *et al*. 1998). Climate effects related to temperature regimes and flow conditions determine juvenile salmon growth and habitat (Friedland1998). One study conducted in the Connecticut and Penobscot rivers, where temperatures and average discharge rates have been increasing over the last 25 years, found that dates of first capture and median capture dates for Atlantic salmon have shifted earlier by about 0.5 days/ year, and these consistent shifts are correlated with long-term changes in temperature and flow (Juanes *et al*. 2004). Temperature increases are also expected to reduce the abundance of salmon returning to home waters, particularly at the southern limits of Atlantic salmon spatial distribution (Beaugrand and Reid 2003).

One recent 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 mortality affecting Atlantic salmon occurs in the marine phase, both the temperature and the productivity of the coastal environment may be critical to survival (Drinkwater *et al.* 2003). Temperature influences the length of egg incubation periods for salmonids (Elliot *et al*. 1998) and higher water temperatures could accelerate embryo development of salmon and cause premature emergence of fry.

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

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

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

Humans may also seek to adapt to climate change by manipulating water sources, for example in response to increased irrigation needs, which may further reduce stream flow and biodiversity

(Bates *et al*. 2008).Water extraction is a high level threat to Atlantic salmon, as adequate water quantity and quality are critical for all life stages of Atlantic salmon (NMFS and USFWS 2005). Climate change will also affect precipitation, with northern areas predicted to become wetter and southern areas predicted to become drier in the future (Karl *et al*. 2009). Droughts may further exacerbate poor water quality and impede or prevent migration of Atlantic salmon (Riley *et al*. 2009).

It is anticipated that these climate change effects could significantly affect the functioning of the Atlantic salmon critical habitat. Increased temperatures will affect the timing of upstream and downstream migration and make some areas unsuitable as temporary holding and resting areas. Higher temperatures could also reduce the amount of time that conditions are appropriate for migration (<23 degrees 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.

5.2.2. Shortnose sturgeon

Global climate change may affect shortnose sturgeon in the future. Rising sea level may result in the salt wedge moving upstream in affected rivers. Shortnose sturgeon spawning occurs in fresh water reaches of rivers because early life stages have little to no tolerance for salinity. Similarly, juvenile shortnose sturgeon have limited tolerance to salinity and remain in waters with little to no salinity. If the salt wedge moves further upstream, shortnose sturgeon spawning and rearing habitat could be restricted. In river systems with dams or natural falls that are impassable by sturgeon, the extent that spawning or rearing may be shifted upstream to compensate for the shift in the movement of the saltwedge would be limited. While there is an indication that an increase in sea level rise would result in a shift in the location of the salt wedge, for most spawning rivers there are no predictions on the timing or extent of any shifts that may occur; thus, it is not possible to predict any future loss in spawning or rearing habitat. However, in all river systems, spawning occurs miles upstream of the saltwedge. It is unlikely that shifts in the location of the saltwedge would eliminate freshwater spawning or rearing habitat. If habitat was severely restricted, productivity or survivability may decrease.

The increased rainfall predicted by some models in some areas may increase runoff and scour spawning areas and flooding events could cause temporary water quality issues. Rising temperatures predicted for all of the U.S. could exacerbate existing water quality problems with DO and temperature. While this occurs primarily in rivers in the southeast U.S. and the Chesapeake Bay, it may start to occur more commonly in the northern rivers. Shortnose sturgeon are tolerant to water temperatures up to approximately 28°C (82.4°F); these temperatures are experienced naturally in some areas of rivers during the summer months. If river temperatures rise and temperatures above 28°C are experienced in larger areas, sturgeon may be excluded from some habitats.

Increased droughts (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 spring may also expose eggs and larvae in rearing habitats. If a river becomes too shallow or flows become intermittent, all shortnose sturgeon life stages, including adults, may become susceptible to strandings. Low flow and drought conditions are also expected to cause additional water quality issues. Any of the conditions associated with climate change are likely to disrupt river ecology causing shifts in community structure and the type and abundance of prey. Additionally, cues for spawning migration and spawning could occur earlier in the season causing a mismatch in prey that are currently available to developing shortnose sturgeon in rearing habitat; however, this would be mitigated if prey species also had a shift in distribution or if developing sturgeon were able to shift their diets to other species.

5.2.3. Atlantic sturgeon

Global climate change may affect all DPSs of Atlantic sturgeon in the future; however, effects of increased water temperature and decreased water availability are most likely to effect the South Atlantic and Carolina DPSs. Rising sea level may result in the salt wedge moving upstream in affected rivers. Atlantic sturgeon spawning occurs in fresh water reaches of rivers because early life stages have little to no tolerance for salinity. Similarly, juvenile Atlantic sturgeon have limited tolerance to salinity and remain in waters with little to no salinity. If the salt wedge moves further upstream, Atlantic sturgeon spawning and rearing habitat could be restricted. In river systems with dams or natural falls that are impassable by sturgeon, the extent that spawning or rearing may be shifted upstream to compensate for the shift in the movement of the saltwedge would be limited. While there is an indication that an increase in sea level rise would result in a shift in the location of the salt wedge, at this time there are no predictions on the timing or extent of any shifts that may occur; thus, it is not possible to predict any future loss in spawning or rearing habitat. However, in all river systems, spawning occurs miles upstream of the saltwedge. It is unlikely that shifts in the location of the saltwedge would eliminate freshwater spawning or rearing habitat. If habitat was severely restricted, productivity or survivability may decrease.

The increased rainfall predicted by some models in some areas may increase runoff and scour spawning areas and flooding events could cause temporary water quality issues. Rising temperatures predicted for all of the U.S. could exacerbate existing water quality problems with DO and temperature. While this occurs primarily in rivers in the southeast U.S. and the Chesapeake Bay, it may start to occur more commonly in the northern rivers. Atlantic sturgeon prefer water temperatures up to approximately 28°C (82.4°F); these temperatures are experienced naturally in some areas of rivers during the summer months. If river temperatures rise and temperatures above 28°C are experienced in larger areas, sturgeon may be excluded from some habitats.

Increased droughts (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 spring may also expose eggs and larvae in rearing habitats. If a river becomes too shallow or flows become intermittent, all Atlantic sturgeon life stages, including adults, may become susceptible to strandings or habitat restriction. Low flow and drought conditions are also expected to cause additional water quality issues. Any of the conditions associated with climate change are likely to disrupt river ecology causing shifts in community structure and the type and abundance of prey. Additionally, cues for spawning migration and spawning could occur earlier in the season causing a mismatch in prey that are currently available to developing sturgeon in rearing habitat.

6. EFFECTS OF THE ACTION

This section of an Opinion assesses the direct and indirect effects of the proposed action on threatened and endangered species or critical habitat, together with the effects of other activities that are interrelated or interdependent (50 CFR 402.02). Indirect effects are those that are caused later in time, but are still reasonably certain to occur. Interrelated actions are those that are part of a larger action and depend upon the larger action for their justification. Interdependent actions are those that have no independent utility apart from the action under consideration (50 CFR 402.02). The trapping of Atlantic salmon by MDMR will occur at the Lockwood fish trap and Brunswick fishway after the proposed action has occurred. This activity would not occur but for the existence of the fish traps. However, as this activity has already been authorized under a research and recovery blanket permit with USFWS (permit number 697823); its effects will not be addressed in this Opinion. We have not identified any other interrelated or interdependent actions.

These activities will affect the GOM DPS of Atlantic salmon, shortnose sturgeon, the GOM DPS of Atlantic sturgeon and the New York Bight DPS of Atlantic sturgeon as well as critical habitat designated from the GOM DPS of Atlantic salmon. The sections that follow present our analysis of the following: (1) construction of fish passage facilities; (2) hydroelectric operations under the terms of the ISPP; and (3) implementation of upstream and downstream fish passage efficiency and survival studies required by the proposed ISPP.

6.1. Effects of Fishway Construction

Effects of the construction of fishways at the Lockwood, Shawmut, and Weston Projects are likely to be restricted to the habitat immediately downriver each of these Projects. Shortnose and Atlantic sturgeon use habitat downstream of the Lockwood Project; but as they are not passed at the facility it is not anticipated that they would be present in the habitat downstream of the Shawmut and Weston Projects. Construction at the Lockwood Project itself is not anticipated to require in-water work (R. Richter, Brookfield Renewable Power, 2013). Therefore, shortnose and Atlantic sturgeon are not anticipated to be exposed to the effects of construction.

The mainstem Kennebec River serves as an important migratory corridor for adult Atlantic salmon migrating upriver to spawning habitat between May and October, as well as to outmigrating smolts between April and June and outmigrating kelts in early winter and spring. Potential effects associated with in-water construction generally include inhibiting fish passage, increasing noise and suspended sediment levels, causing direct injury and mortality during construction, and potentially spilling toxic substances (e.g., equipment leaks). Interim upstream fish passage at the Lockwood Project involves trapping and trucking pre-spawn Atlantic salmon upriver to spawning and rearing habitat in the Sandy River. Therefore, no pre-spawn Atlantic salmon will be in the vicinity of the Shawmut and Weston Projects at the time of construction. To minimize the effects to outmigrating smolts and kelts all in-river construction will occur outside of the outmigration period. Therefore, as construction at Lockwood will not involve any in-water work, it is expected that construction associated with the proposed ISPP will not affect listed sturgeon and salmon in the action area.

Atlantic Salmon Critical Habitat

Proposed construction activities will temporarily reduce the status of several habitat indicators relative to Atlantic salmon critical habitat. We expect these activities to cause temporary adverse effects to the migratory PCE of critical habitat by reducing water quality due to increased turbidity and the filling of habitat. The habitat in the Kennebec River does not currently function for upstream migration of pre-spawn adult Atlantic salmon due to the lack of fish passage facilities at all of the Projects upstream of Lockwood. However, the habitat does function as a migration corridor for outmigrating smolts and kelts in the spring as they make their way to the estuary. Construction will be timed so that in-water effects to the habitat (turbidity, noise and the presence of temporary fill) will not coincide with the smolt outmigration period.

The construction of the fishways will place temporary and permanent fill below the ordinary high water (OHW) line in the Kennebec River. It is anticipated that the amount of temporary and permanent fill will not exceed 500 square feet at either the Shawmut or Weston Projects. As all fill will be placed and removed in the Kennebec River outside of the spring outmigration period and as adults cannot access the Projects, it is anticipated that construction activities will have an insignificant effect on the migration PCE. However, the placement of permanent fill will negatively affect the functioning of the habitat at these Projects by precluding the use of the habitat for migration. However, as the permanent fill associated with the new structures will occupy less than half of one habitat unit at the Shawmut and Weston Projects, it is not anticipated that it will alter the functioning of the habitat for Atlantic salmon.

6.2. Effects of Hydroelectric Operations

Hydroelectric dams can impact Atlantic salmon, shortnose sturgeon and Atlantic sturgeon through habitat alteration, fish passage delays, entrainment in turbines and impingement on screens and/or racks. Currently, the Lockwood, Shawmut, Weston, and Brunswick, and Lewiston Falls Projects are operated pursuant to the terms and conditions of existing FERC licenses. Existing FERC license articles require that all of the Projects except Lewiston Falls be operated in a run-of-river mode with minimal impoundment fluctuations. The Lewiston Falls Project is licensed to operate with up to four feet of impoundment fluctuation to allow for peaking under normal conditions.

6.2.1. Atlantic salmon

The modified licenses proposed by FERC implement protection measures described in the ISPP to minimize the effect of operations of the licensee's hydroelectric facilities on migrating Atlantic salmon. The ISPP involves 1) the sequential construction of upstream fishways at the Lockwood, Shawmut, and Weston Projects; 2) downstream survival studies at the Lockwood, Shawmut, Weston, and Brunswick Projects; and 3) upstream passage studies at the Lockwood and Brunswick Projects. The studies conducted at the Projects are a component of an adaptive management strategy that will be implemented by the licensee in consultation with us to maximize the survival of outmigrating smolts and kelts and the passage success of upstream migrating pre-spawn salmon. Although no performance standards have been proposed as part of the ISPP, it is expected that high survival and passage rates will be required under the terms of the final SPP. Since we cannot accurately predict the survival of Atlantic salmon achieved through each of the individual protection measures, it will be assumed that survival and passage efficiency at these Projects will at a minimum be maintained at existing levels throughout the interim period, but most likely will improve as a result of adaptive management.

6.2.1.1. Upstream Passage Effects

To complete their upstream migration, all pre-spawn Atlantic salmon in the Androscoggin and Kennebec Rivers must navigate past hydroelectric projects via fishways. Fishways collect motivated fish into human-made structures that allow them to proceed in their migration. These fish are necessarily crowded together into a narrow channel or trap, which exposes them to increased levels of injury and delay, as well as to stress from elevated water temperatures, energetic exhaustion and disease. Forcing fish to alter their migratory behavior and potentially exposing them to the corresponding stress and injury negatively affects 100% of the Atlantic salmon motivated to migrate past a hydroelectric project.

Except for the Lockwood Project, all of the Projects on the Kennebec River currently lack upstream passage facilities for diadromous fish. The construction of fishways at the Lockwood, Hydro-Kennebec, Shawmut, and Weston Projects will improve access to approximately 70,000 habitat units in the Merrymeeting Bay SHRU. In addition to the 37,105 habitat units available in the Sandy River, the new upstream fishways will improve access to 32,739 habitat units between the Hydro-Kennebec Project and the impassable dams in Madison (Wright *et al.* 2008). This habitat is primarily located in Bombazee Ripps, Wesserunsett Stream and Carrabassett Stream. The upstream fishways at the Lockwood, Shawmut, and Weston Projects will become operational in 2016, 2018, and 2020, respectively. In addition, a volitional upstream fish lift will become operational at the Hydro-Kennebec Project in 2016. Salmon will need volitional passage at all four of these dams in order to access the spawning and rearing habitat in the Sandy River. Therefore, until the fishway at the Weston Project is operational, it is anticipated that pre-spawn Atlantic salmon will not have access to mainstem habitat in the Kennebec River upriver of the Lockwood Project. The existing trap and truck operation provides interim upstream passage for Atlantic salmon by transporting them above the currently impassable dams to the habitat in the Sandy River.

Between 2013 and 2020, Atlantic salmon will continue to be trucked from the Lockwood Project to the Sandy River by the MDMR. As such, upstream migrating Atlantic salmon would continue to be denied volitional access to upstream spawning habitat by the licensee's Projects on the Kennebec until 2020. While trap and truck fish passage can successfully move migrants to upstream areas, trap and truck operations to transport migratory fish species can result in adverse impacts including injury, disorientation, disease and mortality, delay in migration, and interruption of the homing instinct, which can lead to straying (OTA 1995). Other disadvantages to trap and truck passage include: holding and handling stress, reduced passage by other species that will not enter traps, and the need for long-term, guaranteed operational funding for dedicated biological staff, equipment, supplies, vehicles and tanks, etc. Therefore, we assume that all upstream migrating adult Atlantic salmon will be affected by trap and truck operations on the Kennebec River over the interim period. Since 2006, adult Atlantic salmon returns to the Kennebec River have ranged from 5 to 64 fish (average = 26). We expect these relatively low numbers of returning adults to continue throughout the duration of the ISPP.

The handling and trucking of the Atlantic salmon that enter the fish trap at Lockwood will be conducted by MDMR, which holds a section 10(a)(1)(A) research permit under the USFWS's regional endangered species blanket permit (No. 697823) that authorizes the handling of listed Atlantic salmon. Therefore, the effects of handling and transporting are not considered as part of the proposed action. However, all migrating adult Atlantic salmon in the mainstem will be affected by the Project as they will be trapped and potentially delayed by the dam and its fish passage facilities.

No upstream passage studies have been conducted at the Lockwood Project so it is unknown what proportion of salmon are able to locate and utilize the existing fish trap. A review of the literature and passage efficiencies at dams in Maine suggests that passage rates at lifts tend to be low. A meta-analysis conducted by Noonan *et al.* (2012) indicates that the average passage efficiency of salmonids at five fish lifts was approximately 35%. A study at the Golfech-Malause hydroelectric complex on the River Garonne in France determined that only 47% of motivated Atlantic salmon successfully used the fish lift (Croze *et al.* 2008). Hydropower dams in Maine have also shown similarly low success rates at passing salmon. Fish lifts exist at the Cataract and Skelton Projects on the Saco River in Maine. Based on trap counts between 2002 and 2012, an average of 54% (range: 20%-100%) of Atlantic salmon that were passed at the Cataract Project were passed at the Skelton Project, the next upstream dam on the river (FPL Energy 2007-2013). Likewise, a telemetry study conducted on the Androscoggin River indicated that only 43% of the salmon motivated to migrate upriver of the Brunswick Project successfully use the fish lift at the Pejepscot Project, the next upstream dam on the River (MDMR 2012). As many of the Atlantic salmon that migrate in the Androscoggin and Saco Rivers have strayed from other rivers, it is likely that the observed passage rates are affected by a lack of motivation to migrate. However, we consider the passage rates at these fishways as the best available information on fish lift passage effectiveness for Atlantic salmon. The average passage rate at these eight Projects is approximately 40%. We assume, therefore, that at least 40% of Atlantic salmon motivated to migrate upstream of the Lockwood Project during the proposed interim period are trapped successfully.

Although no studies have looked directly at the fate of fish that fail to pass through Lockwood's upstream fish passage facilities, we convened an expert panel in 2010 to provide the best available information on the fate of these fish at fishways on the Penobscot River. The panel was comprised of state, federal, and private sector Atlantic salmon biologists and engineers with expertise in Atlantic salmon biology and behavior at fishways. The group estimated a baseline mortality rate of 1% for Atlantic salmon that fail to pass a fishway at a given dam on the Penobscot River (NMFS 2010). Therefore, assuming a similar effect occurs at the fish trap at Lockwood, 1% of the Atlantic salmon that fail to pass the Project may be subject to mortality. Therefore, it is assumed that of the Atlantic salmon that are motivated to pass the Lockwood Project, 40% will pass successfully, 0.6% (1% x 60% failing to pass) will be killed, and 59.4% (99% x 60% failing to pass) will either spawn in downstream habitat or return to the ocean without spawning.

Androscoggin River

The vertical slot fishway at the Brunswick Project was designed to pass anadromous fish including Atlantic salmon, and consequently it provides access for adult Atlantic salmon to habitat upstream of the Project. With passage facilities also at the Pejepscot and Worumbo Projects, Atlantic salmon can migrate up to impassable barriers 1) in the main stem to the next upstream dam at Lewiston Falls in Lewiston, 2) to Lower Barker Mills Dam in the Little Androscoggin River in Auburn, and 3) to Lower Dam (a.k.a. Farwell) in the Sabattus River in Lisbon (MDMR 2010).

Atlantic salmon are known to successfully utilize the upstream fishway at the Brunswick Project. However, no studies have been conducted to determine the passage efficiency of the fishway for Atlantic salmon. A similar fishway at the West Enfield Project on the Penobscot River has been found to be 88-89% effective at passing upstream migrating Atlantic salmon (Shepard 1995). However, Noonan *et al.* (2012) found that not all vertical slot fishways are as successful at passing salmonids. In a meta-analysis of fishway efficiency at dams, they determined that the average passage efficiency of three pool and slot type fishways was 52% for salmonids. Averaging the efficiencies of these four projects would suggest that the Brunswick fishway is at least 61% efficient at passing motivated pre-spawn Atlantic salmon.

The conclusions from the upstream passage expert panel that we convened in 2010 can be used to estimate mortality of pre-spawn adults at the Brunswick Project. Assuming a similar effect occurs at Brunswick as occurs in the Penobscot, 1% of the Atlantic salmon that fail to pass the Project, may be subject to mortality. Therefore, it is assumed that of the Atlantic salmon that are motivated to pass the Brunswick Project, 61% will pass successfully, 0.4% (1% x 39% failing to pass) will be killed, and 38.6% (99% x 39% failing to pass) will either spawn in downstream habitat, migrate to the Kennebec River, or return to the ocean without spawning.

Upstream Impediments to Passage

The Androscoggin River upriver of the Lewiston Falls Dam is currently inaccessible to anadromous fish because there is no fish passage at the Project. This unoccupied habitat is not designated as critical habitat for Atlantic salmon as it was not deemed essential for the recovery of the species (50 CFR Part 226). However, impassable dams exclude Atlantic salmon from approximately 80,000 units of spawning and rearing habitat within the Androscoggin River (NMFS 2009b), or 83% of the potential rearing habitat within the Androscoggin drainage. No upstream passage facilities exist at the Lewiston Falls Project, and the licensee is not proposing to construct any during the seven year ISPP.

The Deer Rips Dam is 4.40 kilometers upriver of the Lewiston Falls Project and is the next upstream barrier to migrating fish. The approximately one square kilometer of habitat between the two projects has been made inaccessible to Atlantic salmon by the lack of passage at the Lewiston Falls Project. The habitat is impounded and is, therefore, not currently suitable as rearing or spawning habitat. This reach of river is not currently stocked with Atlantic salmon so there should be no homing of salmon to it.

The presence of the dam may force upstream migrating Atlantic salmon approaching the dam to stray into downstream habitat. It may also lead to some fish being significantly delayed downstream of the Project as they seek a path past the dam. Between 2003 and 2012, an average of two salmon a year succeeded in passing the Worumbo Project. Therefore, it is expected that very few salmon would be in the habitat immediately downstream of the Lewiston Falls Project.

Stranding

It is possible that operation of the Lewiston Falls or Lockwood Projects could affect migrating Atlantic salmon, particularly during flashboard replacement and/or during and after spill events, by inadvertently trapping or stranding them in the various pools downstream of the Projects. To reduce the potential effects of stranding on Atlantic salmon and other fish species, the licensee will monitor downstream pools after significant spill events and during flashboard replacement and collect any stranded Atlantic salmon and release them back into the river. The licensee will record its monitoring actions following each significant spill event.

The addition of rubber dams along the spillways at the Lewiston Falls Projects are expected to help reduce the potential impacts to Atlantic salmon in two ways: 1) by allowing better control of the location of spill, and 2) by reducing the time it currently takes to replace failed flashboard sections. Combined, these modifications are anticipated to reduce the potential for stranding of Atlantic salmon in the various pools in and around Great Falls.

The licensee has developed a draft Atlantic Salmon Rescue and Handling Plan for the Lewiston Falls Project, and has proposed to monitor ledge areas in the Lockwood bypass reach during flashboard replacement. The licensee has proposed to implement the rescue plan at Lewiston Falls between May 1 and July 31 annually. In a telemetry study conducted in 2011, one of the three Atlantic salmon that passed the Worumbo Project was documented to move back and forth between the area downstream of Lower Barker Dam on the Little Androscoggin and just downstream of Lewiston Falls in the mainstem between October 14 and December 12. Given this information, the Atlantic salmon Rescue and Handling Plan should be implemented between May 1 and December 31 if salmon are known to be in the area.

The licensee has been surveying the ledges downstream of the Lewiston Falls Dam for the last four years (2009-2012) and has not detected any stranded salmon (R. Richter, Brookfield Renewable Power, pers. comm., 2013). Regardless, as an average of two adult salmon pass the Worumbo Project every year, Atlantic salmon could be present in the habitat downstream of Lewiston Falls and, given the flow and ledge conditions could become stranded in the pools downstream of the Project. Given that no salmon have been stranded over the last four years, it is assumed that no more than one Atlantic salmon will become stranded over the seven year interim period. The licensee monitors for salmon in the Lockwood bypass reach annually during flashboard replacement, and occasionally have had to rescue up to two fish a year due to dewatering of the reach (R. Richter, Brookfield Renewable Power, pers. comm., 2013). Therefore, it is assumed that two Atlantic salmon a year could become stranded at the Lockwood Project. Any stranded fish could potentially be injured due to abrasions caused with contact with ledge, and could be severely stressed due to the effects of stranding, handling, and transport. Given the implementation of the handling plan, this injury and stress is not likely to be long lasting and should have no effect on the survival of the fish.

6.2.1.2. Downstream Passage Effects

Under the proposed action, the Lockwood, Shawmut, Weston, and Brunswick Projects could potentially affect any outmigrating juvenile salmon and kelts by: 1) injury and mortality associated with entrainment through project facilities, 2) delayed outmigration influencing outmigrating timing, 3) potential to increase predation on outmigrating juveniles in project reservoirs, and 4) increasing stress levels, which leads to a subsequent decrease in saltwater tolerance. The Projects' impoundments would continue to alter water quality, stream channel migratory routes, and the timing and behavior of outmigrating fish.

The Lockwood, Shawmut, Weston, and Brunswick Projects all operate with some form of downstream fish passage and protection for outmigrating smolts and kelts, including reduced spacing of trashracks and guidance booms for protection against turbine entrainment and sluice gates or other openings for downstream passage. Since none of the fishways are 100% effective, turbine entrainment, impingement and migratory delays of Atlantic salmon are expected at each dam. Therefore, continuing to operate the Lockwood, Shawmut, Weston, and Brunswick Projects will affect downstream movements of Atlantic salmon in the Kennebec and Androscoggin River watersheds.

Atlantic salmon smolts

Site-specific mortality (initial; 1-hr and delayed; 48-hr) rates for Atlantic salmon smolts passed via turbine units were not available for the Weston, Shawmut, Lockwood or Brunswick projects. As such, the licensee has conducted an assessment of Atlantic salmon smolt and kelt survival in the BA submitted to FERC. Estimates for passage survival of Atlantic salmon smolts through Francis, Kaplan and propeller units were developed based on existing empirical studies conducted at other hydroelectric projects with similar characteristics. Average turbine injury and survival rates varied among projects due to differences in turbine types as well as their differing site characteristics. Survival estimates for turbine passage were also generated using the Advanced Hydro Turbine model developed by Franke *et al.* (1997). The Franke blade strike model predicts the probabilities of leading edge strikes, considered the primary mechanism of mortality when fish pass through turbines (Eicher Associates Inc. 1987, Cada 2001). Turbine passage survival was calculated using site-specific turbine parameters and for a range of body lengths (5-9 inches) considered to be representative of outmigrating salmon smolts in Maine rivers (NRC 2004, Fay *et al.* 2006).

Whole station smolt survival estimates for each of the projects were calculated by integrating river flows, Project operating flows, spill effectiveness, downstream bypass effectiveness rates, turbine entrainment rates, and spillway and turbine survival rates. Three models intended to estimate whole station survival of smolts passing each Project were constructed using the available empirical and modeled survival estimates for both spill and turbine passage (Table 17):

1. Initial Survival Rate Model (Model A): Spill survival based on 1-hr empirical survival

data and turbine survival based on 1-hr empirical survival data.
2. Delayed Survival Rate Model (Model B): Spill survival based on 48-hr empirical survival data and turbine survival based on 48-hr empirical survival data.
3. Delayed/Calculated Survival Rate Model (Model C): Spill survival based on 48-hr empirical survival data and turbine survival based on Franke estimates.
4. Delayed/Calculated Survival Rate Model (Model C*): Same analysis as Model C, but the rates have been updated to incorporate the results of a downstream passage efficiency study conducted in 2012.

Table 17. Whole Station Survival Estimates for Atlantic Salmon Smolts Passing the Weston, Shawmut, Lockwood and Brunswick Projects under Median Flow Conditions (50% Flow Exceedence)

Project	Model A	Model B	Model C	Model C*
Weston	93%	92%	90%	94%
Shawmut	91%	90%	90%	95%
Lockwood	94%	93%	92%	94%
Brunswick	95%	93%	93%	93%

As Model C* includes the most recent data on the passage efficiency of the interim downstream fishways, and incorporates a level of delayed mortality (48-hours), it is assumed that it is the best available estimate of downstream survival at these Projects. Therefore, for the interim period downstream survival at median flows is anticipated to be at least 94%, 95%, 94%, and 93% at the Weston, Shawmut, Lockwood, and Brunswick Projects, respectively. These survival rates will vary based on the amount of water passing each Project. In their draft BA, the licensee estimated a correction factor to account for different flow exceedence levels at each Project (Table 18). Although these estimates did not incorporate the updated passage efficiency data (the Model C* condition), it is assumed that the variation is on the order of what has been estimated for Model C.

Table 18. Impacts Due to Variation in the Monthly River Flow to the Whole Station Survival Estimates for Atlantic Salmon Smolts Passing the Weston, Shawmut, Lockwood and Brunswick Projects.

			Percent of Time Flow is Exceeded			
Project	Model	***BASE*** [1]	**10%**	**25%**	**75%**	**90%**
Weston	A	93%	2%	1%	-2%	-1%
	B	92%	3%	2%	-1%	0%
	C	90%	4%	3%	-2%	-2%
Shawmut	A	91%	3%	2%	-2%	-2%
	B	90%	4%	2%	-2%	-2%
	C	90%	4%	2%	-1%	-1%
Lockwood	A	94%	2%	1%	-1%	-1%
	B	93%	2%	1%	-1%	-2%
	C	92%	2%	2%	-2%	-2%

	A	95%	1%	0%	0%	0%
Brunswick	B	93%	2%	1%	0%	0%
	C	93%	2%	1%	0%	0%

A desktop analysis provides an estimate of survival and does not assess potential impacts resulting from migratory delays, non-lethal injuries, or latent death. Therefore, actual survival of smolts is most likely less than what was reported in the FERC's BA. This conclusion is supported by the analyses conducted by Randy Bailey and Jeffrey Hutchings in their declarations to the US District Court in Maine in March of 2013. In his declaration, Bailey (2013) enumerated the reasons why these estimates likely overestimate actual survival through the Weston, Shawmut, Lockwood and Brunswick Projects. Among the reasons were:

- The Franke Model was designed for use with Kaplan turbines and, thus, likely underestimates the effect of the Francis turbines at these projects;
- The estimates are based on a range of fish lengths that is not necessarily representative of what has been found in the Kennebec River watershed; and
- The estimates do not account for mortality that occurs more than 48-hours after smolt passage.

For these reasons, we expect that the survival estimates included in FERC's BA may overestimate smolt survival through these Projects. The smolt studies that will be conducted by the licensee between 2013 and 2015 will determine actual survival rates at the Projects.

The potential for delays in the timely passage of smolts encountering hydropower dams is evident in some tracking studies on the Penobscot. At the Mattaceunk Dam, the average time needed for hatchery smolts to pass the dam, after being detected in the forebay area, was 15.6 hours (range 0 to 72 hours), 39.2 hours (range 0 to 161 hours), 14.6 hours (range 0 to 59.4 hours) and 30 hours (range 0.2 to 226 hours) in four different study years (GNP 1995, GNP 1997, GNP 1998, GNP 1999). At the West Enfield Dam, the median delay was 0.86 hours (range 0.3 to 49.7 hours) for hatchery smolts in 1993 (BPHA 1993), and approximately 13 hours (range 0.2 to 102.9 hours) for wild smolts in 1994 (BPHA 1994). At the Orono Dam, the median delay between release and passage of smolts was 3.4 hours (range 0.6 to 33.3 hours) in 2010 (Aquatic Science Associates, Inc 2011). While these delays can lead to direct mortality of Atlantic salmon from increased predation (Blackwell *et al.* 1998), migratory delays 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 effects (McCormick *et al.* 1999). Late migrants lose physiological smolt characteristics due to high water temperatures during spring migration (McCormick *et al.* 1999). 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 may reduce smolt survival (McCormick *et al.* 1999).

Atlantic salmon kelts

Very limited studies of kelt passage have been conducted on the Kennebec or Androscoggin rivers. Kelt studies conducted in the lower Penobscot River documented that most kelts passed the dams in spilled water, typically over the spillways, but also through gates and sluices (Hall and Shepard 1990). Observation of the initial approach of kelts at the Veazie and Milford projects reflected the distribution of flow, whereby the proportion of kelts that approached spillways was correlated with spillway flow (Hall and Shepard, 1990). Shepard (1989) made a similar finding at the confluence of the Stillwater Branch and the mainstem Penobscot, where kelts followed routes in approximate proportion to flow in the two channels.

Lacking site specific kelt passage data on the Androscoggin and Kennebec rivers, the licensee conducted a detailed assessment of the mortality potential for outmigrating Atlantic salmon kelts for the Weston, Shawmut, and Lockwood Projects on the Kennebec River and the Brunswick Project on the Androscoggin River. At each individual project, downstream passage of outmigrating kelts must occur via one of three routes:1) unregulated spillage, 2) permanent or interim downstream bypass facilities, or 3) the Project turbines. These three potential routes of passage were considered and incorporated into the whole station kelt survival model for each project. Prior to construction of the whole station kelt survival models, information related to kelt run timing, spill effectiveness, downstream bypass effectiveness, trash rack screening, and survival rates for kelts passed via spill and turbine units at each project was obtained.

Site-specific injury and mortality rates for Atlantic salmon kelts passed via unregulated spill or via a downstream bypass were not available for the Weston, Shawmut, Lockwood, or Brunswick projects. As a result, estimates for passage survival of Atlantic salmon smolts through project spillways and downstream bypasses, developed based on existing empirical studies conducted at other hydroelectric projects with similar characteristics, were used as a surrogate. Since the principal causes of potential injury and mortality for fish passed through either a spillway or bypass sluice are shear forces, turbulence, rapid deceleration, terminal velocity, impact against the base of the spillway, scraping against the rough concrete face of the spillway and rapid pressure changes, empirical studies related to spillway and bypass survival were pooled into a single data set. A delayed (48-hr) survival rate for Atlantic salmon kelts passed via spill of 96.3% was assumed for the generation of whole station kelt survival estimates for each of the four projects.

Estimates for passage survival of Atlantic salmon kelts through Francis, Kaplan and propeller units were made using the Advanced Hydro Turbine model developed by Franke *et al.* (1997). The Franke blade strike model predicts the probabilities of leading edge strikes, considered the primary mechanism of mortality when fish pass through turbines (Eicher Associates Inc. 1987, Cada 2001). Turbine passage survival was calculated using site-specific turbine parameters and for a range of body lengths considered to be representative of outmigrating salmon kelts in Maine rivers as well as not physically excluded by project trashracks. The average survival of salmon kelts passing through a particular turbine type was determined by averaging the modeled survival estimates for each similar type unit at a project.

The licensee calculated whole station kelt survival for each of the Projects by integrating river flows, project operating flows, spill effectiveness, downstream bypass effectiveness rates, turbine entrainment rates and spillway and turbine survival rates. The estimates of whole station kelt survival at Weston, Shawmut, Lockwood, and Brunswick Projects under median flow conditions (i.e. the value with 50% flow exceedence) are 73%, 89%, 88%, and 85%, respectively. As with smolts, whole station kelt survival increases with increasing river flow (i.e. those exceeded only

10 or 25% of the time) as a greater number of kelts are passed via spill. In contrast, when the monthly flow rate decreases to less than median flow conditions (i.e., those exceeded 75 and 90% of the time), a decrease in whole station kelt survival is observed.

6.2.2. Atlantic Salmon Critical Habitat

As discussed in Section 3.2, critical habitat for Atlantic salmon has been designated in the Kennebec and Androscoggin Rivers including the sections of river in the vicinity of the Lockwood, Shawmut, Weston, and Brunswick Projects. Within the action area of this consultation, the PCEs for Atlantic salmon include: 1) sites for spawning and rearing; and, 2) sites for migration (excluding marine migration). The analysis presented in Section 3 shows several habitat indicators are not properly functioning, and biological requirements of Atlantic salmon are not being met in the action area. We expect that the Projects considered in this Opinion will continue to harm these already impaired habitat characteristics. We expect the continued operations of these Projects to cause adverse effects to some essential features of critical habitat, including water quality, substrate, migration conditions, and forage in a similar manner as present in the environmental baseline. However, designated critical habitat in the Kennebec and Androscoggin River watersheds is anticipated to improve for Atlantic salmon with the construction and operation of permanent upstream and downstream fishways.

The licensee has proposed to provide upstream passage facilities at the Lockwood, Shawmut, and Weston Projects, which will significantly improve migration habitat for pre-spawn Atlantic salmon. In addition, the KHDG Agreement requires that permanent downstream fishways be operational at the same time as the upstream fishways. To that end, the existing downstream passage facilities will be studied as part of the proposed ISPP, and will be improved upon as necessary to achieve the high levels of survival that would be expected of a "permanent" downstream fishway. This will improve the migration habitat for Atlantic salmon smolts and kelts. Table 19 below summarizes the condition of essential features of Atlantic salmon critical habitat following implementation of the ISPP at the Lockwood, Shawmut, Weston, and Brunswick Projects.

Table 19. Atlantic salmon critical habitat essential features following the implementation of the proposed ISPP.

Pathway/Indicator	Life Stages Affected	PCEs Affected	Effect	Population Viability Attributes Affected
Access to Historical Habitat	Adult, smolt, juvenile	Migration	Improved upstream passage will reduce delays to spawning habitat. Improved downstream passage will reduce direct and delayed mortality of smolts and kelts	Adult abundance and productivity

The Lewiston Falls Project is licensed to operate with up to four feet of impoundment fluctuation to allow for peaking under normal conditions. No studies have been conducted to determine the effects of peaking at Lewiston Falls on downstream habitat. As there is minimal spawning and rearing habitat in the mainstem of the Androscoggin River below the project, it is anticipated that fluctuating water levels will only effect the migration PCE for Atlantic salmon. The current minimum flow of 1,430 cfs approximates the USFWS' New England Aquatic Base Flow (ABF). The ABF, which equates to the median August flow, is intended to represent limiting water quality and quantity conditions for aquatic life (USFWS 1999). According to USFWS, the ABF method establishes baseline flow for the protection and propagation of aquatic life. Therefore, flows lower than ABF may not be suitable for fish protection and propagation. Since the minimum flow requirement of 1,430 cfs at Lewiston Falls equates to the ABF, we would not expect Atlantic salmon passage impediments in the reach of river downstream of the Lewiston Falls Project. However, given the potential for effects the licensee should conduct a flow demonstration assessment during this interim period to document the effects of peaking on the availability and quality of downstream habitats.

6.2.3. Shortnose and Atlantic Sturgeon

It is believed that prior to dam construction, shortnose and Atlantic sturgeon ranged as far as the site of the Lockwood Project on the Kennebec River and the Brunswick Project on the Androscoggin River (Houston *et al*. 2007). We believe, therefore, that both species currently can access the entirety of their historic mainstem habitat in these two rivers. However, as described previously, it is expected that both species could be present downstream of the Brunswick and Lockwood Project at certain times of year and, therefore, could be affected by Project operation. Operations could directly affect the species due to 1) potential stranding in the downstream pools during the maintenance and /or replacement of flashboards in the spring, 2) entrapment in fishways, and 3) entrainment in the units when they are shut down and dewatered for annual maintenance (Brunswick only). In addition to these direct effects, the operation of the Brunswick and Lockwood Projects may affect suitable spawning habitat, flow fluctuations, and water quality in the Rivers.

As discussed previously, spawning has been documented downstream of both the Brunswick and Lockwood Projects. In the Kennebec River, spawning of shortnose and Atlantic sturgeon has been documented primarily downstream of Gardiner, approximately 20 miles downstream of the Lockwood Project. In the Androscoggin River, spawning has been documented approximately 500 meters downstream of the Brunswick Project. Both Projects operate as run of river facilities, which minimizes the scouring of habitats and the likelihood of pulsed discharges that could result in the stranding of adult or early life stage Atlantic and shortnose sturgeon. Based on this, we do not expect that operations of Lockwood and Brunswick will affect the ability of shortnose or Atlantic sturgeon to spawn successfully in the vicinity of these Projects or that the operation of these projects will affect the successful development of early life stages of shortnose or Atlantic sturgeon that may be present in the action area.

6.2.3.1. Direct Effects

Stranding

Once a year, the impoundments of the Lockwood and Brunswick Projects are lowered to a point where the flashboards can safely be replaced, resulting in a short period (a few hours) of receded flows downstream. There is potential during these low flow periods for sturgeon to become stranded in pools, as evidenced by the capture of a shortnose sturgeon in a pool at the base of the Lockwood Project on May 19, 2003. While no sturgeon have been documented in the Lockwood pools since 2003, and none have ever been documented in the ledges below the Brunswick Dam, they have access to both Projects, and could be in the action area at the time of flashboard maintenance (April-June). As described previously, there is a ledge drop at the outlet of the large pool downstream of the Brunswick spillway that likely precludes sturgeon from accessing the ledges near the spillway under most conditions. However, there is still a small chance that an adult could make it into the pool at high tide and become stranded under low flow conditions. It is expected that these falls are impassable to juvenile sturgeon.

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

Without the development of a rescue procedure for the Lockwood and Brunswick Projects, shortnose and Atlantic sturgeon stranded in the pools at the base of the dams would likely suffer injuries and possibly be killed. The licensee has been implementing a sturgeon handling plan at Lockwood since 2005 for shortnose sturgeon. In the proposed Sturgeon Handling and Protection Plan, they have proposed to implement the plan for Atlantic sturgeon, as well. There has not been an approved plan in place for either species of sturgeon at the Brunswick Project. Therefore, the implementation of a Sturgeon Handling and Protection Plan will reduce the likelihood of injury and will eliminate this potential source of mortality in the Androscoggin River. While the capture of shortnose and Atlantic sturgeon in nets and the subsequent transport and handling may stress the fish, this stress is not likely to be long lasting and should have no effect on the survival of the fish. Based on the occurrence of one shortnose sturgeon stranding in the bypass reach at the Lockwood Project in the last ten years (2003-2013), we anticipate that one shortnose sturgeon is likely to be stranded every ten years at each Project. Likewise, no more than one Atlantic sturgeon is likely to become stranded every ten years at the Brunswick and Lockwood Projects. The implementation of a handling plan and the use of proper handling techniques will minimize the potential for injury. No mortality is expected to occur due to the short time period fish will be caught in the pools and the implementation of proper handling techniques.

Upstream Passage Facilities

The fishways at the Lockwood and Brunswick fishways will be operational during the time of year (April - June) when shortnose and Atlantic sturgeon are likely to be present downstream. 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 2006 when the fish lift was constructed at the Lockwood Dam, no shortnose or Atlantic sturgeon have been captured. Similarly, no sturgeon have ever been detected in the fishway at the Brunswick Project. Data on the effects of the fish lift at the Holyoke Hydroelectric Project on the Connecticut River suggest that fish lifts that successfully attract other species (i.e, shad, salmon etc.) do a poor job of attracting sturgeon. Attraction and lifting efficiencies for shortnose sturgeon at the Holyoke Project have been estimated at approximately 11%. As the fishways at the Lockwood and Brunswick Projects were not designed to pass sturgeon, they are unlikely to achieve as high passage efficiencies as Holyoke. In addition, shortnose sturgeon at the Holyoke Dam are actively seeking to migrate upstream to spawning and overwintering habitat while the sturgeon at the Lockwood and Brunswick Dams are not expected to be experiencing this behavioral drive. Given this information, we anticipate that no more than one shortnose sturgeon every ten years will become entrapped in the fishways at the Lockwood and Brunswick projects.

Similar to shortnose sturgeon, Atlantic sturgeon are rarely found to use fishways. No Atlantic sturgeon have been trapped in the fishways at the Lockwood or Brunswick Projects since they began operating in 2006. Similarly, in the 31 years that records have been kept at the Holyoke Project, only a single Atlantic sturgeon has ever been trapped in the fishway. Given the low usage of fishways by Atlantic sturgeon in the Northeast, it is anticipated that only one Atlantic sturgeon every ten years will be trapped at the Lockwood and Brunswick Projects over the terms of their existing licenses.

Because it is possible, although remotely so, that a shortnose or Atlantic sturgeon may enter the fishways at Lockwood or Brunswick, the proposed Sturgeon Handling and Protection Plan, includes a condition that requires the licensee to require that all fishway operators are trained in handling sturgeon and that any sturgeon caught in the fish lift be removed with long handled nets and returned to the tailrace. This condition would ensure that no shortnose or Atlantic sturgeon are inadvertently passed above the dam, or injured in the process of returning them below the dam.

Unit Maintenance

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

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

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

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

The procedures and modifications implemented at the Brunswick Project since the 2010 incident will significantly reduce the probability of sturgeon becoming entrapped during unit dewatering. Therefore, no more than one shortnose sturgeon and one Atlantic sturgeon a year are anticipated to be captured when units are dewatered.

6.3. Effects of Fish Handling

6.3.1. Trapping and Handling of Atlantic Salmon

Trapping, handling and trucking fish causes them stress. The primary contributing factors to stress and death from handling are excessive doses of anesthetic, differences in water temperatures (between the river and wherever the fish are held), dissolved oxygen conditions, the amount of time that fish are held out of the water, and physical trauma. Stress on Atlantic salmon increases rapidly from handling if the water temperature is too warm or dissolved oxygen is below saturation. Fish that are transferred to holding tanks can experience trauma if care is not taken in the transfer process, and fish can experience stress and injury from overcrowding in traps that are not emptied on a regular basis. Debris buildup at traps can also kill or injure fish if the traps are not monitored and cleared on a regular basis.

Until volitional upstream fishways have been completed at the four lower most dams on the Kennebec River, Atlantic salmon will continue to use the fish lift and trap at the Lockwood Project. These fish will be trapped and then released in the suitable spawning and rearing habitat in the Sandy River. The handling and trucking of these fish will be conducted by MDMR, which holds a section 10(a)(1)(A) research permit under the USFWS's regional endangered species blanket permit (No. 697823) which authorizes the handling of listed Atlantic salmon. Therefore, the effects of handling and transporting are not considered as part of the proposed action.

However, all migrating adult Atlantic salmon in the mainstem will be affected by the Project as they will be trapped and potentially delayed by the dam and its fish passage facilities.

6.3.2. Trapping and Handling of Sturgeon

Atlantic and shortnose sturgeon could be trapped in the fish lift at the Lockwood Project, or in the vertical slot fishway at the Brunswick Project. As the spawning habitat in the Kennebec and Androscoggin Rivers is below Ticonic and Brunswick Falls, it is unlikely that sturgeon will be motivated to pass the Projects. However, it is possible that a few sturgeon per year will be attracted to the Lockwood and Brunswick Projects, and become trapped. Likwise, there is a small chance that sturgeon could become entrapped within the turbines when they are dewatered for maintenance. These fish will be handled as proposed in the Sturgeon Handling and Protection Plan, and will be released downriver of the Projects as soon as possible. They will not be transported in trucks and the handling will be minimized to the extent possible.

As described above, when flashboards are replaced at the Lockwood and Brunswick Projects, or other operations cause no-spill or no-leakage conditions, there is a possibility that sturgeon may become stranded in pools below the dams. When these activities occur trained staff will survey isolated pools downstream and transport trapped fish back into the river. Handling time is anticipated to be minimal; therefore, it is anticipated that all sturgeon will be moved back to the river without significant injury or mortality.

6.3.3. Effects of Aquatic Monitoring and Evaluation

Under the proposed action, measures will be implemented to minimize project effects on Atlantic salmon passage in the Kennebec and Androscoggin Rivers. These measures include the construction of fish passage facilities and the implementation of an adaptive management strategy to maximize passage and survival at the Weston, Shawmut, Lockwood, and Brunswick Projects. In order to determine the effectiveness of these measures, the licensee proposes to conduct downstream survival studies and upstream effectiveness studies.

Proposed Studies

In order to determine the effectiveness of the upstream and downstream fish passage facilities, the licensee proposes to conduct downstream survival studies for Atlantic salmon kelts and smolts at the Weston, Shawmut, Lockwood, and Brunswick Projects, as well as an upstream passage efficiency study for pre-spawn adults at the Brunswick and Lockwood Projects during the interim period. Upstream passage studies will be conducted at the Weston and Shawmut Projects once volitional upstream fishways have become operational at the lower four dams in the River (2020).The handling and implantation of radio tags will injure all of the fish used in the studies, and a small proportion will likely be killed.

The downstream smolt survival studies will involve obtaining Atlantic salmon smolts from GLNFH, surgically implanting radio transmitter tags, and then conducting paired releases in groups up and downriver of the Projects. The handling and implantation of radio tags will injure all of the fish used in the studies, and a small proportion will likely be killed. The licensee will monitor and evaluate the effectiveness of the downstream fish passage facilities for up to three years at all four projects. It is expected that 100 to 200 smolts will be used per year per Project, which includes fish released upriver and downriver of each Project and fish used in tag retention studies. This equates to up to 2,400 smolts being used as part of the three year study (200 smolts x 4 projects x 3 years).

Upstream passage efficiency studies will be conducted using adult Atlantic salmon trapped at the Brunswick and Lockwood Projects. The adult fish will be radio tagged prior to being released downstream. Topsham Hydro, the operator of the Pejepscot Project, will be tagging up to 40 upstream migrants a year between 2013 and 2015 to monitor passage at the Pejepscot Project. It is anticipated that the licensee will utilize the same fish for the monitoring of the upstream fishway at Brunswick on the Androscoggin River. Therefore, the monitoring of upstream passage at the Brunswick Project will not involve any additional handling and tagging effects to adult Atlantic salmon.

The licensee will conduct a similar study at the Lockwood Project between 2016 and 2018. It is expected that they will trap and tag up to 40 pre-spawn salmon a year over the three year period prior to returning them downstream of the dam. As upstream fish passage will not be available at the Shawmut and Weston Projects at this time, salmon will not be released into the Lockwood headpond during the study, but will be trapped and trucked to the Sandy River. As it is expected that some proportion of test fish will not be able to relocate and use the fishway, only male salmon will be used as part of these studies.

The licensee will also conduct downstream passage studies involving kelts between 2013 and 2015 at the Lockwood, Shawmut, Weston and Brunswick projects. The intent of these studies is to determine passage routes and the existing downstream survival for Atlantic salmon kelts at each of the four projects. The studies will be up to three years in length and will coincide with smolt monitoring. It is anticipated that these studies will involve the handling and radio-tagging of no more than 20 male kelts per project per year. The licensee will consult with us on the development of study plans for these efforts.

Tagging

Techniques such as PIT tagging, coded wire tagging, fin-clipping, and the use of radio transmitters are common to many scientific research efforts using listed species. All sampling, handling, and tagging procedures have an inherent potential to stress, injure, or even kill the marked fish. Radio telemetry will be used as the primary technique for the proposed studies.

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

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

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

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

All 2,400 Atlantic salmon smolts used in the downstream survival studies will be harassed and injured. In addition, a proportion of the smolts are anticipated to be killed due to handling and tagging, as well as to the direct and indirect effects associated with dam passage. There is some variability in the reported level of mortality associated with tagging juvenile salmonids. We did not document any immediate mortality while tagging 666 hatchery reared juvenile Atlantic salmon between 1997 and 2005 prior to their release into the Dennys River. After two weeks of being held in pools, only two (0.3%) of these fish were subject to delayed mortality. 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.* (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 per year during the proposed downstream monitoring. The proportion of smolts anticipated to be injured and killed due to the effects of downstream passage is addressed in Section 6.2.1.2.

All adult Atlantic salmon used in the upstream and downstream passage studies will be harassed and injured due to handling and tagging. However, long term effects of handling and tagging on adult salmon appear to be negligible. Bridger and Booth (2003) indicate that implanting tags gastrically does not affect the swimming ability, migratory orientation, and buoyancy of test fish. Due to handling and tag insertion, it is possible that a small proportion of study fish can be killed 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 2% represents a conservative estimate of tagging mortality in the adult salmon being used in the passage studies at the Weston, Shawmut, Lockwood, and Brunswick Projects. Given the small number of Atlantic salmon being tagged and that adult salmon are less likely than yearling Chinook salmon to be significantly injured by tag implantation, it is not expected that any adult Atlantic salmon will be killed as part of the upstream passage studies. Similarly, it is not expected that any kelts that are released as part of a downstream kelt study will be killed by the insertion of radio tags. Injuries are expected to be minimized by having trained professionals conduct the procedures using established protocols. The proportion of kelts anticipated to be injured and killed due to the effects of downstream passage is addressed in Section 6.2.1.2.

In an effort to monitor smolt outmigration timing, the licensee will be trapping Atlantic salmon smolts in a rotary screw trap in the Sandy River (2013-2015). Captured smolts will be anesthetized and measured, and scale samples will be taken. These fish will then be allowed to recover prior to being released back into the River downstream of the trap. All of the trapped fish will be harassed and harmed as a result of this treatment, and some may be subjected to injury or death. No mortalities were observed in 2012, the first year the RST was operated at this location (R. Richter, Brookfield Renewable Power, pers. comm., 2013), however, there is still a chance that a small proportion of salmon smolts could be injured or killed between 2013 and 2015 due to the effects of being trapped, handled, and anesthetized. Through investigation and summarization of NMFS RST data in the GOM DPS, Music *et al.* (2010) determined that under normal operating conditions RST function and environmental conditions within the live-car are not a significant source of mortality at a population level. Between 2005 and 2012, NMFS and MDMR captured 32,551salmon smolts in seven RSTs placed in the Sheepscot and Narraguagus Rivers. Of these, 240 smolts, or 0.74% of fish trapped, were killed due to trapping and handling. It should be noted that 79% of the smolts that were killed died in a single event on the Narraguagus River. These fish had been stocked the day before and were, therefore, likely subject to stocking stress as well as to being trapped. Therefore, we consider 0.74% a conservative estimate of the proportion of smolts trapped in the Sandy River RST that could be subject to mortality.

7. CUMULATIVE EFFECTS

Cumulative effects are defined in 50 CFR §402.02 as those effects of future state or private activities, not involving Federal activities, that are reasonably certain to occur within the action area of the Federal action subject to consultation.

The effects of future state and private activities in the action area that are reasonably certain to occur are continuation of recreational fisheries, discharge of pollutants, and development and/or construction activities resulting in excessive water turbidity and habitat degradation.

Impacts to shortnose sturgeon, Atlantic sturgeon and Atlantic salmon from non-federal activities are largely unknown in the Kennebec and Androscoggin Rivers. It is possible that occasional recreational fishing for anadromous fish species may result in incidental takes of these species. There have been no documented takes of shortnose sturgeon from fisheries in the action area although one Atlantic sturgeon was captured by an angler in 2005, and two others were reported as being captured in 2011 (MDMR 2012). The operation of these hook and line fisheries and other fisheries could result in future sturgeon or Atlantic salmon mortality and/or injury.

In December 1999, the State of Maine adopted regulations prohibiting all angling for sea-run salmon statewide. A limited catch-and-release fall fishery (September 15 to October 15) for Atlantic salmon in the Penobscot River was authorized by the MASC for 2007. The fishery was closed prior to the 2009 season. Despite strict state and federal regulations, both juvenile and adult Atlantic salmon remain vulnerable to injury and mortality due to incidental capture by recreational anglers and incidental catch in commercial fisheries. The best available information indicates that Atlantic salmon are still incidentally caught by recreational anglers. Evidence suggests that Atlantic salmon are also targeted by poachers (NMFS 2005). An adult female salmon was poached downstream of the Worumbo Project in the Androscoggin River in 2011 (MDMR 2012). Commercial fisheries for elvers (juvenile eels) and alewives may also capture Atlantic salmon as bycatch. No estimate of the numbers of Atlantic salmon caught incidentally in recreational or commercial fisheries exists.

Pollution from point and non-point sources has been a major problem in this river system, which continues to receive discharges from sewer treatment facilities and paper production facilities (metals, dioxin, dissolved solids, phenols, and hydrocarbons). Contaminants introduced into the water column or through the food chain, eventually become associated with the benthos where bottom dwelling and feeding species like shortnose and Atlantic sturgeon are particularly vulnerable. Atlantic salmon are also vulnerable to impacts from pollution and are also likely to continue to be impacted by water quality impairments in the Kennebec and Androscoggin Rivers and their 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 shortnose sturgeon, Atlantic sturgeon and Atlantic salmon will continue to be affected by contaminants in the action area in the future.

Industrialized waterfront development will continue to impact the water quality in and around the action area. Sewage treatment facilities, manufacturing plants, and other facilities present in the action area are likely to continue to operate. Excessive water turbidity, water temperature variations and increased shipping traffic are likely with continued future operation of these facilities. As a result, shortnose and Atlantic sturgeon foraging and/or distribution in the action area may be adversely affected.

Sources of contamination in the action area include atmospheric loading of pollutants, stormwater runoff from development, groundwater discharges, and industrial development. Chemical contamination may have an effect on listed species reproduction and survival.

As noted above, impacts to listed species from all of these activities are largely unknown. However, we have no information to suggest that the effects of future activities in the action area will be any different from effects of activities that have occurred in the past.

8. INTEGRATION AND SYNTHESIS OF EFFECTS

In the discussion below, we consider whether the effects of the proposed action reasonably would be expected, directly or indirectly, to reduce appreciably the likelihood of both the survival and recovery of the listed species in the wild by reducing the reproduction, numbers, or distribution of the GOM DPS of Atlantic salmon, shortnose sturgeon and the NYB and GOM DPSs of Atlantic sturgeon. The purpose of this analysis is to determine whether the proposed action, in the context established by the status of the species, environmental baseline, and cumulative effects, would jeopardize the continued existence of the GOM DPS of Atlantic salmon, shortnose sturgeon and the NYB and GOM DPSs of Atlantic sturgeon. In addition, the analysis will determine whether the proposed action will adversely modify designated critical habitat for Atlantic salmon.

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.

We have determined that the proposed action will result in harm or harassment to Atlantic salmon, shortnose sturgeon and Atlantic sturgeon in the action area. While lethal injuries and/or mortalities are being reduced by adhering to construction BMPs and the provisions of the ISPP, it is anticipated that some Atlantic salmon will be injured or killed as a result of the continued operations of the five hydroelectric projects considered in this Opinion. Whereas, no Atlantic sturgeon or shortnose sturgeon are expected to be injured or killed by the action.

8.1. 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 (approximately 6% over the last ten years) and is continuing to decline. 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 Lockwood, Shawmut, Weston , Brunswick, and Lewiston Falls Projects pursuant to amended licenses that incorporate the proposed ISPP will lead to an improvement in upstream passage for Atlantic salmon as compared to current operations. Additionally, existing obligations under the existing licenses and KHDG Agreement that require the operation of permanent downstream passage facilities are anticipated to improve downstream passage and survival past the Projects. However, the Projects will continue to affect the abundance, reproduction and distribution of salmon in the Kennebec and Androscoggin Rivers by delaying, injuring and killing upstream migrating pre-spawn adults, as well as outmigrating smolts and kelts. While FERC will require that the licensee implement several measures to reduce adverse impacts of project operation, all Atlantic salmon in the Kennebec and Androscoggin River watersheds will be adversely affected by continued operation of these facilities.

Summary of Upstream Passage Effects

Only two of the five projects (Lockwood and Brunswick) considered in this Opinion currently provide upstream passage to pre-spawn Atlantic salmon. Furthermore, even when operated pursuant to the amended licenses, it is unlikely that these fishways are 100% effective at passing all Atlantic salmon that are motivated to access habitat upriver. Adult salmon that are not passed at these Projects will either spawn in downstream areas, return to the ocean without spawning, or die in the river. These salmon are significantly affected by the stress, injury and mortality associated with locating and successfully passing these fishways. Although no studies have looked directly at the fate of fish that fail to pass through upstream fish passage facilities on the Kennebec and Androscoggin Rivers, we convened an expert panel in 2010 to provide the best available information on the fate of these fish in the Penobscot River. The panel was comprised of state, federal, and private sector Atlantic salmon biologists and engineers with expertise in Atlantic salmon biology and behavior at fishways. The group estimated a baseline mortality rate of 1% for Atlantic salmon that fail to pass a fishway at a given dam on the Penobscot River (NMFS 2011). Dams that do not have fishways were not considered to have baseline mortality, as fish are not subject to the stresses of upstream passage (although they may be subjected to significant delays).

Assuming that the existing fishway at the Lockwood Project is at least 40% effective, it is anticipated that 0.6% (1% mortality x 60% that fail to pass) of Atlantic salmon that attempt to pass the Lockwood Project will die. The remaining 59.4% will either spawn in habitat downstream of the Project or leave the river without spawning. Likewise, assuming that the existing fishway at the Brunswick Project is at least 61% effective, it is anticipated that 0.4% (1% mortality x 39% that fail to pass) of Atlantic salmon that attempt to pass the Brunswick Project will die. The remaining 38.6% will either spawn in habitat downstream of the Project, migrate to the Kennebec River to spawn, or leave the river without spawning.

Although the Shawmut and Weston Dams are not currently accessible to upstream migrating Atlantic salmon, it is assumed that 100% of Atlantic salmon that approach the Lewiston Falls Dam on the Androscoggin River could experience adverse effects due to delay. As no upstream passage facilities are proposed, these conditions will continue to be experienced even when FERC issues amended licenses. Therefore, these adverse effects will continue during the entirety of the interim period.

As Atlantic salmon cannot access spawning habitat above Lewiston Falls, returning salmon will not be homing to the upper river. However, it is anticipated that some salmon that are homing to habitat lower in the River may stray to the area immediately below the Lewiston Falls Dam. Over the last ten years, 22 Atlantic salmon have successfully passed the Worumbo Project, the first dam downstream of Lewiston Falls (average=2 salmon/year). Although many of these fish may not have been motivated to continue their migrations, this represents a conservative estimate of the number of Atlantic salmon affected between 2003 and 2012 by the lack of passage facilities at Lewiston Falls. Therefore, it is anticipated that the Project adversely affects an average of two pre-spawn Atlantic salmon per year by blocking passage and by contributing to migratory delay. Although the duration of the delay is not known, it is expected that these fish will be delayed for some amount of time prior to dropping back into the lower river. We believe that a delay in migration of more than two days per project could affect a salmon's ability to migrate successfully to suitable spawning habitat. The licensee will assess the level of delay that is resulting due to project operations. FERC is proposing to implement a license article requiring the licensee to meet with us every five years to discuss the operation of the project in relation to listed species. If significant delay is occurring, possible solutions will be discussed at that time.

The existing hydroelectric projects result in a certain amount of delay in upstream migration. Numerous studies collectively report a wide range in time needed for individual adult salmon to pass upstream of various dams in the Penobscot River once detected in the vicinity of a spillway or tailrace. The yearly pooled median passage time for adults at Milford Dam ranged from 1.0 days to 5.3 days over five years of study, while the total range of individual passage times over this study period was 0.1 days to 25.0 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). It is unknown what level of delay occurs at the Lockwood, Brunswick, and Lewiston Falls Projects, although it is anticipated to be similar to what has been observed at other dams. The proposed upstream passage studies at Brunswick will quantify the amount of significant delay (greater than 48 hours) between 2013 and 2015. If levels of delay are deemed excessive, measures will be incorporated in order to minimize this effect. Upstream studies will be conducted as part of the final SPP at the Shawmut and Weston Projects.

Upstream Distribution Effects

The operation of new upstream volitional fishways at the Lockwood, Shawmut, and Weston Projects will significantly improve the distribution of Atlantic salmon throughout the Kennebec River watershed. However, these fishways will not become accessible to upstream migrating salmon until fishways at all four of the dams in the lower Kennebec River become operational (anticipated in 2020). Therefore, the distribution of the species is not anticipated to improve over the timeframe of the ISPP (2013-2019).

Until 2018, the only operational upstream fishway for Atlantic salmon on the Kennebec River is the Lockwood Project. Of the Atlantic salmon that fail to pass this fishway, the vast majority are assumed to stray to other habitat and spawn. The expert panel convened by us in 2010 addressed this issue, and determined that the presence of the dams would cause the majority of straying Atlantic salmon to spawn in habitat downriver of the dam that halted their migration. For Lockwood, this would mean that 100% of the fish that stray would fall back in the river, and would potentially spawn in the mainstem Kennebec, or in one of its tributaries. Of the Atlantic salmon that fail to pass Brunswick, it is assumed that some proportion drop back down into Merrymeeting Bay and then continue their migrations in the Kennebec River. There is no mapped spawning habitat below the Brunswick Dam on the Androscoggin River. This forced straying of a small proportion of migrating Atlantic salmon may lead to a gradual shift downriver in the distribution of the species in the Merrymeeting Bay SHRU.

Atlantic salmon are prevented from accessing approximately 80,000 habitat units in the upper Androscoggin River (NMFS 2009a). This habitat represents approximately 83% of the potential spawning and rearing habitat within the Androscoggin drainage. The Lewiston Falls Project itself only prevents passage to the next upstream barrier, the Deer Rips Dam about 4.40 kilometers upriver and, on its own, is not preventing access to a significant quantity of habitat. However, straying caused by dams leads to increased energy expenditure and delay, which could prevent salmon from accessing suitable spawning habitat.

Summary of Downstream Passage Effects

A significant proportion of Atlantic salmon smolts and kelts are injured or killed while passing dams during their downstream migration. It is assumed for this Opinion that the existing downstream passage rates will be maintained throughout the interim period (2013-2019).

Atlantic salmon smolts outmigrate to the estuary in the spring after rearing in freshwater streams. Under current operations, the licensee has estimated that 48-hour smolt survival rates (based on median flows) on the Kennebec River are 94%, 95%, and 94% at the Lockwood, Shawmut, and Weston Projects, respectively. As described previously, these estimates likely overestimate actual survival; however, they represent the best available information of survival rates past the these Projects. Therefore, cumulative survival of the smolts migrating out of the Sandy River over these three dams is anticipated to be approximately 85%.

Atlantic salmon kelts outmigrate in the fall after spawning, or in the spring after overwintering in freshwater. They are subject 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 (Alden Lab 2012). Under current operations, the licensee has estimated survival rates for outmigrating kelts to be 73%, 89%, and 88% at the Weston, Shawmut, and Lockwood Projects, respectively. Therefore, cumulative survival of kelts through all three Projects in the Kennebec is 57%.

It is not known how many smolts outmigrate past the Brunswick Project on the Androscoggin River every year, but it is anticipated to be very few given the lack of accessible spawning habitat upriver. A portion of these smolts will be injured or killed while passing downstream at the Brunswick Project. Based upon information in FERC's BA, it is estimated that 48-hour survival rates for smolts would be approximately 93%. Survival of kelts is estimated to be approximately 85% at the Brunswick Project.

Similar to migrating pre-spawn adults, outmigrating smolts and kelts are subject to delay by the presence of hydroelectric dams. While these delays can lead to mortality of Atlantic salmon from increased predation (Blackwell *et al.* 1998), migratory delays 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 effects (McCormick *et al.* 1999). Late migrants lose physiological smolt characteristics due to high water temperatures during spring migration (McCormick *et al.* 1999). 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 may reduce smolt survival (McCormick *et al.* 1999).

We expect that 24 hours provides adequate opportunity for smolts and kelts to locate and utilize well-designed downstream fishways at hydroelectric dams. A 24-hour period would allow these migrants an opportunity to locate and pass the fishway during early morning and dusk, a natural diurnal migration behavior of Atlantic salmon. Passage times in excess of 24 hours would result in unnatural delay for migrants leading to increased predation and reduced fitness in the freshwater to saltwater transition. Therefore, any smolt or kelt documented to take longer than 24 hours to pass a downstream passage facility during downstream survival studies will be considered to have failed in their passage attempt.

In addition to the direct and indirect mortality associated with dam passage for smolts and kelts, there is also the possibility of additional dam-related mortality occurring in the early marine phases of the salmon's life history. For Pacific salmon species, this concept is known as the hydrosystem-related delayed-mortality hypothesis (Budy *et al.* 2002, Schaller and Petrosky 2007). This delayed mortality is thought to be attributable to physiological stress associated with dam passage that affects smolts and post-smolts experiencing the challenges of transitioning to the marine environment (osmoregulation, novel predators, etc.). Very recently, Haeseker *et al.* (2012) provided evidence supporting this hypothesis for Snake River Chinook salmon and steelhead. At this time, it is impossible to quantify how much (if any) early marine mortality of Atlantic salmon may be attributable to similar mechanisms in the Kennebec and Androscoggin River watersheds. However, it is reasonable to assume that some level of delayed (and as yet undocumented) early marine mortality of Atlantic salmon is ultimately due to earlier hydrosystem experience.

8.1.1. Survival and Recovery Analysis

Jeopardy is defined by USFWS and NMFS (1998) 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." Therefore, to determine if the proposed action will jeopardize the GOM DPS of Atlantic salmon, an analysis of the effects on survival and recovery must be conducted. The ISPP and this Opinion are valid for a seven-year period and expire in 2019. Therefore, the following section analyzes whether interim operation of the projects will jeopardize the GOM DPS of Atlantic salmon during this seven-year period. In 2019, this Opinion will no longer be valid and consultation under section 7 will need to be reinitiated by FERC.

Survival Analysis

The first step in conducting this analysis is to assess the effects of the proposed project on the survival of the species. Survival can be 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).

While implementing the proposed ISPP will result in the loss of Atlantic salmon smolts and kelts, the relatively short time frame of the action (seven years) will greatly reduce the potential of the project to affect the long-term survival potential of the species. Almost all production of Atlantic salmon in the Kennebec River is the result of egg planting in the Sandy River. Hutchings (2013) estimated that approximately 19,762 Atlantic salmon smolts would be outmigrating through the Kennebec River in 2013. Not all of these smolts will pass through the Weston, Shawmut, Hydro-Kennebec, and Lockwood Dams due to natural instream mortality (e.g., predation). However, based on the estimated survival rates (Weston-94%, Shawmut-95%, Hydro-Kennebec-92% (NMFS 2012), Lockwood (94%)) of the dams in the lower river, we can estimate how hydroelectric operations are cumulatively affecting the number of smolts reaching the estuary and, correspondingly, the number of pre-spawn adult salmon that return to the river. At the above survival rates, the operation of the four dams on the lower Kennebec would be expected to kill approximately 23% of outmigrating smolts every year. Three of these projects (Weston, Shawmut, and Lockwood) are being considered as part of this consultation. If these three projects were not operating, it is expected that approximately 8% of smolts would be killed by the remaining Project in the lower River. Therefore, conceptually the operation of these three Projects leads to a 15% reduction in cumulative smolt survival. We would expect this level of mortality to be reduced once the final SPP is implemented using data collected as part of the ISPP process.

Hutchings (2013) estimated that in 2013, 964 smolts would be outmigrating in the Androscoggin

River. The licensee has estimated that the Brunswick Project kills approximately 7% of migrating smolts at median flows. Most, if not all, of the current smolt production in the watershed occurs in the Little River, a tributary upstream of the Pejepscot Project. Topsham Hydro has estimated downstream smolt mortality at the Pejepscot Project at 8.40%. At the above survival rates, the operation of the two dams on the lower Androscoggin would be expected to kill approximately 15% of outmigrating smolts every year. If the Brunswick Project was not operating, it is expected that approximately 8.40% of smolts would be killed by the remaining Project downstream of spawning habitat in the lower River. Therefore, conceptually the operation of the Brunswick Project leads to a 7% reduction in cumulative smolt survival in the Androscoggin River. We would expect this level of mortality to be reduced once the final SPP is implemented using data collected as part of the ISPP process.

The licencee's proposed project is expected to significantly benefit the distribution of the species by improving upstream and downstream passage at the Projects. The construction and operation of new volitional upstream fishways at the Lockwood, Shawmut, and Weston Projects will improve reproduction since the effects of transporting adult Atlantic salmon around the projects will be eliminated. Although these effects will not come into effect until after 2020, the actions that are proposed for the interim period will facilitate these improvements over the long term. The operation of effective permanent downstream passage facilities at the Weston, Shawmut, Lockwood, and Brunswick Projects, as required under the KHDG Agreement and the existing licenses, is expected to increase the number of smolts surviving in the Kennebec and Androscoggin Rivers, which will lead to increased number of adults returning to the River. We also expect current stocking practices to continue during the ISPP period which will help insure the survival of Atlantic salmon in the action area. Therefore, we have determined that the loss of Atlantic salmon smolts, kelts, and prespawn adults over a seven year period under the proposed action will not appreciably reduce the likelihood that the species will survive in the wild.

Recovery Analysis

The second step in conducting this analysis is to assess the effects of the proposed project on the recovery of the species. Recovery is defined as the improvement in the status of listed species to the point at which listing is no longer appropriate under the criteria set out in section 4(a)(1) of the ESA (USFWS and NMFS 1998). As with the survival analysis, there are three criteria that are evaluated under the recovery analysis; reproduction, numbers and distribution. In the recovery analysis, the same measures are used to evaluate these criteria as are used in the survival analysis. However, unlike with survival, the recovery analysis requires an adjustment to the existing freshwater and marine survival rates to allow for a population that has a positive growth rate. The recovery condition includes existing dam passage rates, but does not include hatchery supplementation as it is assumed that in a recovered population, stocking will not be necessary to sustain a viable population.

In certain instances, an action may not appreciably reduce the likelihood of a species survival (persistence) but may affect its likelihood of recovery or the rate at which recovery is expected to occur. As explained above, we have determined that the proposed action will not appreciably reduce the likelihood that Atlantic salmon will survive in the wild. Here, we consider the potential for the action to reduce the likelihood of recovery. As noted above, recovery is defined as the improvement in status such that listing is no longer appropriate.

Section 4(a)(1) of the ESA requires listing of a species if it is in danger of extinction throughout all or a significant portion of its range (i.e., “endangered”), or likely to become in danger of extinction throughout all or a significant portion of its range in the foreseeable future (i.e., “threatened”) because of any of the following five listing factors: (1) The present or threatened destruction, modification, or curtailment of its habitat or range, (2) overutilization for commercial, recreational, scientific, or educational purposes, (3) disease or predation, (4) the inadequacy of existing regulatory mechanisms, (5) other natural or manmade factors affecting its continued existence.

At existing freshwater and marine survival rates (the medians have been estimated by NMFS as 1.1% and 0.4%, 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 5, the dot represents current marine and freshwater survival rates; 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 horizontal lines indicate the rates of freshwater survival that have been historically observed (Legault 2004). This model indicates that there are many potential routes to recovery; for example, recovery could be achieved by significantly increasing the existing marine survival rate while holding freshwater survival at existing levels, or, conversely, by significantly increasing freshwater survival while holding marine survival at today’s levels. Conceptually, however, the figure makes clear that an increase in both freshwater and marine survival will lead to the shortest and, therefore, most likely, path to achieving a self-sustaining population that is trending towards recovery.

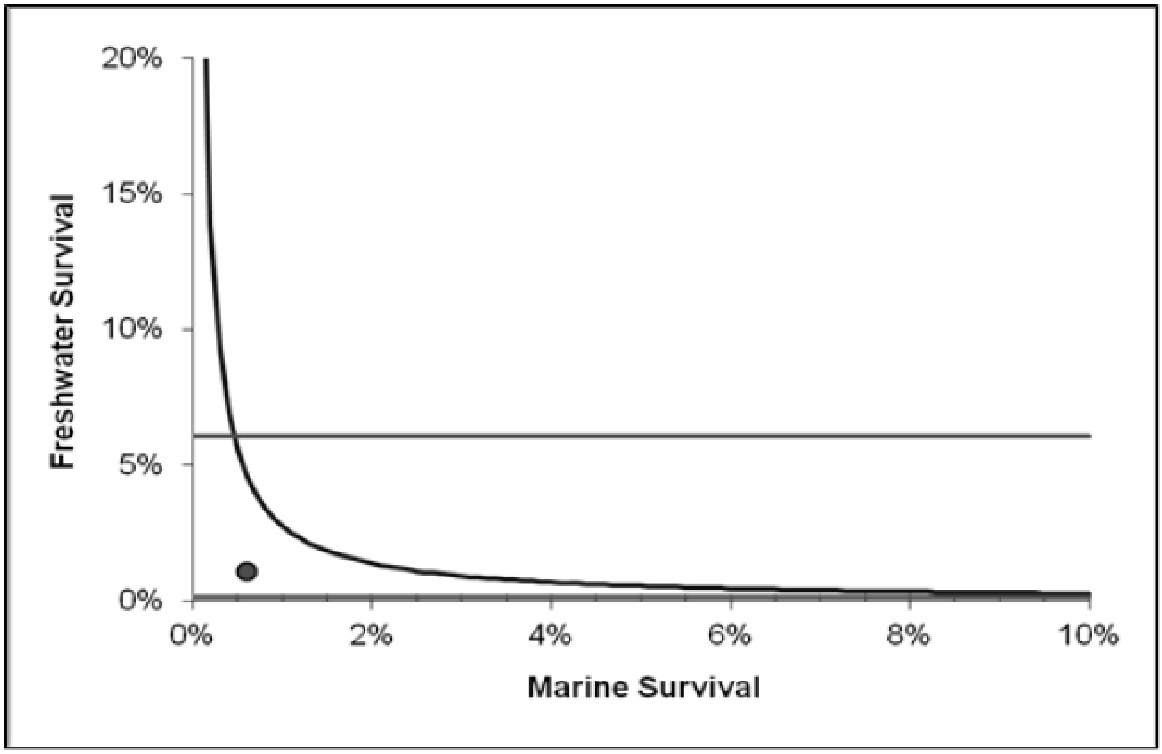

Figure 5. NMFS (2010) conceptual model depicting marine and freshwater survival relative to recovery of the GOM DPS of Atlantic salmon (Note: The dot represents current conditions, the curved line represents recovery, and the horizontal lines are the historic maximum and minimum freshwater survival).

While implementing the proposed ISPP will result in the loss of Atlantic salmon smolts and adults, the relatively short time frame of the action (seven years) will greatly reduce the potential of the project to affect the long-term recovery potential of the species. In addition, the proposed ISPP will significantly benefit the distribution of the species by improving upstream passage at the Projects. Improved upstream passage is also expected to improve reproduction of the species since the effects of transporting adult Atlantic salmon around the Projects will be eliminated. Therefore, we have determined that the proposed action will not appreciably reduce the likelihood that Atlantic salmon will recover in the wild.

Summary of Effects of the Proposed Action to Atlantic Salmon

In this section, we summarize the effects of the proposed action on the GOM DPS of Atlantic salmon in conjunction with the environmental baseline. Based on the information provided above, the proposed action will not appreciably reduce the likelihood of survival for Atlantic salmon in the wild (i.e., it will not decrease the likelihood that the species will continue to persist into the future with sufficient resilience to allow for the potential recovery from endangerment). While juvenile and adult Atlantic salmon mortality associated with dam passage at the Lockwood, Shawmut, Weston and Brunswick Projects will continue to have an adverse effect on Atlantic salmon in the Kennebec and Androscoggin Rivers for a relatively short period (seven years), we believe that the loss will not be sufficient to appreciably diminish the species ability to achieve recovery. As such, there is not likely to be an appreciable reduction in the likelihood of survival and recovery in the wild of the Kennebec and Androscoggin River populations or the species as a whole.

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 which 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 reproduction and distribution of Atlantic salmon. This is the case because: 1) the new upstream fishways will reduce injury to adult Atlantic salmon that were transported upstream via trap and truck; 2) increased passage will improve the distribution of the species in the Kennebec River; and 3) improved access will increase reproduction in high quality spawning habitat in the upper Kennebec River and thus increase the number of returning 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. 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 effects related to climate change to Atlantic salmon in the action area are anticipated over the life of the proposed action (seven years). 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. Atlantic Salmon Critical Habitat

Critical habitat for Atlantic salmon has been designated in the Kennebec and Androscoggin Rivers including the sections of river in the vicinity of the Lockwood, Shawmut, Weston, and Brunswick Projects. Critical habitat has also been designated downstream of the Lewiston Falls Project. Within the action area of this consultation, the PCEs for Atlantic salmon include: 1) sites for spawning and rearing; and, 2) sites for migration (excluding marine migration). Although there is a small amount of spawning and rearing habitat in the mainstem of the Kennebec River, the habitat in the proposed project area primarily functions as a migration corridor for migrating pre-spawn adults, as well as for outmigrating smolts and kelts

Summary of Construction Effects

Construction related effects are anticipated to occur at the Shawmut and Weston Projects where a small amount of in-water work will likely be required for the construction of the new fishways. This habitat does not currently function as migratory habitat for pre-spawn Atlantic salmon because all Atlantic salmon are trapped at the Lockwood Project downstream and trucked upstream to the Sandy River. The work will occur outside of the time of year when smolts and kelts would be outmigrating through the River, so effects to the migration PCE are anticipated to be discountable.

Summary of Upstream Passage Effects

The proposed upstream fishways at the Lockwood, Shawmut, and Weston Projects on the Kennebec River will improve migratory conditions in the action area by improving volitional access to approximately 70,000 habitat units in the Kennebec River watershed, including 37,105 units in the Sandy River and 32,739 units in the mainstem and small tributaries downstream of the Anson and Abenaki Projects in Madison (Wright *et al.* 2008). Passage conditions will not be improved until Atlantic salmon have volitional passage all the way to the Sandy River, which is not anticipated to occur until 2020. During the interim period, passage will continue to occur via trap and truck at the Lockwood Project. It is expected that the existing fishway is not 100% effective and that its presence in the river will continue to negatively affect Atlantic salmon migration by increasing straying behavior and delay.

On the Androscoggin, upstream passage will continue through the Brunswick Project during the interim period. Passage studies will be conducted and modifications will be considered and implemented to minimize Project effects to the migratory PCE. However, like Lockwood, the Brunswick Dam is not 100% effective at passing fish and its presence in the River will continue to negatively affect Atlantic salmon migration by increasing straying behavior and delay.

Summary of Downstream Passage Effects

The proposed downstream survival studies are a component of an adaptive management strategy that will improve migratory conditions in the action area by allowing more Atlantic salmon smolts and kelts to survive downstream passage through the Weston, Shawmut, Lockwood, and Brunswick Projects. A significant proportion of Atlantic salmon smolts and kelts are injured or killed while passing dams during their downstream migration. Although no performance standards have been proposed at this time, it is anticipated that they will be developed as part of a final SPP and that these fishways will need to be highly effective.

We expect that the proposed project would continue to harm the PCEs in the action area. We expect the continued operations of these Projects to cause adverse effects to some essential features of critical habitat, including water quality, substrate, migration conditions, and forage in a similar manner as present in the environmental baseline. However, designated critical habitat in the Kennebec and Androscoggin River watersheds is anticipated to improve for Atlantic salmon with the implementation of improved upstream and downstream passage as outlined in the proposed ISPP. During the seven year interim period the effects of hydroelectric operations to the migration PCE will be reduced by improving passage conditions and reducing delay for both upstream and downstream migrating Atlantic salmon. Therefore, the proposed project is not likely to adversely modify or destroy Atlantic salmon critical habitat.

8.3. Shortnose sturgeon

Historically, shortnose sturgeon are believed to have inhabited nearly all major rivers and estuaries along nearly the entire east coast of North America. Today, only 19 populations remain. The shortnose sturgeon residing in the Kennebec and Androscoggin Rivers come from one of these nineteen populations. The present range of shortnose sturgeon is disjunct, with northern populations separated from southern populations by a distance of about 400 kilometers. Population sizes range from under 100 adults in the Cape Fear and Merrimack Rivers to tens of thousands in the St. John and Hudson Rivers. As indicated in Kynard (1996), adult abundance is less than the minimum estimated viable population abundance of 1,000 adults for five of 11 surveyed northern populations and all natural southern populations. The only river systems likely supporting populations close to expected abundance are the St John, Hudson and possibly the Delaware and the Kennebec (Kynard 1996), making the continued success of shortnose sturgeon in these rivers critical to the species as a whole.

Future operations of the Shawmut, Weston, and Lewiston Falls Projects are not likely to result in negative effects to shortnose sturgeon as they are located upstream of what is believed to be the historic range of shortnose sturgeon in the Kennebec and Androscoggin Rivers, and no shortnose sturgeon will be exposed to effects of Project operations. The Lockwood and Brunswick Projects are located at what is believed to be the upstream extent of the historic range of shortnose sturgeon and, therefore, they are not considered barriers to upstream migration. Shortnose sturgeon are known to utilize habitat downstream of these projects, potentially for spawning. Therefore, it is possible that the operation of the facilities could impact shortnose sturgeon and its habitat downriver of these two dams.

We have determined that the proposed action will affect shortnose sturgeon by resulting in the capture of one adult every ten years in the fishways at the Lockwood and Brunswick Projects. Additionally, the stranding of one shortnose sturgeon at each of the two Projects every ten years is expected in pools downstream of the spillways during the replacement or maintenance of flashboards. Over the terms of the existing licenses, therefore, it is anticipated that four sturgeon (two trapped in the fishway and two stranded in downstream pools) could become trapped at both the Lockwood and Brunswick Projects. 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. Shortnose sturgeon captured in the fishways will be temporarily delayed from carrying out spawning activities. However, given that monitoring will be continuous 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 one shortnose sturgeon every ten years at the Brunswick and Lockwood Projects, and an additional one stranded at each of the two Projects every ten years in pools during flashboard replacement, is not likely to result in any injury or mortality or affect the fitness of any individuals, or cause any reduction in the number of eggs spawned or in the successful development of those eggs and larvae.

The proposed action is not likely to reduce reproduction of shortnose sturgeon in the action area because: (1) there will be no reduction in the number of spawning adults; (2) there will be no reduction in fitness of spawning adults; (3) there is not anticipated to be any reduction in the number of eggs spawned or the fitness of any eggs or larvae; and (4) the projects will continue to operate in run of river mode thus there is no potential for pulsed flows which could disrupt spawning or rearing.

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, as shortnose sturgeon will have access to the entirety of its historic range.

Based on the information provided above, the proposed action will not appreciably reduce the likelihood of survival for shortnose sturgeon in the wild (i.e., it will not decrease the likelihood that the species will continue to persist into the future with sufficient resilience to allow for the potential recovery from endangerment). The action will not affect shortnose sturgeon in a way that prevents the species from having a sufficient population, represented by all necessary age classes, genetic heterogeneity, and number of sexually mature individuals producing viable offspring and it will not result in effects to the environment which would prevent shortnose sturgeon from completing their entire life cycle, including reproduction, sustenance, and shelter. This is the case because: (1) the action will not result in the mortality of any shortnose sturgeon (2) as the action will not result in the mortality of any individuals, the action is not likely to have an effect on the levels of genetic heterogeneity in the population; (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 distribution of shortnose sturgeon in the action area or beyond the action area (i.e., throughout its range); (6) 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; (7) the operations of the project will not affect the ability of shortnose sturgeon to successfully spawn or for eggs and larvae to successfully develop and, (9) the action will have no effect on the ability of shortnose sturgeon to shelter or forage.

In certain instances an action may not appreciably reduce the likelihood of a species survival (persistence) but may affect its likelihood of recovery or the rate at which recovery is expected to occur. As explained above, we have determined that the proposed action will not appreciably reduce the likelihood that shortnose sturgeon will survive in the wild. Here, we consider the potential for the action to reduce the likelihood of recovery. As noted above, recovery is defined as the improvement in status such that listing is no longer appropriate.

Section 4(a)(1) of the ESA requires listing of a species if it is in danger of extinction throughout all or a significant portion of its range (i.e., “endangered”), or likely to become in danger of extinction throughout all or a significant portion of its range in the foreseeable future (i.e., “threatened”) because of any of the following five listing factors: (1) The present or threatened destruction, modification, or curtailment of its habitat or range, (2) overutilization for commercial, recreational, scientific, or educational purposes, (3) disease or predation, (4) the inadequacy of existing regulatory mechanisms, (5) other natural or manmade factors affecting its continued existence.

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 utilize shortnose sturgeon for recreational, scientific or commercial purposes, affect the adequacy of existing regulatory mechanisms to protect this species, or affect their continued existence. 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.

8.4. Atlantic sturgeon

We have estimated that the proposed project may interact with New York Bight and GOM DPSs of Atlantic sturgeon. As explained in the "Effects of the Action" section, the operation of fishways at the Lockwood and Brunswick Projects and the lowering of water levels during flashboard maintenance is expected to directly affect adult Atlantic sturgeon. We anticipate that one Atlantic sturgeon will become stranded at each of the two Projects every ten years through the end of the existing Project licenses. Likewise, we anticipate that one Atlantic sturgeon will become trapped in the fishways at the two Projects every ten years over the same timeframe. (Table 20). As described previously, we expect Atlantic sturgeon to occur at the following frequencies in the action area: St. John River (Canada) 7%; Gulf of Maine DPS 92% and New York Bight DPS 1%. As eight Atlantic sturgeon are anticipated to be affected by the proposed actions, seven of those are expected to come from the GOM DPS, and one is expected to be from the St. John River. Given the small number of NYB fish anticipated to be in the action area, it is not anticipated that any of the affected fish will originate from that DPS. Therefore, impacts from the anticipated interaction and capture of several individual Atlantic sturgeon that could originate from the GOM DPS are described below.

Table 20. Number of Atlantic Sturgeon expected to be affected by the proposed project.

Project	Source	Duration	Total
Lockwood	Trapping	2013-2036	2

	Stranding		2
Brunswick	Trapping	2013-2029	2
	Stranding		2

8.4.1 Gulf of Maine DPS of Atlantic Sturgeon

While Atlantic sturgeon occur in several rivers in the Gulf of Maine, recent spawning has only been documented in the Kennebec River and Androscoggin River. Future operations of the Shawmut, Weston, and Lewiston Falls Projects are not likely to result in negative effects to Atlantic sturgeon as they are located upstream of what is believed to be the historic range of Atlantic sturgeon in the Kennebec and Androscoggin Rivers, and no Atlantic sturgeon will be exposed to effects of project operations. The Lockwood and Brunswick Projects are located at what is believed to be the upstream extent of the historic range of Atlantic sturgeon and, therefore, they are not considered barriers to upstream migration. Atlantic sturgeon are known to utilize habitat downstream of these Projects, potentially for spawning. Therefore, it is possible that the operation of the facilities could impact Atlantic sturgeon and its habitat downriver of these two dams. As both projects operate as run of river facilities, we do not expect that operations of Lockwood and Brunswick will affect the ability of Atlantic sturgeon to spawn successfully in the vicinity of these projects or that the operation of these projects will affect the successful development of early life stages that may be present in the action area.

We have determined that the proposed action will affect Atlantic sturgeon by resulting in the capture of one adult per Project every ten years in the fishways at the Lockwood and Brunswick Projects. As outlined in Table 16, over the term of the FERC license this equates to the capture of no more than four Atlantic sturgeon at the Lockwood Project. Likewise, no more than four Atlantic sturgeon are expected to be captured at the Brunswick Project over the term of its license. The licensee will adhere to a Sturgeon Handling and Protection Plan to ensure that any GOM DPS Atlantic sturgeon captured in the fish lifts, or in isolated pools, are removed promptly and returned safely downstream. It is possible that some captured GOM DPS Atlantic sturgeon could experience minor injuries, such as abrasions, due to contact with the concrete surface of the fishways. GOM DPS Atlantic sturgeon captured in the fishways will be temporarily delayed from carrying out spawning activities. However, given that monitoring will be continuous 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 traps, or in the pools, and subsequent removal and placement back downstream of the fishway would cause an individual Atlantic sturgeon to abandon their spawning attempt. Considering this analysis, the capture of GOM DPS Atlantic sturgeon at the Lockwood and Brunswick Projects, is not likely to result in any injury or mortality or affect the fitness of any individuals, or cause any reduction in the number of eggs spawned or in the successful development of those eggs and larvae.

The proposed action is not likely to reduce reproduction of GOM DPS 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; (3) there is not anticipated to be any reduction in the number of eggs spawned or the fitness of any eggs or larvae; and (4) the project will continue to operate in run of river mode thus there is no potential for pulsed flows which could disrupt spawning or rearing.

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

Based on the information provided above, the proposed action will not appreciably reduce the likelihood of survival for GOM DPS 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 GOM DPS 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 which would prevent Atlantic sturgeon from completing their entire life cycle, including reproduction, sustenance, and shelter. This is the case because: (1) the action will not result in the mortality of any GOM DPS Atlantic sturgeon (2) as the action will not result in the mortality of any individuals, the action is not likely to have an effect on the levels of genetic heterogeneity in the population; (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 distribution of Atlantic sturgeon in the action area or beyond the action area (i.e., throughout its range); (6) 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; (7) the operations of the project will not affect the ability of Atlantic sturgeon to successfully spawn or for eggs and larvae to successfully develop and, (9) the action will have no effect on the ability of Atlantic sturgeon to shelter or forage.

In certain instances an action may not appreciably reduce the likelihood of a species survival (persistence) but may affect its likelihood of recovery or the rate at which recovery is expected to occur. As explained above, we have determined that the proposed action will not appreciably reduce the likelihood that GOM DPS Atlantic sturgeon will survive in the wild. Here, we consider the potential for the action to reduce the likelihood of recovery. As noted above, recovery is defined as the improvement in status such that listing is no longer appropriate.

Section 4(a)(1) of the ESA requires listing of a species if it is in danger of extinction throughout all or a significant portion of its range (i.e., “endangered”), or likely to become in danger of extinction throughout all or a significant portion of its range in the foreseeable future (i.e., “threatened”) because of any of the following five listing factors: (1) The present or threatened destruction, modification, or curtailment of its habitat or range, (2) overutilization for commercial, recreational, scientific, or educational purposes, (3) disease or predation, (4) the inadequacy of existing regulatory mechanisms, (5) other natural or manmade factors affecting its continued existence.

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 GOM DPS Atlantic sturgeon in the action area and since it will not affect the overall distribution of Atlantic sturgeon other than to cause temporary changes in movements throughout the action area. The proposed action will not utilize Atlantic sturgeon for recreational, scientific or commercial purposes, affect the adequacy of existing regulatory mechanisms to protect this species, or affect their continued existence. 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 GOM DPS Atlantic sturgeon can be brought to the point at which they are no longer listed as endangered or threatened.

Despite the threats faced by individual Atlantic sturgeon inside and outside of the action area, the proposed action will not increase the vulnerability of individual GOM DPS Atlantic 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 GOM DPS Atlantic 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 GOM DPS Atlantic 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.

9. CONCLUSION

After reviewing the best available information on the status of endangered and threatened species under our jurisdiction, 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 shortnose sturgeon, the GOM DPS of Atlantic sturgeon, the New York Bight DPS of Atlantic sturgeon or the GOM DPS of Atlantic salmon. Furthermore, the proposed action is not expected to result in the destruction or adverse modification of critical habitat designated for the GOM DPS of Atlantic salmon.

10. INCIDENTAL TAKE STATEMENT

Section 9(a)(1) of the ESA prohibits any taking (harass, harm, pursue, hunt, shoot, wound, kill, trap, capture, collect, or attempt to engage in any such conduct) of endangered species without a specific permit or exemption. We interpret the term ''harm'' as an act which actually kills or injures fish or wildlife. It is further defined to include significant habitat modification or degradation that results in death or injury to listed species by significantly impairing behavioral patterns such as spawning, rearing, feeding, and migrating (50 CFR §222.102; NMFS 1999b). We have not defined the term "harass"; however, it is commonly understood to mean to annoy or bother. In addition, legislative history helps elucidate Congress' intent that harassment would occur where annoyance adversely affects the ability of individuals of the species to carry out biological functions or behaviors: "[take] includes harassment, whether intentional or not. This would allow, for example, the Secretary to regulate or prohibit the activities of birdwatchers where the effect of those activities might disturb the birds and make it difficult for them to hatch or raise their young" (HR Rep. 93-412, 1973). Incidental take is defined as take that is incidental to, and not the purpose of, the carrying out of an otherwise lawful activity by a Federal agency or applicant (50 CFR §402.02). Under the terms of section 7(b)(4) and section 7(o)(2), taking that is incidental to and not intended as part of the agency action is not considered to be prohibited under the ESA, provided that such taking is in compliance with the terms and conditions of the incidental take statement.

The prohibitions against incidental take are currently in effect for the GOM DPS of Atlantic salmon, shortnose sturgeon, and all DPSs of Atlantic sturgeon except the threatened GOM DPS. A final section 4(d) rule for the GOM DPS of Atlantic sturgeon will apply the appropriate take prohibitions. The proposed 4(d) rule for the GOM DPS was published on June 10, 2011 (76 FR 34023) and includes prohibitions on take with very limited exceptions. The appropriate prohibitions on take of GOM DPS Atlantic sturgeon will take effect on the date the final 4(d) rule is effective and at that time, the take provided in this ITS will apply to the GOM DPS.

An incidental take statement specifies 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 the FERC fails to include these conditions in the license articles or the licensee fails to assume and carry out the terms and conditions of this incidental take statement, the protective coverage of section 7(a)(2) may lapse. To monitor the effect of incidental take, the FERC must require the licensee to report the progress of the action and its effect on each listed species to us, as specified in this incidental take statement (50 CFR §402.14(i)(3)).

10.1. Amount or Extent of Take

In Section 6, we described the mechanisms by which ESA-listed anadromous fish and designated critical habitat would likely be affected by the construction of fishways at the Lockwood, Shawmut, and Weston Projects, and the implementation of the licensee's proposed ISPP at the Lockwood, Shawmut, Weston, Brunswick, and Lewiston Falls Projects. The following sections describe the amount or extent of take that we expect would result based on the anticipated effects of the proposed action.

If the proposed action results in take of a greater amount or extent than that described, the FERC would need to reinitiate consultation. The exempted take includes only take incidental to the proposed action.

10.1.1. Amount or Extent of Incidental Take of Atlantic salmon

10.1.1.1. Hydroelectric Operations

We anticipate that the continued operation of the Lockwood, Shawmut, Weston, Brunswick, and Lewiston Falls Projects could potentially harm Atlantic salmon adults and smolts in the mainstem of the Kennebec and Androscoggin Rivers. However, the licensee's proposal to implement the provisions of the ISPP will reduce the number of takes associated with these Projects. The following sections describe the amount or extent of take that we expect would result based on the anticipated effects of the proposed action (Table 21). If the proposed action results in take of a greater amount or extent than what is described, the FERC would need to reinitiate consultation. The exempted take includes only take incidental to the proposed action. The incidental take provided by this Opinion is valid until 2019. In 2020, this Opinion will no longer be valid for Atlantic salmon.

Upstream Passage

As described above, section 9(a)(1) of the ESA prohibits any taking (harass, harm, pursue, hunt, shoot, wound, kill, trap, capture, collect, or attempt to engage in any such conduct) of endangered species without a specific permit or exemption. The Merriam-Webster Dictionary defines "collect" as "to bring together into one body or place". The dictionary further defines "capture" as "to take captive" and "trap" as "to place in a restricted position". The function of a fishway is to temporarily collect, capture and trap all migrating fish that are motivated to pass a dam, and to provide a mechanism for them to do so. Therefore, it is anticipated that 100% of the Atlantic salmon that use the upstream passage facilities at the Lockwood and Brunswick Projects during the interim period are collected, captured and trapped and, therefore, could potentially be exposed to the stress, injury and delay associated with being forced into fishways.

Table 21. Summary of incidental take of Atlantic salmon associated with FERC's authorization of the licensee's proposed project.

Project	Source of Effect	Lifestage	Type of Effect	Mechanism of Effect	Timeframe	Extent
Lockwood	Upstream Passage	Adult	Collect/Capture	Forced straying	2013-2019	40.00%
			Harassment		2013-2019	59.40%
			Mortality			0.60%
	Downstream Passage	Smolt	Mortality	Direct and Indirect	2013-2019	6.00%
		Kelt				12.00%
	Monitoring Studies	Smolt	Harm	Handling/Surgery	2014-2015	400 fish
			Mortality			4 per year
		Adult	Harm	Handling/Surgery	2016-2018	120 fish
		Kelt	Harm	Handling/Surgery	3 year study	60 fish
	Stranding	Adult	Harassment	Delay and injury	2013-2019	2 per year
Shawmut	Downstream Passage	Smolt	Mortality	Direct and Indirect	2013-2019	5.00%
		Kelt				11.00%
	Monitoring Studies	Smolt	Harm	Handling/Surgery	2014-2015	400 fish
			Mortality			4 per year
		Kelt	Harm	Handling/Surgery	3 year study	60 fish
Weston	Downstream	Smolt	Mortality	Direct and	2013-2019	6.00%

	Passage	Kelt		Indirect		27.00%
	Monitoring Studies	Smolt	Harm Mortality	Handling/Surgery	2014-2015	400 fish 4 per year
		Kelt	Harm	Handling/Surgery	3 year study	60 fish
Brunswick	Upstream Passage	Adult	Collect/Capture	Forced straying	2013-2019	61.00%
			Harassment			38.60%
			Mortality			0.40%
	Downstream Passage	Smolt	Mortality	Direct and Indirect	2013-2019	7.00%
		Kelt				15.00%
	Monitoring Studies	Smolt	Harm Mortality	Handling/Surgery	2014-2015	400 fish 4 per year
		Kelt	Harm	Handling/Surgery	3 year study	60 fish
Lewiston Falls	Upstream Passage	Adult	Harassment	Stray and Delay	2013-2029	100.00%
	Stranding	Adult	Harassment	Delay and Injury	2013-2019	1 fish

According to the expert panel convened by NMFS (2011), 1% of the salmon that fail to pass upstream of a fishway on the Penobscot River will die. Assuming that this rate is similar to what would occur on the Kennebec and Androscoggin Rivers, it is anticipated that, over the term of the ISPP (seven years), 40% of salmon that are motivated to pass the Lockwood Project, as well as 61% motivated to pass the Brunswick Project, will do so successfully but will be collected, captured, and trapped and that 0.6% and 0.4% will die, respectively. The salmon that are not able to pass the Project but survive (59.4% at Lockwood and 38.6% at Brunswick) will be harassed by being prevented from completing their spawning migration. These fish may spawn in downstream habitat or migrate back out to the ocean without spawning.

Downstream Passage

Operation of the Weston, Shawmut, Lockwood, and Brunswick Projects over the term of the ISPP (seven years) could result in the injury or death of up to 6%, 5%, 6%, and 7% of smolts and 27%, 11%, 12%, and 15% of kelts, respectively, that migrate through each individual Project. As these estimates were based on median river flows, we expect that the mortality rates documented during the survival studies at each project will vary by 1-2% depending on river flow (e.g., low, median, or high). As such, we will consider take to have been exceeded if the average mortality over the three study years exceeds the above mortality rates. Under the terms of the ISPP, this level of take is expected to occur only until 2019.

10.1.1.2. Fish Passage Monitoring

To assess the present level of upstream passage for pre spawn Atlantic salmon at the Lockwood Project, the licensee will conduct an upstream passage study that will involve the radio tagging of up to 40 adults a year for three years. This will result in the injury and harassment of up to 120 adult salmon over the course of the study (2016-2018). No pre spawn adult salmon are anticipated to be killed by the handling and tagging associated with the proposed study. A similar study will be conducted at the Brunswick Project (2013-2015). As the fish that will be monitored at Brunswick will be tagged as part of studies conducted by Topsham Hydro Partners at the Pejepscot Project, it is not anticipated that the licensee will need to tag or handle any additional adult salmon as part of the proposed study. Therefore, the upstream passage study at the Brunswick Project will not lead to any take of pre-spawn Atlantic salmon.

To assess the present levels of smolt survival at the Weston, Shawmut, Lockwood, and Brunswick Projects, the licensee proposes to use up to 200 hatchery smolts per year per Project for three years, for a total of 2,400 fish. All of these fish are anticipated to be injured due to the effects of handling and tag insertion. Four smolts per year per Project (2% x 200) are expected to be killed as a result of the proposed study (2013-2015). As the first year of the study is authorized under a section 10 permit, this ITS will only apply to the studies conducted in 2014 and 2015. Therefore, over the final two years of the study, it is anticipated that a total of 32 (four projects x two years x four fish per year) salmon smolts could be killed due to the handling effects associated with downstream survival studies.

To assess the present levels of kelt survival at the Weston, Shawmut, Lockwood, and Brunswick Projects, the licensee will conduct a downstream kelt study that will involve the tagging of up to 20 kelts per year per Project for three years, for a total of 240 fish. All of these fish are anticipated to be injured due to the effects of handling and tag insertion. No kelts are anticipated to be killed by the handling and surgical procedures associated with this project.

The operation of a rotary screw trap in the Sandy River during the smolt outmigration in 2014 and 2015 is anticipated to capture smolts outmigrating from the system. All of these smolts will be injured and harassed, but fewer than 0.74% of these smolts are anticipated to be killed due to the effects of trapping, handling, and anesthetizing.

There is potential for stranding of Atlantic salmon adults in the ledges downstream of the Lewiston Falls and Lockwood Projects after periods of high flow or during flashboard maintenance and replacement. It is anticipated that no more than one Atlantic salmon will be harassed or injured due to stranding at the Lewiston Falls Project over the seven year interim period. Given the larger number of fish approaching the Lockwood Project, as well as documented occurrences of stranded salmon, it is anticipated that up to two pre-spawn Atlantic salmon a year could become harassed or injured due to stranding.

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. Amount or Extent of Incidental Take of Shortnose sturgeon

The proposed action has the potential to directly affect shortnose sturgeon by capturing one shortnose sturgeon every ten years at the Lockwood and Brunswick Projects at their upstream fish passage facilities. In addition, the project could result in the capture of one shortnose sturgeon every ten years at the Lockwood and Brunswick Projects in isolated pools downriver of the dams during flashboard maintenance and replacement. Over the term of the amended license, this equates to four shortnose sturgeon being trapped (two in the fishway and two stranded) at the Lockwood Project (license expires in 2036), and another four being trapped (two in the fishway and two stranded) at the Brunswick Project (license expires in 2029). All trapped individuals will be removed from the fish traps, or the isolated pools, and returned downstream. Any captured fish may be harmed by receiving minor injuries due to abrasions on the trap or the pool substrate. Neither mortality nor major injuries of any shortnose sturgeon is anticipated or exempted.

We believe this level of incidental take is a reasonable estimate of incidental take that will occur given the seasonal distribution and abundance of shortnose sturgeon in the action area and the reports of shortnose sturgeon entering fish lifts, or being stranded, in other rivers. In the accompanying biological opinion, we determined that this level of anticipated take is not likely to result in jeopardy to the species.

10.1.3. Amount or Extent of Incidental Take of Atlantic sturgeon

The proposed action has the potential to directly affect GOM DPS Atlantic sturgeon by capturing one every ten years at the Lockwood and Brunswick Projects at their upstream fish passage facilities. In addition, the Projects could result in the capture of one Atlantic sturgeon every ten years at the Lockwood and Brunswick Projects in isolated pools downriver of the dams during flashboard maintenance and replacement. Over the term of the amended license, this equates to four Atlantic sturgeon being trapped (two in the fishway and two stranded) at the Lockwood Project (license expires in 2036), and another four being trapped (two in the fishway and two stranded) at the Brunswick Project (license expires in 2029). All trapped individuals will be removed from the fish traps, or the isolated pools, and returned downstream. Any captured fish may be harmed by receiving minor injuries due to abrasions on the trap or the pool substrate. Neither mortality nor major injuries of any Atlantic sturgeon is anticipated or exempted.

We believe this level of incidental take is a reasonable estimate of incidental take that will occur given the seasonal distribution and abundance of Atlantic sturgeon in the action area and the reports of Atlantic sturgeon entering fish lifts, or being stranded, in other rivers. In the accompanying biological opinion, we determined that this level of anticipated take is not likely to result in jeopardy to the species.

10.2. Reasonable and Prudent Measures

We believe the following reasonable and prudent measures are necessary and appropriate to minimize and monitor incidental take of Atlantic salmon, shortnose sturgeon, and GOM DPS Atlantic sturgeon. These must be included as enforceable terms of any amended operating licenses issued by FERC to the licensees. Please note that these reasonable and prudent measures and terms and conditions are in addition to the measures contained in the March 14, 2013 ISPP that the licensee has committed to implement and FERC is proposing to incorporate into the project licenses. As these measures will become mandatory requirements of any new licenses issued, we do not repeat them here as they are considered to be part of the proposed action.

1. FERC and the ACOE must ensure, through enforceable conditions of the Project licenses, that the licensee conduct all in-water and near-water construction activities in a manner that minimizes incidental take of ESA-listed or proposed species and conserves the aquatic resources on which ESA-listed species depend.

2. FERC must ensure, through enforceable conditions of the Project licenses, that the licensee measure and monitor the provisions contained in the March 14, 2013 Interim Species Protection Plan (SPP) in a way that is adequately protective of listed Atlantic salmon.

3. FERC must ensure, through enforceable conditions of the Project licenses, that the licensee complete an annual monitoring and reporting program to confirm that they are minimizing incidental take and reporting all project-related observations of dead or injured salmon or sturgeon to NMFS.

10.3. Terms and Conditions

In order to be exempt from prohibitions of section 9 of the ESA, FERC must comply with the following terms and conditions, which implement the reasonable and prudent measures described above and which outline required reporting/monitoring requirements. These terms and conditions are non-discretionary. Any taking that is in compliance with the terms and conditions specified in this Incidental Take Statement shall not be considered a prohibited taking of the species concerned (ESA section 7(o)(2)). In carrying out all of these terms and conditions, FERC as lead Federal agency in this consultation, is responsible for coordinating with the other Federal agencies that are party to the consultation, as well as with the licensees. FERC must implement these terms and conditions through enforceable conditions of the project licenses. Where appropriate, the ACOE must require these terms and conditions as enforceable conditions of any permits or authorizations.

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

    a. Hold a pre-construction meeting with the contractor(s) to review all procedures and requirements for avoiding and minimizing impacts to Atlantic salmon and to emphasize the importance of these measures for protecting salmon.

    b. Timing of in-water work: Work below the bankfull elevation should occur outside of the smolt outmigration period (April 1 to June 15) or within a dewatered cofferdam. The licensee must notify NMFS one week before in-water work begins.

    c. Use Best Management Practices that will minimize concrete products (dust, chips, larger chunks) mobilized by construction activities from entering flowing or standing waters. Best practicable efforts shall be made to collect and remove all concrete products prior to rewatering of construction areas.

    d. Employ erosion control and sediment containment devices at the Lockwood, Shawmut, and Weston Dams during in-water construction activities. During construction, all erosion control and sediment containment devices shall be inspected weekly, at a minimum, to ensure that they are working adequately. Any erosion control or sediment containment inadequacies will be immediately addressed until the disturbance is minimized.

e. Provide erosion control and sediment containment materials (e.g., silt fence, straw bales, aggregate) in excess of those installed, so they are readily available on site for immediate use during emergency erosion control needs.

f. Ensure that vehicles operated within 150 feet (46 m) of the construction site waterways will be free of fluid leaks. Daily examination of vehicles for fluid leaks is required during periods operated within or above the waterway.

g. During construction activities, ensure that BMPs are implemented to prevent pollutants of any kind (sewage, waste spoils, petroleum products, etc.) from contacting water bodies or their substrate.

h. In any areas used for staging, access roads, or storage, be prepared to evacuate all materials, equipment, and fuel if flooding of the area is expected to occur within 24 hours.

i. Perform vehicle maintenance, refueling of vehicles, and storage of fuel at least 150 feet (46 m) from the waterway, provided, however, that cranes and other semi-mobile equipment may be refueled in place.

j. At the end of each work shift, vehicles will not be stored within, or over, the waterway.

k. Prior to operating within the waterway, all equipment will be cleaned of external oil, grease, dirt, or caked mud. Any washing of equipment shall be conducted in a location that shall not contribute untreated wastewater to any flowing stream or drainage area.

l. Use temporary erosion and sediment controls on all exposed slopes during any hiatus in work exceeding seven days.

m. Place material removed during excavation only in locations where it cannot enter sensitive aquatic resources.

n. Minimize alteration or disturbance of the streambanks and existing riparian vegetation to the greatest extent possible.

o. Remove undesired vegetation and root nodes by mechanical means only. No herbicide application shall occur.

p. Mark and identify clearing limits. Construction activity or movement of equipment into existing vegetated areas shall not begin until clearing limits are marked.

q. Retain all existing vegetation within 150 feet (46 m) of the edge of the bank to the greatest extent practicable.

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

   a. Prepare in consultation with NMFS a plan to study the passage and survival of migrating Atlantic salmon (adults, smolts, and kelts) at the Lockwood, Shawmut, Weston, and Brunswick Projects.

   b. Upstream passage studies at the Lockwood Project should not allow test fish to migrate upstream of the Project until such time as there is volitional passage all the way to the Sandy River.

   c. Migratory delay of pre-spawn Atlantic salmon should be monitored downstream of the Lewiston Falls Project as part of the upstream passage studies on the Androscoggin River.

   d. Conduct an instream flow demonstration assessment to evaluate the effects of peaking operations at the Lewiston Falls Project on downstream habitat in the Androscoggin River.

   e. The Atlantic salmon Handling and Rescue Plan should be implemented at the Lewiston Falls Project between May 1 and December 31 if salmon are known to be in the vicinity (i.e. if they have passed the Worumbo Project).

   f. The licensee should seek comments from NMFS on any fish passage design plans at the 30%, 60%, and 90% design phase.

   g. The licensee should allow NMFS staff to inspect fishways at the Projects at least annually.

   h. The licensee should inspect the upstream and downstream fish passage facilities at the Lockwood, Shawmut, Weston, and Brunswick Projects daily during from April 1 to December 31, annually. Submit summary reports to NMFS weekly during the fish passage season.

   i. Annual maintenance requiring the shutdown of upstream fishways should be conducted during the first two weeks of August. The fishway should not be inoperable for any longer than it takes to make the necessary repairs. If water temperatures make it unsafe to sample Atlantic salmon, they should be allowed to volitionally swim through the fishway without being handled.

j. Require that the licensee develop, in consultation with NMFS, project specific adaptive management plans to address any downstream passage deficiencies at the Weston, Shawmut, Lockwood, and Brunswick Projects as documented through site-specific survival studies during the period of the ISPP. The plans should include descriptions of: 1. potential measures to be implemented at each project to improve survival 2. the statistical methodology that will be used to interpret study results, and 3. the monitoring studies that will be implemented to verify the efficacy of the permanent downstream fish passage facilities. These plans should be completed no later than January 1, 2014.

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

    a. Notify NMFS of any changes in operation including maintenance activities and debris management at the project during the term of the ISPP.

    b. Contact NMFS within 24 hours of any interactions with Atlantic salmon, shortnose sturgeon or Atlantic sturgeon including non-lethal and lethal takes (Dan Tierney: by email (Dan.Tierney@noaa.gov) or phone (207) 866- 3755 and the Section 7 Coordinator (incidental.take@noaa.gov).

    c. 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, immediate 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 NMFS the need for possible modification of the reasonable and prudent measures.

Reasonable and prudent measures and their implementing terms and conditions may not alter the basic design, location, scope, duration, or timing of the action, and should involve only minor changes (50 CFR §402.14(i)(2)). The FERC and ACOE have reviewed the RPMs and Terms and Conditions outlined above and have agreed to implement all of these measures as described herein. The discussion below explains why each of these RPMs 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 the FERC.

RPM #1, as well as Term and Condition #1 are necessary and appropriate as they will require the licensee and their contractors to use best management practices and best available technology for construction. This will ensure that take of listed Atlantic salmon is minimized to the extent practical. These procedures represent only a minor change to the proposed action as following these procedures should not increase the cost of the project or result in any delays or reduction of efficiency of the project.

RPM #2, as well as Term and Condition #2, are necessary and appropriate as they describe how the licensee will be required to measure and monitor the success of the proposed measures in the ISPP in order to minimize the effects on Atlantic salmon. These procedures represent only a minor change to the proposed action as following these procedures should not increase the cost of the project or result in any delays or reduction of efficiency of the project.

RPM #3, as well as Term and Condition # 3, 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 NMFS in a timely manner with all of the necessary information. This is essential for monitoring the level of incidental take associated with the proposed action. This RPM and the Terms and Conditions represent only a minor change as compliance will not result in any increased cost, delay of the project or decrease in the efficiency of the project.

11. CONSERVATION RECOMMENDATIONS

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

1. If any lethal take occurs, FERC should use its authorities to, and/or direct the licensees to, arrange for contaminant analysis of the specimen. If this recommendation is to be implemented, the fish should be frozen and NMFS should be contacted immediately to provide instructions on shipping and preparation.

2. FERC should use its authorities to implement license requirements for all FERC regulated projects in Maine to provide safe and effective upstream and downstream fish passage for listed Atlantic salmon and other diadromous fish species. For Atlantic salmon, this can be accomplished through station shutdowns during the smolt passage season (April to June) and kelt passage season (October to December and April to June) or the installation of highly effective fishways.

3. FERC should use its authorities to require all FERC regulated hydroelectric projects in Maine to document the effectiveness of station shutdowns or fishways in protecting listed species.

4. FERC should use its authorities to require all FERC regulated hydroelectric projects in Maine to operate in a manner that is protective of NMFS listed species. This can be

accomplished by requiring these facilities to operate in a run-of-river mode to simulate a natural stream hydrograph.

12. REINITIATION NOTICE

This concludes formal consultation concerning FERC's proposal to amend the licenses for the Lockwood, Shawmut, Weston, Brunswick, and Lewiston Falls Projects to incorporate the provisions of the proposed ISPP and Sturgeon Handling and Protection Plan. 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.

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