Appendix 9

2019 Draft Biological Assessment (filed at FERC with Draft SPP; December 31, 2019)

DRAFT BIOLOGICAL ASSESSMENT FOR ATLANTIC SALMON, ATLANTIC STURGEON AND SHORTNOSE STURGEON

AT THE LOCKWOOD, HYDRO-KENNEBEC, SHAWMUT, AND WESTON PROJECTS ON THE KENNEBEC RIVER, MAINE

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LOCKWOOD, HYDRO-KENNEBEC, SHAWMUT, AND WESTON PROJECTS

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1.0 BACKGROUND

1.1 OVERVIEW

Brookfield Renewable Partners LLC (Brookfield) indirectly owns and operates four hydroelectric projects (collectively, the "Projects") located on the Kennebec River in Maine. All four of the hydroelectric Projects are licensed by the Federal Energy Regulatory Commission (FERC): the Lockwood Project is licensed to the Merimil Limited Partnership; the Hydro-Kennebec Project is licensed to Hydro-Kennebec LLC, and the Shawmut and Weston projects are licensed to Brookfield White Pine Hydro LLC (BWPH), herein individually, or collectively, the "Licensee". The expiration years for the current FERC licenses for the Projects are Shawmut (2022)1, Weston (2036), Hydro-Kennebec (2036), and Lockwood (2036).

Each of the Projects occur within the range of the endangered Gulf of Maine Distinct Population Segment (GOM DPS) of Atlantic salmon (Salmo salar), and all four are located entirely within designated critical habitat for salmon. The continued operation of these Projects may have effects on the GOM DPS of Atlantic salmon and its designated critical habitat. In addition, the Lockwood Project tailwater area is in designated critical habitat for the listed Atlantic sturgeon (Acipenser oxyrinchus oxyrinchus) and within the known range of shortnose sturgeon (Acipenser brevirostrum).

Because the Projects are located within designated critical habitat of these species and these species do or could occur within the respective Project areas, FERC is required to engage in endangered species consultation with the U.S. Fish and Wildlife Service (USFWS) and the National Marine Fisheries Service (NMFS, collectively the "Services") pursuant to Section 7 of the Endangered Species Act (ESA) when a FERC federal action is pending. Section 7 of the ESA mandates that federal agencies consult with the Secretaries of Interior (through USFWS) and

[1] By Order dated December 11, 2018, FERC extended the term of the existing license for the Shawmut Project by one year to January 31, 2022 (165 FERC ¶ 62,152).

Commerce (through NMFS) to determine whether a proposed action is likely to jeopardize listed species and/or adversely affect designated critical habitat for such species.

In consultation with federal and state fishery management agencies, including NMFS, USFWS, the Maine Department of Marine Resources (MDMR), and the Maine Department of Inland Fisheries and Wildlife (MDIFW), the Licensee has developed a Species Protection Plan (SPP) for the four Projects. The SPP represents the Licensee's proposed measures to avoid or minimize potential adverse effects of the Projects on Atlantic salmon, Atlantic sturgeon and shortnose sturgeon as part of a request to amend the respective project licenses, which is the federal action pending before FERC for which Section 7 ESA consultation must be undertaken.

Consistent with its designation as FERC's non-federal representative for Endangered Species Act (ESA) consultation for the development of the SPP, the Licensee has developed this draft Biological Assessment (BA) for the federally endangered GOM DPS of Atlantic salmon and shortnose sturgeon, along with the federally threatened GOM DPS of Atlantic sturgeon.

1.2 Purpose and Description of Draft Biological Assessment

Section 9 of the ESA prohibits the take of endangered species, unless the take is authorized under specific provisions of the ESA. "Take" is defined by the ESA as "to harass, harm, pursue, ban, shoot, wound, kill, trap, capture, or collect," these species, or to attempt to engage in any such conduct. Exemptions to the prohibitions of take under Section 9 of the ESA can be provided by the Services through Section 10 or Section 7 of the ESA. Under ESA Section 10(a)(1)(B), permits may be issued for taking that is incidental to the purposes of an otherwise lawful activity (incidental take permits). Under ESA Section 7(a)(2), incidental take statements (ITS) may be issued to exempt the Licensee or Project owner from the prohibitions any take anticipated as an incidental result of an activity conducted, permitted, or funded by a federal agency, provided this take would not be likely to result in jeopardy to the species or destruction of its critical habitat.

Section 7 of the ESA mandates that all federal agencies consult with the Secretaries of Commerce and Interior to determine whether a proposed action is likely to be categorized with respect to listed species and designated critical habitat, as follows:

- No Effect: No effects to the species and its critical habitat from the proposed action, either positive or negative, are expected.
- May Affect, Not Likely to Adversely Affect: All effects of the proposed action to the species and its critical habitat are beneficial, insignificant, or discountable. Beneficial effects have positive effects to the species or its critical habitat. Insignificant effects relate to the size of the impact and should not reach the scale where incidental or unintentional take (harming or killing) occurs. Discountable effects are those that are extremely unlikely to occur. Determinations of “not likely to adversely affect” due to beneficial, insignificant, or discountable effects require written concurrence from the USFWS or NMFS.
- May Affect, Likely to Adversely Affect: The action would have an adverse effect on the species or its critical habitat. Any action that would result in take of an endangered species is considered an adverse effect. A combination of beneficial and adverse effects is still considered “likely to adversely affect” even if the net effect is neutral or positive. Adverse effects are not considered discountable because they are expected to occur. This determination requires formal consultation with the USFWS or NMFS.

The purpose of this draft BA is to evaluate the potential effects of the action of amending the licenses and implementing the measures included in the SPP on the listed species and designated critical habitat and to determine whether the listed species or critical habitats are likely to be adversely affected by the action.

1.3 Existing Authorized Activities Under Previously Approved Interim Species Protection Plans (ISPP)

In 2012 and 2013, the Project licensees proactively initiated Section 7 consultation ahead of any federal action, such as an amendment of license(s) or relicensing a project(s), by filing Interim Species Protection Plans (ISPP) for the Lockwood, Hydro-Kennebec, Shawmut and Weston Projects.[2] NMFS issued Biological Opinions (BO’s) for the four Projects in 2012, 2013 and 2017, which included ITSs and Reasonable and Prudent Measures necessary to “minimize and/or monitor incidental take and set(s) forth terms and conditions with which the action agency must

[2]The ISPP for the Hydro-Kennebec Project was filed with FERC April 6, 2012. FERC issued an Order Approving the Atlantic Salmon ISPP for the Hydro-Kennebec Project on February 28, 2013, and approved an extension of the ISPP on March 14, 2018. The ISPP for the Lockwood, Shawmut and Weston Projects was filed with FERC February 21, 2013. FERC issued an Order Amending License[s] to approve the ISPP and the Handling and Protection Plan for Shortnose and Atlantic Sturgeon for the Lockwood, Shawmut and Weston Projects on May 19, 2016.

comply".[3] Because the ITSs for the Projects expire in December 2019, the Licensee is required to file a final SPP for the Projects for which NMFS would issue a BO and new ITS.

Several fish passage measures that are currently in the process of final implementation have been previously authorized under the ISPPs, BOs, and FERC license amendments for the Lockwood, Hydro-Kennebec, Shawmut and Weston Projects. Specifically, the upstream passage measures for the four projects have been authorized, some have already been constructed, and several of the downstream measures have been authorized and are operational. Table 1-1 provides a summary of the previously approved measures that are ongoing and/or in the process of final implementation. Measures previously approved under the ISPPs for each of the four Projects are outlined in more detail in the Project Descriptions in Section 2.

TABLE 1-1 OVERVIEW OF PREVIOUSLY APPROVED AND ONGOING MEASURES

PROJECT	UPSTREAM PASSAGE MEASURES	DOWNSTREAM PASSAGE MEASURES	MONITORING MEASURES AND MANAGEMENT
Lockwood	Structural – Design, install, and operate permanent volitional passage in the Lockwood bypass reach by May 2022. *(Specific type and design of facility to be determined with the fishery agencies).* Operational – Continue to operate the main channel fish lift in cooperation with MDMR, and in coordination with the other fishery agencies.	Operational – Continue to operate the existing downstream fish passage facility and maintain the forebay fish guidance boom.	Continue to implement Sturgeon Handling Plan. Continue to prepare annual fishway monitoring reports and hold annual meeting with fishery agencies.

[3] The Biological Opinion for the Hydro-Kennebec Project was issued by NMFS on September 17, 2012; a three-year extension of the Biological Opinion for the Hydro-Kennebec Project was issued by NMFS on May 25, 2017. The Biological Opinion for the Lockwood, Shawmut and Weston Projects was issued by NMFS on July 19, 2013.

PROJECT	UPSTREAM PASSAGE MEASURES	DOWNSTREAM PASSAGE MEASURES	MONITORING MEASURES AND MANAGEMENT
Hydro-Kennebec	Operational – Operate the existing upstream fish lift in accordance with agency approved operational plan.	Operational – Continue to operate the existing downstream fish passage facility and maintain the forebay fish guidance boom.	Continue to prepare annual fishway monitoring reports and hold annual meeting with fishery agencies.
Shawmut	Structural – Design, install, and operate upstream fish lift by May 2021. Operational – Operate the new upstream fish lift in accordance with agency approved operational plan.	Operational – Continue to operate the existing downstream fish passage facility and supplemental spill through the hinge boards.	Continue to prepare annual fishway monitoring reports and hold annual meeting with fishery agencies.
Weston	Structural – Design, install, and operate upstream fish lift by May 2022. Operational – Operate the new upstream fish lift in accordance with agency approved operational plan.	Operational – Continue to operate the existing downstream fish passage facility and maintain the forebay fish guidance boom.	Continue to prepare annual fishway monitoring reports and hold annual meeting with fishery agencies.

1.4 PROPOSED ACTION - SPECIES PROTECTION PLAN (SPP)

In consultation with the agencies, the Licensee has developed an SPP that identifies further measures and actions to avoid or minimize potential adverse effects of continued operation of the Projects on GOM DPS of Atlantic salmon and its designated critical habitat. The SPP also includes a Handling Plan for Shortnose and Atlantic Sturgeon (SPP Appendix A) which identifies measures to avoid and minimize potential adverse effects of the Lockwood Project on shortnose sturgeon and GOM DPS Atlantic sturgeon.

Through amendment of the existing licenses and subsequent implementation of the SPP, Atlantic salmon will be protected through a combination of enhanced upstream and downstream passage, avoiding and minimizing delay, injury, and protection of critical migration habitat in the Project areas. The SPP also includes measures for protecting listed shortnose sturgeon and Atlantic sturgeon at the Lockwood Project. The Licensee will request FERC initiate a single, comprehensive consultation for all three species (Atlantic salmon, Atlantic sturgeon, and shortnose sturgeon) with NMFS. In turn, it is anticipated that NMFS will issue a single Biological Opinion (BO) for all species and all the Projects considered in the SPP.

A summary of the primary proposed measures to be undertaken by the Licensee as part of the amendments of licenses and implementation of the SPP for the protection of Atlantic salmon are outlined in Table 1-2. Measures to be undertaken to protect shortnose and Atlantic sturgeon are set forth in the Sturgeon Handling Plan (SPP Appendix A) and are summarized in Section 5.2.

The FERC license for the Shawmut Project expires January 31, 2022, and the Licensee expects to file a Final License Application (FLA) for the Shawmut Project by January 31, 2020. It is anticipated that the continuation of the existing approved measures, and the additional proposed measures in this SPP, for the Shawmut Project will be included as protection, mitigation and enhancement measures in the FLA for incorporation into the New License for the Shawmut Project.

TABLE 1-2 OVERVIEW OF SPECIES PROTECTION PLAN MEASURES

PROJECT	UPSTREAM PASSAGE MEASURES	DOWNSTREAM PASSAGE MEASURES	MONITORING MEASURES AND MANAGEMENT
Lockwood	Operational - Operate permanent volitional passage in the Lockwood bypass (expected to be installed by May 2022) in accordance with agency approved operational plan. Operational – Continue to operate the main channel fish lift in cooperation with MDMR, in coordination with the other fishery agencies.	Operational – Continue to operate the existing downstream fish passage facility and maintain the forebay fish guidance boom. Operational - Provide intentional spill in low flow years (up to 50% of inflows as determined in consultation with the agencies) & Unit 1 prioritization for two weeks in May when river temperature first reaches and or exceeds 10°C.	Up to three years of additional downstream passage monitoring of smolts released at projects upstream of Lockwood to continue to evaluate smolt passage and station survival. Up to two years of adult salmon studies to evaluate the performance of the proposed Lockwood bypass reach fishway and, as appropriate, the existing fish lift. Revise and implement site-specific Fish Passage O&M Plan and Sturgeon Handling Plan.
Hydro-Kennebec	Operational – Operate the existing upstream fish lift in accordance with agency approved operational plan.	Structural – Close existing gap between the Worthington boom and the forebay wall/downstream bypass entrance. Operational – Continue to operate the existing downstream fish passage facility and maintain the forebay fish guidance boom.	Up to three years of additional downstream passage studies to reevaluate smolt passage and station survival. Up to two years of adult salmon studies to evaluate the performance of the Hydro-Kennebec fish lift. Revise and implement site-specific Fish Passage O&M Plan.

PROJECT	**UPSTREAM PASSAGE MEASURES**	**DOWNSTREAM PASSAGE MEASURES**	**MONITORING MEASURES AND MANAGEMENT**
Shawmut	Operational – Operate the new upstream fish lift (expected to be installed by May 2021) in accordance with agency approved operational plan.	Structural – Install guidance boom (e.g., Worthington boom) in forebay (in front of Units 7 and 8) to direct downstream migrants to the bypass gate(s). Operational – Continue to operate the existing downstream fish passage facility and maintain the forebay fish guidance boom.	Up to three years of additional downstream passage studies to reevaluate smolt passage and station survival. Up to two years of adult salmon studies to evaluate the performance of the Shawmut fish lift. Revise and implement site-specific Fish Passage O&M Plan.
Weston	Operational – Operate the new upstream fish lift (expected to be installed by May 2022) in accordance with agency approved operational plan.	Structural - Modify downstream bypass. *(Detailed modifications to be developed with agencies and possibly including smoothing, slope change, ledge removal).* Operational – Continue to operate the existing downstream fish passage facility and maintain the forebay fish guidance boom.	Up to three years of additional downstream passage studies to reevaluate smolt passage and station survival. Up to two years of adult salmon studies to evaluate the performance of the Weston fish lift. Revise and implement site-specific Fish Passage O&M Plan

1.5 ESA Listing of Atlantic Salmon

The GOM DPS of Atlantic salmon was first listed as endangered by the Services on November 17, 2000 (USFWS and NMFS 2000). The GOM DPS designation in 2000 included all naturally reproducing Atlantic salmon populations occurring in an area from the Kennebec River downstream of the former Edwards Dam site extending north to the international border between Canada and the United States at the mouth of the St. Croix River. The November 2000 final rule listing the GOM DPS did not include fish that inhabit the mainstem and tributaries of the Penobscot River above the site of the former Bangor Dam, the Kennebec River above the site of the former Edwards Dam, or the Androscoggin River (USFWS and NMFS 2000).

The 2006 Status Review for anadromous Atlantic salmon in the U.S. (Fay et al. 2006) assessed genetic and life history information and concluded that the GOM DPS, as defined in 2000, should be redefined to encompass the Penobscot, Kennebec, and Androscoggin Rivers. On June 19, 2009, the Services published a final rule determining that naturally spawned and conservation hatchery populations of anadromous Atlantic salmon whose freshwater range occurs in the watersheds from the Androscoggin River northward along the Maine coast to the Dennys River, including those that were already listed in November 2000, constitute a DPS and hence a “species” for listing as endangered under the ESA (USFWS and NMFS 2009). This range includes the lower portions of the Kennebec River.

The GOM DPS of Atlantic salmon is divided into three salmon habitat recovery units (SHRUs) within the range of the GOM DPS and includes the following: the Downeast Coastal SHRU, the Penobscot Bay SHRU, and the Merrymeeting Bay SHRU. The three SHRUs were created to ensure that Atlantic salmon were widely distributed across the DPS such that recovery of the GOM DPS of Atlantic salmon is not limited to one river or one geographic location, because widely distributed species are less likely to become threatened or endangered by limited genetic variability and tend to be more stable over space and time (NOAA 2009).

The Merrymeeting Bay SHRU contains historically accessible spawning and rearing habitat for Atlantic salmon. Most of the habitat within the Merrymeeting Bay SHRU is in the Kennebec River basin. A variety of issues and conditions, including dams, affect Atlantic salmon recovery in the Kennebec River, including also agriculture, forestry, changing land use, hatcheries and stocking, roads and road crossings, mining, dredging, aquaculture, and introductions of non-native species such as smallmouth bass (NMFS 2009a).

1.5.1 Critical Habitat Designation

As a result of the June 19, 2009, endangered species listing, NMFS was required to evaluate historical occupancy of the watershed for the process of designating critical habitat for the GOM DPS. Section 3 of the ESA defines critical habitat as the following:

1. Specific areas within the geographical area occupied by the species at the time of listing, in which are found those physical or biological features that are essential to the conservation of the listed species and that may require special management considerations or protection; and
2. Specific areas outside the geographical area occupied by the species at the time of listing that are essential for the conservation of a listed species.

As part of the critical habitat designation, NMFS described the known primary constituent elements (PCEs) that are deemed essential to the conservation of the GOM DPS, including (1) sites for spawning and rearing and (2) sites for migration (excluding marine migration). 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:

- A1. 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.
- A2. 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.
- A3. 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.
- A4. Freshwater rearing sites with space to accommodate growth and survival of Atlantic salmon parr.
- A5. 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.
- A6. Freshwater rearing sites with cool, oxygenated water to support growth and survival of Atlantic salmon parr.

A7. Freshwater rearing sites with diverse food resources to support growth and survival of Atlantic salmon parr.

Physical and Biological Features of the Migration PCE:

B1. 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.

B2. 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.

B3. Freshwater and estuary migration sites with abundant, diverse native fish communities to serve as a protective buffer against predation.

B4. Freshwater and estuary migration sites free from physical and biological barriers that delay or prevent emigration of smolts to the marine environment.

B5. Freshwater and estuary migration sites with sufficiently cool water temperatures and water flows that coincide with diurnal cues to stimulate smolt migration.

B6. Freshwater migration sites with water chemistry needed to support sea water adaptation of smolts.

On June 19, 2009, NMFS designated as critical habitat 45 specific areas occupied by GOM DPS Atlantic salmon at the time of listing. Critical habitat includes the stream channels within the designated stream reaches, and includes a lateral extent as defined by the ordinary high-water line (33 C.F.R. 329.11). Critical habitat in estuaries 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. Critical habitat is designated to include all perennial rivers, streams, and estuaries and lakes connected to the marine environment within the range of the GOM DPS of Atlantic salmon, except for those particular areas within the range which are specifically excluded (NMFS 2009b).

The Lockwood, Hydro-Kennebec, Shawmut, and Weston projects all lie within the designated critical habitat of the Merrymeeting Bay SHRU for Atlantic salmon. Critical habitat is further delineated into HUC 10 watersheds. In the Merrymeeting Bay SHRU there are an estimated 372,600 units of historically accessible spawning and rearing habitat for Atlantic salmon, found among approximately 5,950 km2 of historically accessible rivers, streams and lake. Of these units, 136,000 units of habitat are considered to be critical habitat. Of these, NMFS estimates there to be nearly 40,000 functional equivalents of habitat or approximately 11 percent of the historical functional potential. This estimate is based on the configuration of dams within the SHRU that limit migration and degradation of physical and biological features from land use activities which reduce the productivity of habitat within each HUC 10 (NMFS 2013). NMFS has further determined that for each SHRU to achieve recovery objectives for Atlantic salmon, 30,000 fully functional units of habitat are needed (NMFS, 2009b).

The Kennebec River in the vicinity of the Lockwood, Hydro-Kennebec, 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 four Projects is within the Sandy River located approximately 11 miles upstream of the Weston Project dam. 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 (NMFS 2013). There is also significant juvenile habitat in Wesserunsett Stream which flows into the mainstem Kennebec River downstream of Weston dam. Despite this production potential, it is unlikely that much of this habitat is used, as pre-spawn salmon are currently trucked from Lockwood to spawning and rearing habitat in the Sandy River (NMFS 2013).

The 1,126 habitat units downstream of Lockwood is currently accessible to pre-spawn 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 efforts have identified suitable spawning habitat in the mainstem river below the Lockwood Project, some of which is within 300 meters of the Project (NMFS 2013).

1.5.2 ATLANTIC SALMON RECOVERY PLAN

Efforts by federal, state and local government agencies, as well as many private conservation organizations aimed at protecting Atlantic salmon and its habitat in Maine have been underway for well over one hundred years. The 2019 *Final Recovery Plan for the Gulf of Maine Distinct Population Segment of Atlantic Salmon* (the Plan) for listed GOM DPS presents a strategy for recovering Atlantic salmon in the rivers listed as endangered under the ESA (USFWS and NMFS 2019).

The Plan focuses on the three statutory requirements in the ESA including: site-specific recovery actions; objective, measurable criteria for delisting; and time and cost estimates to achieve recovery and intermediate steps. It's based on two premises: first, that recovery must focus on rivers and estuaries located in the GOM DPS until threats in the marine environment are better understood; and second, that survival of Atlantic salmon in the GOM DPS depends on conservation hatcheries through much of the recovery process (USFWS and NMFS 2019). The main objectives of the Plan are to maintain self-sustaining, wild populations with access to sufficient suitable habitat in each SHRU, and to ensure that necessary management options for marine survival are in place. In addition, the plan seeks to reduce or eliminate all threats that either individually or in combination might endanger the DPS (USFWS and NMFS 2019).

The current recovery criteria for downgrading classification from endangered to threatened consist of:

1. The entire DPS has a total annual escapement of at least 1,500 naturally reared adults spawning in the wild, with at least two of the three SHRUs having at least 500 naturally reared adult returns;
2. The population in each of at least two of the three SHRUs must also have a population growth rate greater than 1.0 in the 10-year period preceding reclassification;
3. Adults originating from stocked eggs, fry, and parr are included when estimating population growth rates; and
4. Sufficient suitable spawning and rearing habitat for the offspring of the 1,500 naturally reared adults is accessible and distributed throughout designated Atlantic salmon critical habitat, with at least 7,500 accessible and suitable habitat units in each of at least two of the three SHRUs (USFWS and NMFS 2016).

The longer-term recovery target for the delisting of Atlantic salmon consists of:

1. The DPS has a self-sustaining annual escapement of at least 2,000 wild adult salmon returns in each of the three SHRUs for a DPS-wide total of at least 6,000 wild adults;
2. Each SHRU has a population growth rate of greater than 1.0 in the 10-year period preceding delisting, and at the time of delisting, the DPS demonstrates self-sustaining persistence; and
3. Sufficient suitable spawning and rearing habitat for the offspring of 6,000 wild adults is accessible and distributed throughout designated Atlantic salmon critical habitat, and with at least 30,000 accessible and suitable habitat units in each SHRU, located according to the known migratory patterns of returning wild adult salmon.

The Plan includes a table that generally identifies the priority, timing, and involved parties for the various actions, but it is important to recognize that annual decisions made about recovery priorities will be formulated in SHRU-level work plans (USFWS and NMFS 2019). SHRU-level work plans provide the basis for determining activities that should be implemented in the short term for each of the plan's recovery actions. The seven categories of recovery actions include:

- Habitat Connectivity, intended to enhance connectivity between the ocean and freshwater habitats important for salmon recovery;
- Genetic Diversity, intended to maintain the genetic diversity of Atlantic salmon populations over time;
- Conservation Hatchery, intended to increase adult spawners through the conservation hatchery program;
- Freshwater Conservation, intended to increase adult spawners through the freshwater production of smolts;
- Marine and Estuary, intended to increase survival in these habitats by increasing understanding of these salmon ecosystems and identifying the location and timing of constraints to the marine productivity of salmon in support of management actions to improve survival;
- Federal/Tribal Coordination, intended to facilitate consultation with all involved Tribes on a government-to-government basis; and
- Outreach, Education, and Engagement, intended to collaborate with partners and engage interested parties in recovery efforts for the GOM DPS (USFWS and NMFS 2016).

For geographically based recovery actions, the SHRU-level work plans describe threats and recovery activities with a high priority within a 5-year period. Threats listed for the overall Merrymeeting Bay SHRU consist of:

- Climate change and the adverse effect it may have on habitats most suitable for Atlantic salmon;
- Dams and culverts that block or impede access to Atlantic salmon spawning and rearing habitat degrade habitat features for native riverine species;
- The stocking and introduction of non-native species, particularly smallmouth bass, compete with and prey on Atlantic salmon;
- Pollution attributed to land use and development practices in the Merrymeeting Bay SHRU can harm Atlantic salmon and degrade the productive capacity of freshwater and estuary habitats;
- Historic and current land uses have degraded the complexity and productivity of freshwater habitats that support Atlantic salmon (e.g., historic log drives, past and current agriculture and forestry practices, and residential development practices);

- The small population size and small number of remaining family groups within the Merrymeeting Bay Coastal SHRU compromises the overall fitness of the GOM DPS; and
- Limited resources to assess all areas that could be occupied by Atlantic salmon.

Recovery actions are also outlined in the recovery plan (USFWS and NMFS 2019). The recovery action identified for the Kennebec River that is relevant to the Kennebec projects SPP is:

- As necessary and appropriate for salmon recovery, develop broodstock programs in watersheds that currently do not have locally adapted breeding populations within the GOM DPS (e.g. Kennebec and Androscoggin rivers).

The 2019 recovery plan generally discusses the successes of combined efforts undertaken on the Kennebec River to restore Atlantic salmon to the river as follows:

> *There has also been significant conservation successes in the Kennebec River watershed. The Kennebec River Diadromous Fish Restoration Project was initiated in 1986 when the Maine Department of Marine Resources (MDMR) signed a settlement agreement with the Kennebec Hydro-Developers Group (KHDG). A second settlement agreement signed in 1998 by state and federal fisheries resource agencies, non-governmental organizations, and the KHDG resulted in the removal of Edwards Dam in Augusta to provide fish passage for all diadromous fish species, instituted schedules or triggers for fish passage at the seven KHDG dams, and provided additional funding for the stocking program. From 1837 to 1999 the Edwards Dam in Augusta prevented any upstream fish passage. Removal of Edwards dam restored full access to historical spawning habitat for species like Atlantic sturgeon, shortnose sturgeon, and rainbow smelt, but not for species including alewife, American shad and Atlantic salmon that migrated much further up the river (MDMR, 2007). With the removal of Edwards Dam, the first dam on the Mainstem is now the Lockwood Dam in Waterville. In 2006, a fish lift was constructed with the ability to trap and truck Atlantic upstream of three dams that continued to block access to the Sandy River. The Sandy River contains high quality, abundant Atlantic salmon spawning and nursery habitat.*

2.0 PROJECT DESCRIPTIONS

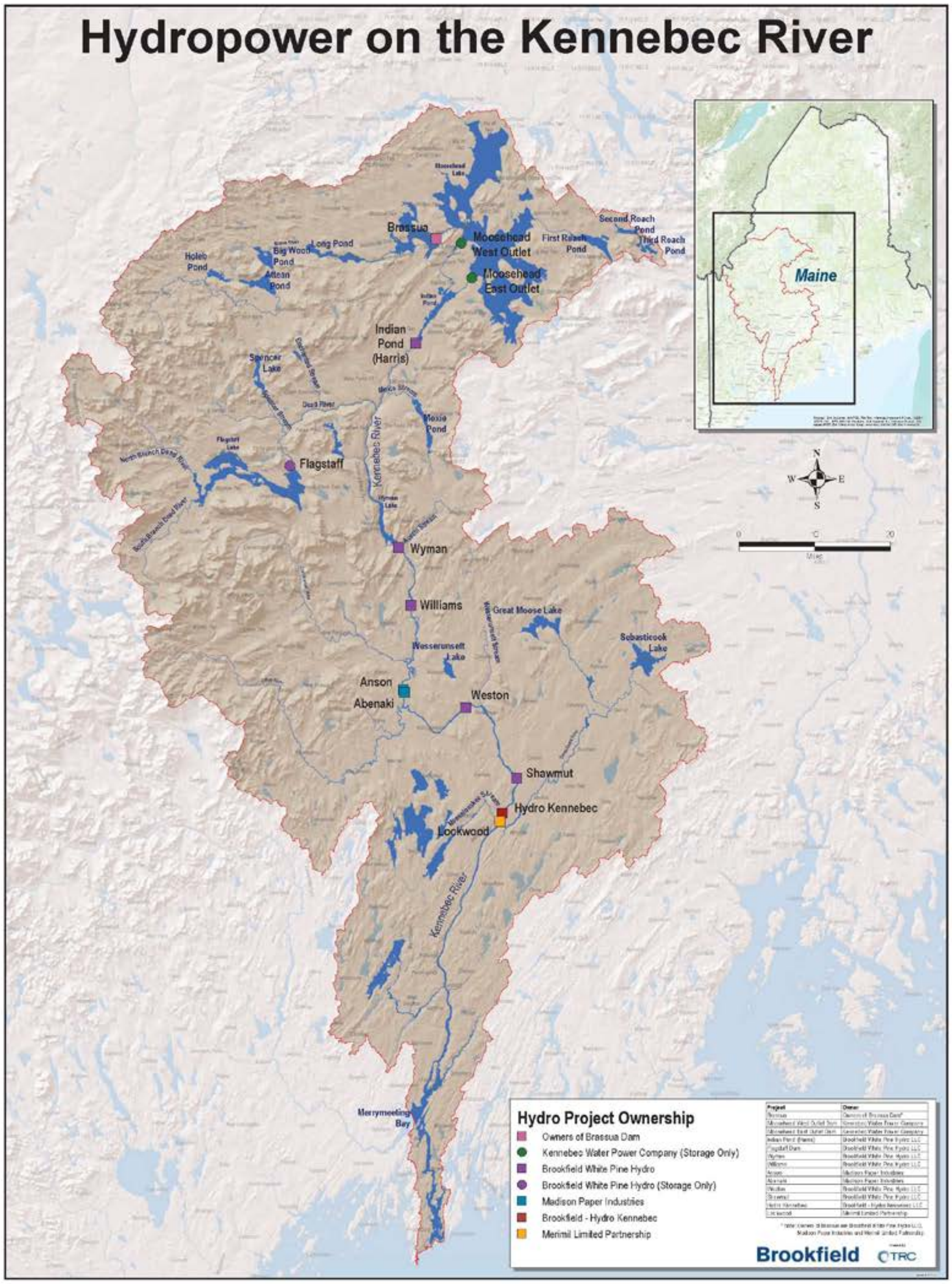
2.1 KENNEBEC RIVER BASIN

The Kennebec River basin is the largest of the watersheds that comprise the Merrymeeting Bay SHRU. The Kennebec River watershed covers an area of 5,910 square miles, approximately 1/5 of the state of Maine, and flows 138 miles from Moosehead Lake to Merrymeeting Bay where it joins the Androscoggin River. The Kennebec watershed is bordered on the west by the Androscoggin River Basin, on the north and east by the Penobscot River Basin, and by coastal streams and the Gulf of Maine on the south.

The Kennebec River's mainstem originates at the outlet of Moosehead Lake and flows generally southward through the towns and cities of Bingham, Solon, Anson, Madison, Norridgewock, Skowhegan, Waterville, and Augusta. The river transitions from a high gradient cold water river from upstream of Indian Pond to Madison, to a warmwater river from Skowhegan to Augusta. A 24-mile-long, mostly freshwater tidal segment of the river exists downstream from Augusta, and slightly brackish conditions exist periodically in Merrymeeting Bay (CABB, 2006).

The Kennebec River basin has been extensively developed for over a century for industrial use, including driving of logs and pulp, mills, and hydroelectric power production. The Lockwood Project (FERC Project No. 2574), located at river mile 63, is the lowermost dam and hydroelectric plant on the mainstem river. The drainage area above the Lockwood Project is 4,228 square miles. Other mainstem projects upstream of Lockwood include Hydro-Kennebec (FERC Project No. 2611), Shawmut (FERC Project No. 2322), Weston (FERC Project No. 2325), Abenaki (FERC Project No. 2364), Anson (FERC Project No. 2365), Williams (FERC Project No. 2335), Wyman (FERC Project No. 2329), and Harris (FERC Project No. 2142) (Figure 2-1). The Fort Halifax Project (FERC No. 2552), which was removed in 2008, was formerly located near the mouth of the tributary Sebasticook River, only about 0.5 miles downstream of Lockwood. Edwards dam (FERC Project No. 2389), which was removed in 1999, was located about 18 miles downstream of Lockwood on the main stem.

FIGURE 2-1 LOCATION OF HYDROELECTRIC PROJECTS IN THE KENNEBEC RIVER BASIN



Source: Brookfield White Pine Hydro, 2019

2.2 LOCKWOOD PROJECT

2.2.1 EXISTING PROJECT FACILITIES AND OPERATIONS

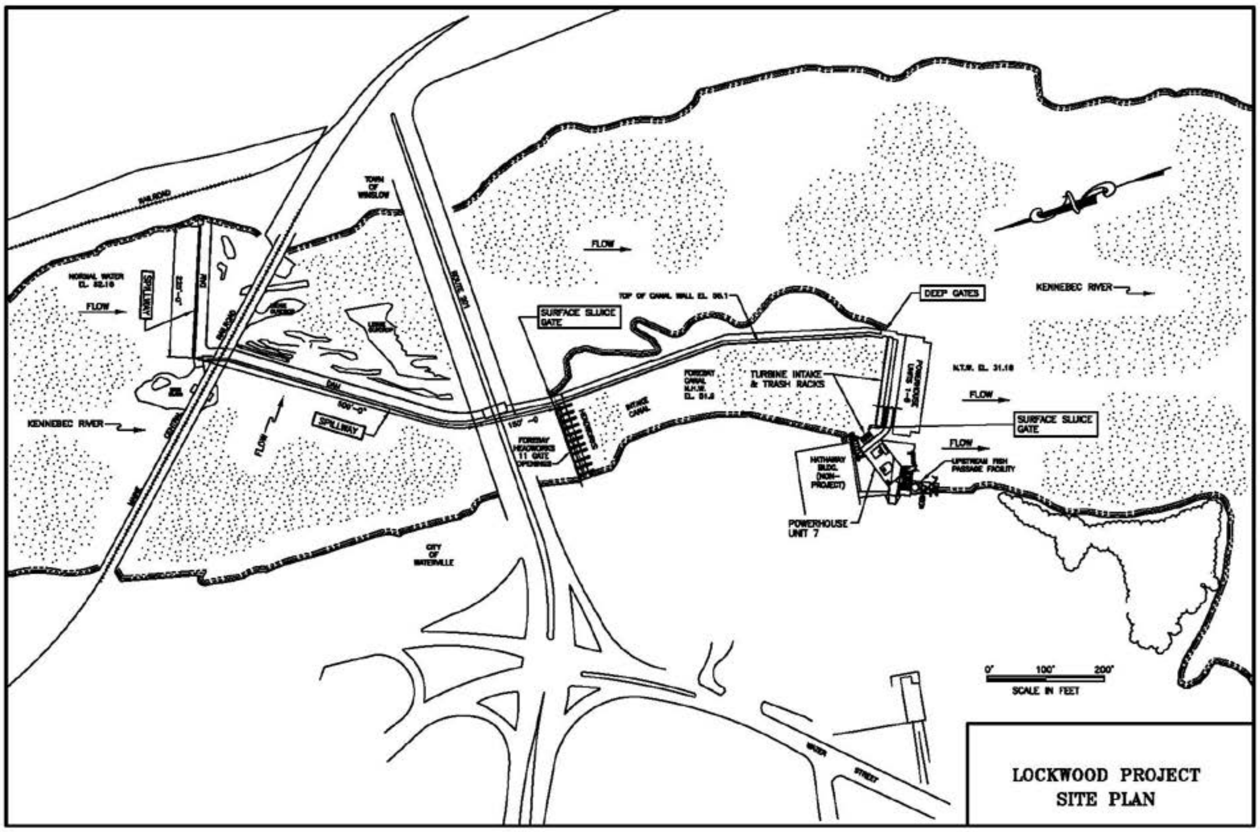
The Lockwood Project is owned by the Merimil Limited Partnership (MLP) and is located at river mile 63 and is the first dam on the mainstem of the Kennebec River. The Lockwood Project includes an 81.5 acre impoundment, an 875 ft. long and approximately 17-ft high dam with two spillway sections and a 160-ft long forebay headworks section, a 450-ft long forebay canal, and two powerhouses. The dam and forebay headworks span the Kennebec River immediately upstream and downstream of the U.S. Route 201 Bridge along a site originally known as Ticonic Falls. The spillway sections impound the river on either side of a small island; the east spillway section begins at the east abutment of the dam and extends about 225 ft. in a westerly direction to the small island, while the west spillway extends about 650 ft. from the small island in a southwesterly direction to the forebay canal headworks, which in turn extend to the west bank of the river. Each spillway is equipped with 15-inch high wooden flashboards.

The headworks and intake structures are integral to the dam and the powerhouses, respectively. The forebay intake section contains eleven headgates measuring 8.5-ft wide by 12-ft high. From the headworks, the forebay canal directs water to two powerhouses located on the west bank of the Kennebec River: the original 1919 powerhouse contains six vertical Francis units and the 1989 powerhouse contains one horizontal Kaplan unit, which combined have a total authorized capacity of 6.8 MW and a flow of approximately 5,660 cubic feet per second (cfs).

The generating unit trash racks are serviced by a track mounted, hydraulically operated trash rake with trash removal capabilities. The trash racks screening the intakes are 2.0 inch clear spacing in front of Units 1-6 and 3.5 inch clear spacing in front of Unit 7. The project's tailrace returns the flow to the Kennebec River about 1,300 ft. downstream from the east spillway section.

The Lockwood Project is operated in a run-of-river mode. The normal full pond elevation is 52.16 feet above mean sea level (msl) when the flashboards are in place. The Project is normally operated to provide an instantaneous minimum flow of 2,114 cfs or inflow, if less, below the powerhouse to maintain downstream aquatic habitat in the river. Flow in the approximately 1,300-ft long bypassed reach is currently limited to leakage around and through the flashboards, including through three (3-ft long by 8-inches high) engineered orifices cut into the flash boards (estimated at a total of 50 cfs), or as spill over the flashboards when river flow exceeds about 5,600 cfs.

FIGURE 2-2 LOCKWOOD PROJECT



2.2.2 FISH PASSAGE FACILITIES

2.2.2.1 UPSTREAM PASSAGE

Upstream passage at Lockwood is currently provided via a main channel fish lift which was commissioned in spring 2006. The facility is located on the west side of the original powerhouse and adjacent to the Unit 7 powerhouse and is designed to pass up to 164,640 alewives, 228,470 American shad and 4,750 Atlantic salmon. The fish lift is required to be operated annually from May 1 to October 31, dependent on river conditions. During the river herring, shad and Atlantic salmon peak migration season (lasting from approximately May through mid-July), the fish lift is operated seven days per week to meet resource agency trap and truck requirements. During that migration season, the fish lift is generally operated from early morning to evening.

The timing and frequency of lifts are a function of the number of migrating fish, water temperature and river flow, and the lift is operated based on direct camera monitoring of the fishway and V-gate entrance. During the remainder of the season (approximately mid-July through the end of October), lift cycles are less frequent and are specifically for the capture of Atlantic salmon. Pursuant to MDMR's Atlantic salmon handling protocol, the fish lift is not operated when the river water temperature exceeds 24.5ºC, in order to prevent injury or mortality of Atlantic salmon. However, if this temperature threshold is exceeded while shad are still migrating, the Licensee in consultation with MDMR has the option of continued operation of the fish lift to accommodate shad passage. If a salmon is observed in the hopper during a lift, the hopper can be placed back down into the water allowing the salmon to volitionally swim back downstream.

The lift operates with an attraction flow of approximately 170 cfs, an entrance flow velocity of 4 to 6 ft per second (fps) and a flow velocity over the hopper of 1.0 to 1.5 fps. An auxiliary water system provides the attraction flow upstream of the hopper. The 1,800-gallon hopper discharges water and fish into a 12-ft diameter 2,500-gallon sorting tank. River herring and shad are sorted into one of two ten-foot diameter 1,250-gallon sorting tanks. Atlantic salmon are removed and held in a 250-gallon isolation tank. Liquid oxygen is supplied to the sorting tanks and isolation tank via carbon micro porous stones to maintain safe dissolved oxygen levels at all times. Two auxiliary water pumps provide a constant flow of ambient river water to all the tanks and for filling of stocking truck tanks. Block ice is used, as necessary, to reduce water temperature in the Atlantic salmon holding tank in preparation for transport to the cooler waters of the Sandy River by MDMR staff. Other species of non-anadromous fish captured in the fish lift are returned to the tailrace via a discharge pipe. At the direction of MDIFW and MDMR, undesirable fish species (e.g. carp, white catfish, Northern pike and gizzard shad, etc.) are removed and euthanized.

2.2.2.2 DOWNSTREAM PASSAGE

Downstream fish passage is provided at the Lockwood Project via a 7-ft wide by 9-ft deep mechanical over-flow gate (fish sluice) located on the outboard side of the power canal just upstream of the Unit 1 trash rack and discharges directly into the river. Maximum flow through the gate is 6% of station capacity or 340 cfs. In 2009, a floating guidance boom was installed in the forebay angled across the forebay from the west wall of the canal downstream to the fish sluice to enhance use of the downstream passage. Following several years of evaluation and modifications made to the original guidance boom, the current design consists of a 300-ft long boom with two ten-ft-long plastic cylindrical “Tuff Boom” brand floats per section. From the upstream end, the first 250-ft of boom has 4-ft deep steel punch plate guidance panels (5/16” diameter holes). An additional six feet of Dynema curtain is attached to the bottom of each panel. The lower 50-ft section of boom has 10-ft. deep steel punch plate guidance panels with no Dynema curtain attached at the bottom. All gaps between the panels are covered by rubber flanges. In addition to the fish sluice gate and associated guidance boom, downstream migrating fish may also use the three submerged orifices (3-ft long by 8-inches high), cut into the flashboards along the spillway. The orifices are designed to provide flow through the ledges and pools in the bypass reach and pass a total of approximately 25 cfs of the required 50 cfs minimum flow at normal full pond, the remainder of which is provided by flashboard leakage. The orifices provide additional downstream passage routes along the spillway even when the project is not spilling over the top of the flashboards.

2.2.3 PREVIOUSLY APPROVED FISH PASSAGE FACILITIES

There are fish passage measures that have been authorized under the previous ISPPs, BOs, and FERC license amendments for the Lockwood Project that are currently in the process of final implementation. FERC amended the Lockwood Project license on May 19, 2016 to approve the February 21, 2013 ISPP and authorized a number of facilities/activities/measures including the design and installation of a volitional upstream fish passage facility (the approval required the filing of final plans and construction schedule). In addition, the terms and conditions of the July 19, 2013 BO issued by NMFS in conjunction with FERC’s license amendment include volitional fishway construction requirements such as in-water work restrictions, adherence to Best Management Practices, and pollution and sediment controls. The BO also requires: that Atlantic salmon not be passed upstream at the Lockwood volitional passage facility until all lower Kennebec fishways are operational; study plans and fishway designs be prepared in consultation with NMFS; routine inspections and maintenance requirements; take reporting; and provisions for adaptive management.

2.3 HYDRO-KENNEBEC PROJECT

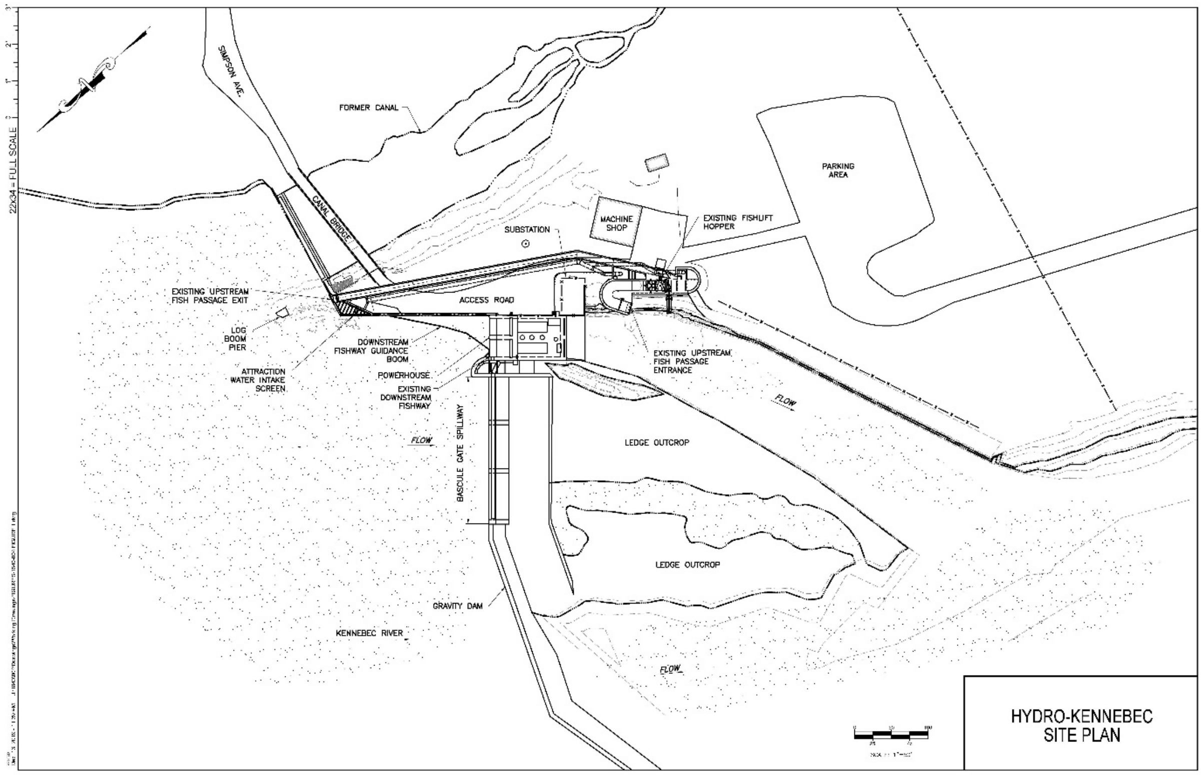
2.3.1 EXISTING PROJECT FACILITIES AND OPERATIONS

The Hydro-Kennebec Project is located at river mile 64 on the Kennebec River in the cities of Waterville and Winslow, Maine. Hydro-Kennebec is the second dam upstream on the Kennebec River. The Hydro-Kennebec Project has a total authorized capacity of 15.4 MW. The principal features include a concrete gravity dam with flashboards, forebay, impoundment, and a powerhouse containing two horizontal pit-type Kaplan turbines.

The Project consists of a 555-foot long un-gated concrete gravity spillway and a 200-foot long gated spillway. The dam also includes an 18-foot long east abutment adjacent to the powerhouse. The ungated spillway structure is 35 feet high at its maximum section with 6-foot high wooden flashboards, bringing the normal full headpond elevation to 81 feet. The gated spillway section has a permanent crest elevation of 68 feet and is equipped with three hydraulically controlled gates (each 15 feet high by 60 feet wide) to maintain the normal full pond elevation of 81 feet. The impoundment is approximately 250 acres in area.

The powerhouse is located between the middle retaining wall and the left bank and is 131.5 feet long and 62.2 feet wide at its base. The intake has steel trash racks supported by concrete piers equipped with steel maintenance gates and a mechanical trash rake. Each of the two four-blade pit-type Kaplan turbine units are capable of operating over a flow range of 1,550 cubic feet per second (cfs) to 3,961 cfs. Unit 2 is located on the bank side of the powerhouse and Unit 1 is located on the river side of the powerhouse. The turbines are approximately 13 feet in diameter and have an operating speed of 115 rpm. The runner speed (115 rpm) is stepped up using a speed increaser to result in a generator speed of 600 rpm. The powerhouse draft tube has roller gates, which are hydraulically operated. Flow from the turbines is directly discharged to the tailrace and into the Kennebec River. The tailrace is separated from the Kennebec River by a narrow section of bedrock stabilized by rock anchors.

FIGURE 2-3 HYDRO-KENNEBEC PROJECT



2.3.2 FISH PASSAGE FACILITIES

2.3.2.1 UPSTREAM PASSAGE

A fish lift was constructed at the Hydro-Kennebec Project in 2016-2017 and became operational in September 2017. The facility was designed in consultation with the fishery agencies and is designed to pass 12,000 Atlantic salmon, 210,000 American shad, 15,000 alewives, and 1,200,000 blueback herring. The fish lift consists of a tailrace entrance located immediately downstream of the Project powerhouse, a hopper elevator system, exit flume, and upstream exit located adjacent to the Project's abandoned gatehouse. The concrete upstream fish passage entrance is 14.0-ft wide and equipped with an adjustable overshot attraction flow gate. Fish are guided through a curved concrete entrance chamber leading to a 14-ft wide by 20-ft long lower flume. The elevator raises the hopper approximately 45 ft. to discharge fish and water to the 470-ft long exit flume.

A 40-ft wide attraction water intake screen and associated lifting structure (for cleaning) is installed adjacent to the fishway exit with 3/8-inch diameter holes to allow for screening of attraction flow. The fish lift facility is designed to operate under a normal headpond elevation of 81.0 ft. msl and a normal tailwater of elevation 54.0 ft. msl and is designed for river flows between 2,300 cfs and 23,000 cfs.

The Hydro-Kennebec fish lift has a minimum cycle time of approximately 10 minutes and can be operated in either automatic or manual mode. Water flow within the fish lift is adjusted by a series of manually controlled gates and valves. The system is designed to pass a range of attraction flow at the entrance gate of between 240 cfs to 400 cfs. Flow velocity is maintained at approximately 1-1.5 fps in the exit flume, 1-1.5 fps over the hopper, 2-4 fps in the entrance channel, and 4-6 fps at the fishway entrance.

2.3.2.2 DOWNSTREAM PASSAGE

The downstream passage facility at the Hydro-Kennebec Project consists of a floating angled guidance boom that guides fish to a deep-gated surface bypass slot that directs fish into a plunge pool and then to the tailwater area. The floating guidance boom was installed in the Hydro-Kennebec forebay to guide downstream migrating fish to a 4-ft wide by 8-ft deep gated surface weir capable of passing 320 cfs (4% of station flow). The surface weir discharges into a plunge pool which flows out to the tailrace.

The original boom (installed in 2006) was 160-ft long and utilized a 10-ft deep Kevlar curtain to guide the fish. In 2012, the Kevlar curtain was replaced with steel perforated plates (5/16 inch diameter holes) configured as a series of interlocking panels designed to be left in place year-round. The steel plates are 10-ft deep. The plunge pool has been modified several times since 2006 to improve fish survival through the facility. This includes adding depth to the plunge pool in 2007 by installing a weir in the fish bypass to minimize potential for fish injury. The plunge pool was deepened further in 2012 by adding a stop-log structure to the downstream fish passageway. A confining sill was also installed on the roof of the draft tube extension in the tailrace to keep the discharge jet from spreading over the exposed draft tube roof.

2.3.3 PREVIOUSLY APPROVED FISH PASSAGE FACILITIES

The fish lift described in Section 2.3.1 was constructed at the Hydro-Kennebec Project in 2016-2017 and was authorized under the previous ISPP, BO, and FERC license amendments for the Hydro-Kennebec Project. FERC amended the Hydro-Kennebec Project license on

February 28, 2013 to approve the April 6, 2012 ISPP and authorized the design and installation of the upstream fish lift.

2.4 Shawmut Project

2.4.1 Existing Project Facilities and Operations

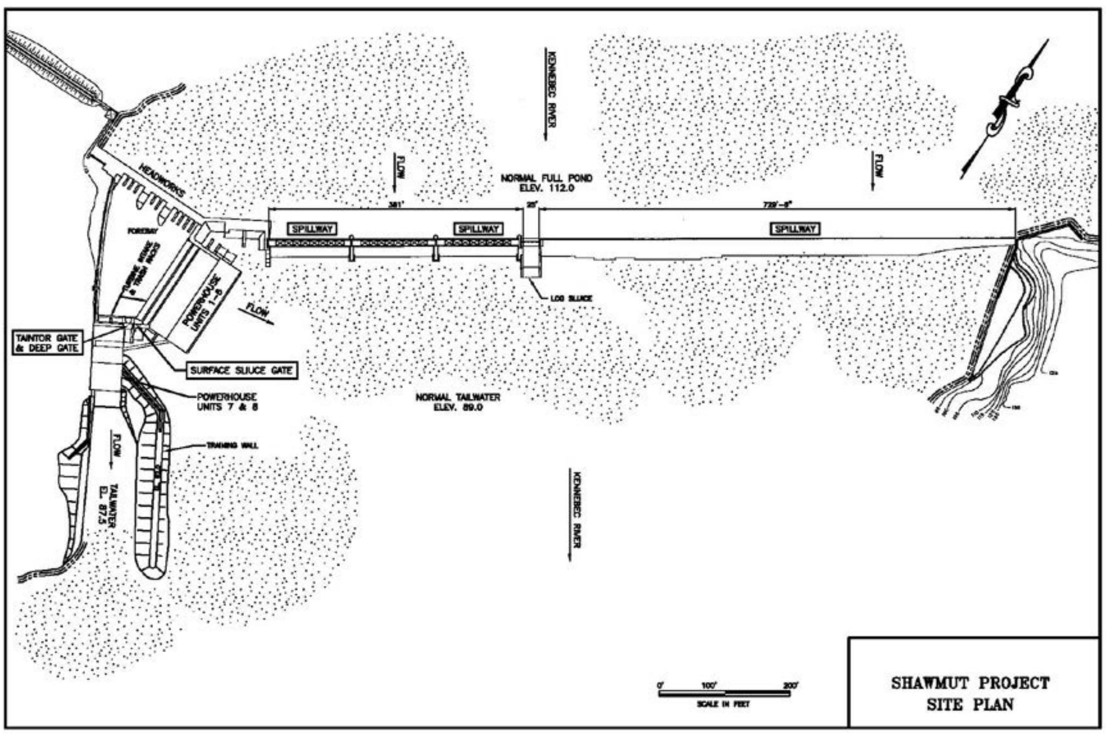
The Shawmut Project is located at river mile 70 and is the third dam on the main stem of the Kennebec River. It includes a 1,310-acre impoundment, a 1,135-foot long dam with an average height of about 24 feet, headworks structure, enclosed forebay, and two powerhouses with intake structures. The crest of the dam has 380 feet of hinged flashboards 4 feet high serviced by a steel bridge with a gantry crane, a 730-foot long inflatable bladder composed of three sections, each 4.5 feet high when inflated and a 25-foot wide by 8-foot deep sluice equipped with a timber and steel gate.

The headworks and intake structures are integral to the dam and the powerhouses, respectively. The forebay intake section contains eleven headgates and two filler gates. Five of the headgates are installed in openings 10 feet wide by 15.5 feet high and six are installed in openings 10 feet by 12.5 feet. The two filler gate openings are 4 feet by 6 feet. A non-overflow concrete gravity section of dam connects the west end of the concrete filled 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 1924 powerhouse located to the east and the 1982 powerhouse located to the south. An approximately 240-foot-long concrete retaining wall is located on the west side of the forebay. Located at the south end of the forebay between the powerhouses is a 10-foot by 7-foot Tainter gate. In addition, a 6-foot by 6-foot-deep gate and a surface sluice (4-foot-wide by 22-inch-deep, passing 35 cfs) which discharges into a 3-foot deep plunge pool are located at the south end of the forebay. In the original powerhouse, the intake section has six open flumes each fitted with two 10.5 foot by 14-foot double leaf slide gates and a continuous trash rack. In the newer powerhouse, the intake section contains two openings fitted with vertical headgates about 12 feet high by 12 feet wide and operated by hydraulic cylinders. The trash racks are serviced by a track mounted, hydraulically operated trash rake with trash removal capabilities. The trash racks screening the intakes are 1.5 inch clear spacing in front of Units 1-6 and 3.5 inch clear spacing in front of Units 7 and 8.

The original powerhouse contains six horizontal Francis-design units and the newer powerhouse contains two horizontal propeller units, having a total combined authorized capacity of 8.74 MW and combined station flow of approximately 6,700 cfs. The Project's tailrace channels are excavated riverbed located downstream of the powerhouses. The Project is typically operated in a run-of-river mode, normally passing a minimum flow of 2,110 cfs, with a normal full pond elevation of about 112.0 ft msl.

FIGURE 2-4 SHAWMUT PROJECT



2.4.2 FISH PASSAGE FACILITIES

2.4.2.1 UPSTREAM PASSAGE

A fish lift for the Shawmut Project has been designed and, as approved under the FERC license pursuant to the ISPP and BO, construction of the fish lift is expected to begin in May 2020 and is targeted to be completed and become operational in May 2021. Until the Shawmut fish lift is completed, upstream fish passage at the Shawmut Project continues to be provided via trap and truck operations from Lockwood to habitats further upstream.

2.4.2.2 DOWNSTREAM PASSAGE

Downstream passage for Atlantic salmon at Shawmut is currently provided through a combination of a surface weir (sluice), Tainter gate, and opened hinged flashboards. The sluice is located within the forebay at the right side of the intake structure next to Unit 6. It is 4-ft wide by 22-inches deep and flow can be adjusted by adding or removing stoplogs. With all stoplogs removed, the sluice passes between 30 and 35 cfs which is discharged over the sill into a 3-ft deep plunge pool. The Tainter gate located next to the sluice measures 7 ft. high by 10-ft wide and can pass up to 600 cfs.

The sluice and Tainter gate are operated for Atlantic salmon smolt and kelt passage typically from April 1 through June 15 and from November 1 through December 31, as river flow and ice conditions allow. Downstream passage is also provided along the Shawmut spillway during periods of excess river flow that results in spill. To provide an additional passage during the Atlantic salmon smolt migration season, the Licensee also drops several sections of flashboards. Currently, four hinged flashboards sections located immediately adjacent to the power canal headworks are opened for the Atlantic salmon smolt migration season, April 1 to June 15, and provide up to approximately 560 cfs of spill flow.[4]

2.4.3 PREVIOUSLY APPROVED FISH PASSAGE FACILITIES

There are fish passage facilities that have been previously authorized under the ISPPs, BOs, and FERC license amendments for the Shawmut Project that are currently in the process of final implementation. FERC amended the Shawmut Project license on May 19, 2016 to approve the February 21, 2013 ISPP which authorized a number of facilities/activities/measures including the design and installation of an upstream fish passage facility in consultation with NMFS and the fisheries agencies and the filing of final plans and construction schedule. In addition, the terms and conditions of the July 19, 2013 BO issued by the Services in conjunction with FERC’s license amendment include fish lift construction requirements such as in-water work restrictions,

[4] The hinged flashboard sections pass a flow of approximately 140 cfs per section. With three sections down the flow is approximately 420 cfs; with four sections down the flow is approximately 560 cfs.

adherence to Best Management Practices, and pollution and sediment controls. The BO also requires: that Atlantic salmon not be passed upstream at the Shawmut facility until all lower Kennebec fishways are operational; study plans and fishway designs be prepared in consultation with NMFS; routine inspections and maintenance requirements; take reporting; and provisions for adaptive management.

2.5 WESTON PROJECT

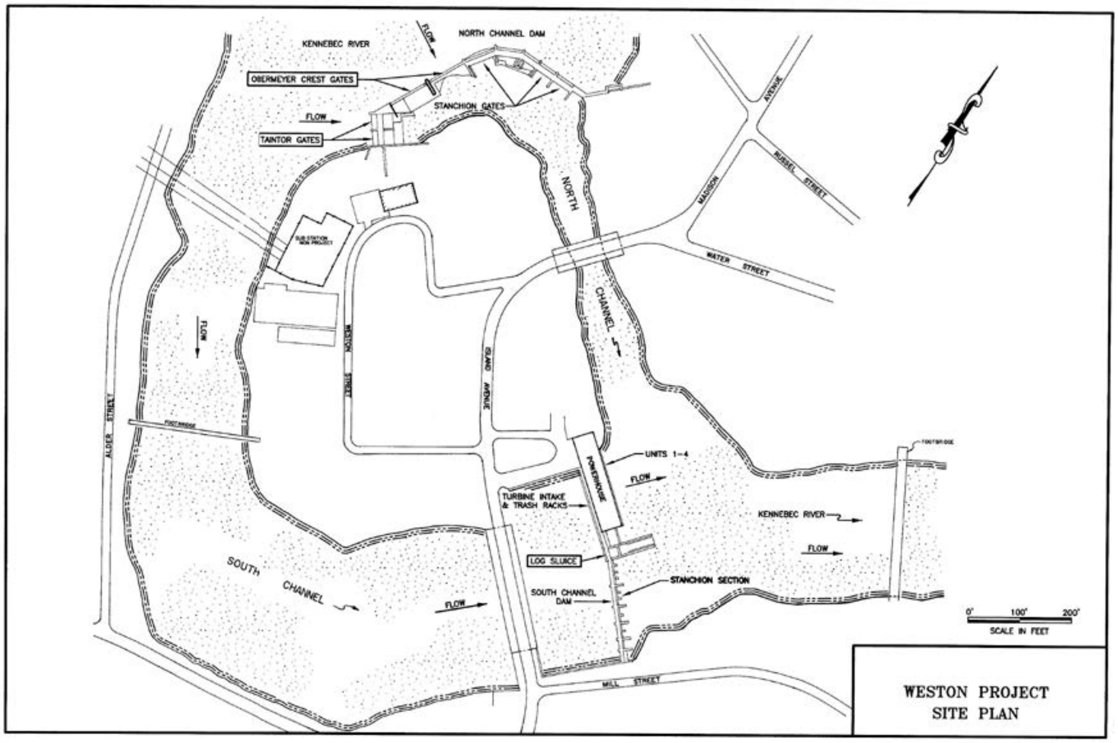
2.5.1 EXISTING PROJECT FACILITIES AND OPERATIONS

The Weston Project is located at river mile 82 and is the fourth dam on the mainstem of the Kennebec River. The Weston Project includes a 930-acre impoundment, 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.

The North Channel dam is a concrete gravity and buttress dam. The dam extends 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 South Channel dam is a concrete gravity and buttress dam that extends between abutment walls from the island to the south river bank. The powerhouse/intake section is integral to the Project dam and includes the headworks and four intake bays, one for each of the four turbine-generator units.

The Weston Project operates in a run-of-river mode, maintaining the impoundment water surface elevation within one foot of the normal full pond elevation, during normal operations. A minimum flow requirement in the existing FERC license requires the Project to release a minimum flow of 1,947 cfs or inflow, whichever is less.

FIGURE 2-5 WESTON PROJECT



2.5.2 FISH PASSAGE FACILITIES

2.5.2.1 UPSTREAM PASSAGE

A fish lift for the Weston Project has been conceptually designed and, as approved under the FERC license pursuant to the ISPP and BO, construction of the fish lift is expected to begin in May 2021 and become operational in May 2022. Until the Weston fish lift is completed, upstream fish passage at the Weston Project will continue to be provided via trap and truck operations from Lockwood to habitats further upstream. Atlantic salmon captured at the Lockwood lift are transported upstream by the MDMR to areas of suitable habitat, primarily the Sandy River, which is upstream of the Weston Project.

2.5.2.2 DOWNSTREAM PASSAGE

Downstream passage at the Weston Project is provided though a sluice gate and associated concrete flume located on the South Channel dam near the Unit 4 intake. The sluice is 20.8 ft. high and 70 ft long and discharges into a deep plunge pool. The gate is capable of discharging up to 2,250 cfs at full pond (approximately 38% of station unit flow) but is typically operated for fish passage to provide 8% of station unit flow from April 1st to June 15th (24 hours / 7 days a week) for smolts and 6% from September 15th to December 1st (8 hours per night).

In 2011, the Licensee enhanced the downstream passage facility by installing a 300-ft long floating guidance boom in front of the intakes with suspended 10-ft deep sections of 5/16-inch metal punch plate screens leading to the sluice gate.

On the North Channel side of the Weston Project, there are two Tainter gates, an inflatable rubber dam section, and stanchion gate sections. Additional passage opportunities are provided at the North Channel side via spillage in times of high flows.

2.5.3 PREVIOUSLY APPROVED FISH PASSAGE FACILITIES

There are fish passage facilities that have been previously authorized under the ISPPs, BOs, and FERC license amendments for the Weston Project that are currently in the process of final implementation. FERC amended the Weston Project license on May 19, 2016 to approve the February 21, 2013 ISPP and authorized a number of facilities/activities/measures including the design and installation of an upstream fish passage facility in consultation with NMFS and the fisheries agencies and the filing of final plans and construction schedule. In addition, the terms and conditions of the July 19, 2013 BO issued by the Services in conjunction with FERC's license amendment include fish lift construction requirements such as in-water work restrictions, adherence to Best Management Practices, and pollution and sediment controls. The BO also requires: that Atlantic salmon not be passed upstream at the Weston facility until all lower Kennebec fishways are operational; study plans and fishway designs be prepared in consultation with NMFS; routine inspections and maintenance requirements; take reporting; and provisions for adaptive management.

3.0 LISTED SPECIES LIFE HISTORY

3.1 ATLANTIC SALMON

Anadromous Atlantic salmon have a complex life history that includes spawning and rearing in freshwater rivers and streams, as well as extensive feeding migrations and sexual maturation in the marine environment (Fay et al. 2006). The freshwater juvenile stage of the life cycle can last from one to three years, after which juveniles undergo a physiological transformation (called smoltification) and migrate downstream to spend one to three years at sea before returning to freshwater to spawn in their natal rivers. Unlike Pacific salmon, Atlantic salmon do not die after spawning, and can return to sea to repeat the migratory cycle.

Although spawning by Atlantic salmon does not occur until late October or November, most adult Atlantic salmon ascend rivers beginning in the spring. In the GOM rivers, the peak upstream migration occurs in June, but may persist until the fall (Fay et al. 2006). After fish enter the freshwater environment, they cease feeding and darken in coloration. Salmon that return early in the spring spend nearly five months in the river before spawning, seeking cool water refuges (e.g., deep pools, springs, and mouths of small cold-water tributaries) during the summer months (Fay et al. 2006). Following spawning, adults (referred to as "kelts") may move downstream in either the fall or the following spring, eventually reaching the estuary and ocean. Once in the marine environment, these salmon resume feeding and a very small percentage may return as repeat spawners one to two years later.

Preferred spawning habitat consists of gravel substrate with adequate water circulation to keep buried eggs well oxygenated. Water depth at spawning sites is typically 30 centimeters (cm) to 61 cm, and water velocity averages 60 cm per second (Fay et al. 2006). Spawning occurs from late October through November when water temperatures are roughly between 7.2 degrees Celsius (°C) to 10.0°C. The female uses its tail to scour or dig a series of nests in the gravel where the eggs are deposited; this series of nests is called a redd. One or more males fertilize the eggs as they are deposited in the redd. The female then continues digging upstream of the last deposition site, burying the fertilized eggs with clean gravel. A female salmon returning to spawn after spending two years at sea will produce approximately 7,500 eggs (Fay et al. 2006).

The eggs hatch in late March or April. At this stage, the young salmon are referred to as alevin or sac fry. Alevins remain in the redd for about six more weeks and are nourished by their yolk sac. Alevins emerge from the gravel in mid-May, and begin active feeding, at which time they are called fry (Fay et al. 2006). Within days, the salmon fry enter the parr stage, indicated by vertical bars (parr marks) visible on their sides. Parr prefer areas with adequate cover, water depths ranging from approximately 10 cm to 60 cm, water velocities between 30 cm and 92 cm per second, and water temperature near 16°C (Fay et al. 2006). Juvenile salmon are territorial and feed on a variety of aquatic invertebrates, including larvae of mayflies, stoneflies, chironomids, and caddis flies; aquatic annelids; mollusks; and numerous terrestrial invertebrate species that fall into the river (Fay et al. 2006). In fall as flows increase, and as temperature and day length decrease, parr often shelter in the substrate. Movement may be quite limited in the winter, but can occur, particularly if the formation of ice reduces available habitat (Fay et al. 2006).

After remaining in freshwater habitat for one to three years (typically two years in Maine), parr undergo a series of physiological, morphological, and behavioral changes in a process called "smoltification." This transformation occurs in the spring and prepares the salmon "smolt" for its dramatic change in osmoregulatory needs that come with movement from a freshwater to marine environment (Fay et al. 2006). The smolt emigration period is rather short and lasts only two to three weeks for each individual (NMFS 2008). While not specifically assessed in the Kennebec River, naturally reared and wild smolts in Maine typically enter the sea during May to begin their ocean migration (Fay et al. 2006).

In the Penobscot River, smolts migrate between late April and early June with a peak migration in early May (Fay et al. 2006). The majority of smolts migrate in a short period of time, as demonstrated by NMFS' Penobscot River smolt trapping studies conducted between 2000 and 2005. These data show that 74 percent of the downstream run occurs in 15 days in mid-May and that the majority of the smolt migration appears to take place after water temperatures rise to 10°C (USFWS unpublished cited in Black Bear 2012). The USFWS conducted a review of literature regarding diurnal migration timing and found that a median of 80.7 percent of smolts migrated at night (USFWS unpublished cited in Black Bear 2012).

Smolts have been documented to move through the Narraguagus River estuary (located in Downeast Maine) to the middle portion of the bay at 0.7 kilometers per hour (km/h) and

1.0 km/h in the outer Narraguagus Bay (Kocik et al. 2009). Higher survival rates were observed for smolts that exhibited a reversal migratory pattern through the bay, suggesting that smolts moving out to sea with the flooding and ebbing tides are more likely to survive than those that do not, likely falling prey to various predators. Overall, this study documented low survival between the estuary and open marine environment from 36 percent to 47 percent (Kocik et al. 2009).

In the Kennebec River basin, rotary screw trap sampling conducted in the Sandy River during 2012-2015 provides some information on the seasonal timing of smolt outmigration for the Kennebec River projects (FPLE 2013; BWPH 2014, 2015). Although the dates of sampler installation and removal varied among years due to river conditions and site access, the date of peak capture for Atlantic salmon smolts ranged from May 7 to May 18 among the four sampling years. Atlantic salmon smolts were observed out-migrating from the Sandy as early as April 18 and as late as June 2, which corresponds to the generally accepted smolt outmigration period between late April and early June with a peak migration in early to mid-May.

Once in the ocean, Atlantic salmon become highly migratory and undertake long migrations from their natal rivers (Fay et al. 2006). Major feeding areas in the ocean include the Davis Strait between Labrador and Greenland (USFWS and NMFS 2009). During their time at sea, Atlantic salmon undergo a period of rapid growth until they reach maturity and return to their natal river to complete the life cycle. Although the GOM DPS yields the highest adult returns, millions of salmon are stocked annually, and data indicate that freshwater and marine survival rates are extremely low (USFWS and NMFS 2009).

3.2 ATLANTIC STURGEON

The Atlantic sturgeon is a long-lived, late maturing, estuarine dependent, anadromous species. Information in the following subsections is taken from the 2007 Atlantic sturgeon status review (Atlantic Sturgeon Status Review Team 2007), unless otherwise noted. The species' historic range included major estuarine and riverine systems that spanned from Hamilton Inlet on the coast of Labrador to the Saint Johns River in Florida. Atlantic sturgeon spawn in freshwater, but spend most of their adult life in the marine environment. Spawning adults generally migrate upriver in the spring/early summer; February-March in southern systems, April-May in mid-Atlantic systems, and May-July in Canadian systems. In some southern rivers, a fall spawning migration may also occur. A fall upriver migration of ripening adults in the Saint John River, New Brunswick is also observed; however, this fall migration is not considered a spawning run as adults do not spawn until the spring. Atlantic sturgeon spawning is believed to occur in flowing water between the salt front and fall line of large rivers, where optimal flows are 46-76 cm/s and depths of 11-27 meters. Sturgeon eggs are highly adhesive and are deposited on the bottom substrate, usually on hard surfaces (e.g., cobble). Hatching occurs approximately 94-140 hours after egg deposition at temperatures of 20° and 18°C, respectively, and larvae assume a demersal existence. The yolk-sac larval stage is completed in about 8-12 days, during which time the larvae move downstream to rearing grounds over a 6-12 day period. During the first half of their migration downstream, movement is limited to night. During the day, larvae use benthic structure (e.g., gravel matrix) as refugia. During the latter half of migration when larvae are more fully developed, movement to rearing grounds occurs both day and night. Juvenile sturgeon continue to move further downstream into brackish waters and eventually become residents in estuarine waters for months or years.

Upon reaching a size of approximately 76-92 cm, the subadults may move to coastal waters where populations may undertake long-range migrations. Tagging and genetic data indicate that subadult and adult Atlantic sturgeon may travel widely once they emigrate from rivers. Subadult Atlantic sturgeon transit between coastal and estuarine habitats, undergoing rapid growth. These migratory subadults, as well as adult sturgeon, are normally found in shallow (10-50 meters) near-shore areas dominated by gravel and sand substrate. Coastal features or shorelines where migratory Atlantic sturgeon commonly aggregate include the Bay of Fundy, Massachusetts Bay, Rhode Island, New Jersey, Delaware, Delaware Bay, Chesapeake Bay, and North Carolina, which presumably provide better foraging opportunities. Despite extensive mixing in coastal waters, Atlantic sturgeon return to their natal river to spawn as indicated from tagging records and the relatively low rates of gene flow reported in population genetic studies. Males usually begin their spawning migration early and leave after the spawning season, while females make rapid spawning migrations upstream and quickly depart following spawning.

Atlantic sturgeon have been aged to 60 years; however, this should be taken as an approximation, as the only age validation study conducted to date shows variations of ±5 years. Vital parameters of sturgeon populations show clinal variation with faster growth and earlier age at maturation in more southern systems, though not all data sets conform to this trend. For example, Atlantic sturgeon mature in South Carolina at 5-19 years, in the Hudson River at

11-21 years, and in the Saint Lawrence River at 22-34 years. Atlantic sturgeon likely do not spawn every year. Multiple studies have shown that spawning intervals range from 1-5 years for males and 2-5 for females. Fecundity of Atlantic sturgeon has been correlated with age and body size (ranging from 400,000 - 8 million eggs). The average age at which 50 percent of maximum lifetime egg production is achieved is estimated to be 29 years, approximately 3-10 times longer than for other bony fish species examined (NOAA 2012a).

The GOM DPS includes all Atlantic sturgeon that are spawned in the watersheds from the Maine/Canadian border and extending southward to include all associated watersheds draining into the Gulf of Maine as far south as Chatham, Massachusetts (NOAA 2012a). This includes the Kennebec River. Tagging and tracking data indicate that there is mixing of sturgeon from different DPSs throughout their marine range, and, consequently, NMFS determined that the marine ranges for the five DPSs are the same: all marine waters, including coastal bays and estuaries, from Labrador Inlet, Labrador, Canada to Cape Canaveral, Florida (NOAA 2012a, 2012b).

3.3 Shortnose Sturgeon

The shortnose sturgeon occurs in large coastal rivers of eastern North America. In the northern part of its range, the species is considered to be “freshwater amphidromous,” meaning it spawns in freshwater, but regularly enters seawater during various stages of its life (NMFS 1998). Shortnose sturgeon are occasionally found near the mouths of rivers, and coastal migrations between the lower Penobscot River and the Androscoggin/Kennebec estuary (i.e., Merrymeeting Bay) have been documented (Zydlewski 2009, Fernandes et al. 2010). Juveniles typically move upstream in rivers in spring and summer and downstream in fall and winter, but inhabit reaches above the freshwater - saltwater interface. Adults may move into higher salinity areas on a more regular basis (NMFS 1998).

Shortnose sturgeon are a long-lived species. The maximum documented age is 67 years for females, while males seldom exceed 30 years of age (NMFS 1987). In the northern part of their range, females do not spawn until about 18 years of age, while males spawn at about 12 years of age (NMFS 1987). Shortnose sturgeon females typically spawn every three to five years, while males may spawn as often as every one to three years (NMFS 1998). Spawning typically takes place in mid- to late spring when water temperatures reach 8-9°C; spawning ends when the water temperature reaches 12-15°C. Spawning may occur over a period of days to a few weeks. Overall spawning success can be negatively impacted if flows are unusually high during the spawning period (NMFS 1998).

Shortnose sturgeon typically seek the most accessible upstream areas for spawning, and may use a variety of micro-habitats. Channels appear to be important for spawning, which takes place over a variety of substrates (often gravel, rubble, or boulders), in shallow to relatively deep water and in moderate velocities (NMFS 1998).

Eggs are demersal and adhesive and remain near the spawning site. After eggs hatch, larval shortnose sturgeon are poor swimmers, and react negatively to light, instead seeking refuge among crevices and other cover on the bottom near the spawning site (NMFS 1998). After 9-12 days, the yolk sac is absorbed and the young sturgeon actively migrate downstream to locate suitable habitat. Young of year sturgeon typically inhabit deeper freshwater areas, and assume a more migratory behavior in the second summer of life (NMFS 1998).

Juvenile shortnose sturgeon (3 to 10 years old) typically inhabit the saltwater/freshwater interface in the lower reaches of rivers, foraging over fine-grained sand/silt/mud substrates. Juvenile and adult sturgeon can often use the same micro-habitats (NMFS 1998).

Adult shortnose sturgeon often inhabit short reaches of rivers, or concentration areas in summer and winter, where depth, velocity and substrate conditions combine to create favorable habitat for freshwater mussels, a preferred food item. Shortnose sturgeon will also forage in backwaters and in tidal channels under various levels of salinity (NMFS 1998).

Shortnose sturgeon are considered to be omnivorous. Juvenile sturgeon feed on a variety of benthic aquatic invertebrates (crustaceans, insects, worms, mollusks); adults show a preference for mollusks (NMFS 1998).

4.0 STATUS OF LISTED SPECIES IN PROJECT AREA

4.1 ATLANTIC SALMON

Runs of Atlantic salmon and other anadromous fish were once common in the Kennebec River, but have declined since the late 1700s and early 1800s with the industrialization of the river and the construction of dams throughout the river basin, including dams at the outlets of many of the lakes and ponds in the drainage, which prevents full access of migratory fish to historical habitat (NMFS 2013).

Since the 1970s, the state of Maine and federal fishery agencies have undertaken numerous activities and efforts to restore anadromous fish stocks to the Kennebec. These efforts have focused on restoration of American shad, river herring, alewife, and Atlantic salmon. Today, the state of Maine has an established Kennebec River Diadromous Fish Restoration Project, the goal of which is to restore Maine’s native diadromous fishes to their historic range and abundance in the watershed. These species include the alewife (*Alosa pseudoharengus*), American shad (*Alosa sapidissima*), blueback herring (*Alosa aestivalis*), Atlantic sturgeon (*Acipenser oxyrhinchus oxyrhinchus*), shortnose sturgeon (*Acipenser brevirostrum*), rainbow smelt (*Osmerus mordax*), Atlantic salmon (*Salmo salar*), striped bass (*Morone saxatilis*), Atlantic tomcod (*Microgadus tomcod*), sea lamprey (*Petromyzon marinus*), and American eel (*Anguilla rostrata*) (State of Maine 2019). Major restoration efforts that have been undertaken by the state and federal fishery agencies, along with hydroelectric project and dam owners include:

- 1987 - First Kennebec Hydro Developers Group (KHDG) settlement agreement signed
- 1998 - Second KHDG settlement agreement signed
- 1987 - 1999 DMR stocks nearly 644,000 adult alewife and 8.4 million American shad fry into spawning and nursery habitat
- 1999 - Removal of Edwards Dam (Kennebec River)
- 2002 - Fish passage completed at Plymouth Pond Dam
- 2003 - Fish passage completed at Sebasticook Lake Dam (Sebasticook River)
- 2006 – Fish lift operational at the Lockwood Project (Kennebec River)
- 2006 – Fish lift operational at Benton Falls Project (Sebasticook River)
- 2006 – Fish lift operational at Burnham Project (Sebasticook River)
- 2006 - Removal of Madison Electric Works Project Dam (Sandy River)
- 2009 - Removal of Fort Halifax Dam (Sebasticook River)

- 2001-2018 –Atlantic salmon egg, fry and smolt stocking in the Sandy River
- 2005- 2019 – installation and improvements to various downstream fish passages at Lockwood, Hydro-Kennebec, Shawmut and Weston hydroelectric projects.
- 2017 – Fish lift operational at Hydro-Kennebec Project

In the 1980s and 1990s, state and federal fishery agencies periodically stocked juvenile life states of Atlantic salmon in the Kennebec River drainage, primarily in the Sandy River. Starting in 2001, an egg planting program was undertaken in the Sandy River, which has become the primary Atlantic salmon hatchery supplementation strategy for the Kennebec River (USASAC 2019). Table 4-1 lists the Atlantic salmon stocking efforts undertaken in the Kennebec River basin in recent years.

TABLE 4-1 NUMBER OF ATLANTIC SALMON STOCKED BY LIFE STAGE IN THE SANDY RIVER

YEAR	EGGS	FRY	PARR	SMOLTS
2001-2008	320,000	169,000	0	0
2009	159,000	2,000	0	200
2010	600,000	147,000	0	0
2011	810,000	2,000	0	0
2012	921,000	2,000	0	0
2013	654,000	2,000	0	600
2014	1,151,000	2,000	0	0
2015	275,000	2,000	0	0
2016	619,000	3,000	0	0
2017	447,000	0	0	0
2018	1,228,000	0	0	0

Source: USASAC 2019.

Returns of adult Atlantic salmon to the Kennebec River are low. Since 2006, returns of adult Atlantic salmon to the Kennebec River have been estimated based on the number of fish captured in the Lockwood fish lift. These totals are shown in Table 4-2 and Table 4-3. Table 4-3 provides age and origin information for returning adult salmon. Detailed biological information on all of the Atlantic salmon captured at the Lockwood fish lift since 2006, including date of capture, age, sex, origin, river temperature and river flow is provided in the annual Kennebec River Diadromous Fish Passage Reports (FPL Energy 2006-2011; Brookfield 2012-2018).

Currently, there are no reliable estimates of smolt production in the Sandy River. However, NMFS has estimated smolt production based on egg to smolt survival estimates from the literature to be 1.5% (NMFS 2013). On this basis, cohort estimates for smolt production from recent egg stockings in the Sandy River (Table 4-1) range from 2,385 (2009) to 18,420 (2018). According to NMFS, given that the Sandy River is relatively pristine, it is possible that production could exceed these estimates (NMFS 2013). In fact, some juvenile production data from the Sandy River suggests these smolt estimates are likely low (NMFS 2013). In addition, some amount of natural reproduction is likely occurring in the Sandy River (NMFS 2013).

TABLE 4-2 NUMBER OF ATLANTIC SALMON ADULTS CAPTURED AT THE LOCKWOOD PROJECT

YEAR	NUMBER OF ATLANTIC SALMON CAPTURED	NUMBER TRUCKED TO SANDY RIVER	NUMBER RELEASED TO MAINSTREAM RIVER DOWNSTREAM OF LOCKWOOD DAM
2006	15	15	0
2007	16	16	0
2008	22	22	0
2009	32	26	6 (these were domestic salmon that had been stocked in the Sandy in the fall 2008)
2010	5	5	0
2011	60	60	0
2012	5	5	0
2013	7	7	0
2014	18	18	0
2015	31	30	1 (At the time MDMR thought it was a landlock salmon)
2016	37	33	20 (16 of these were recaptured)
2017	39	35	20 (14 of these were recaptured)
2018	11	9	6 (4 of these were recaptured)

Sources: Brookfield 2019; USASAC 2019.

TABLE 4-3 ADULT SALMON RETURNS BY ORIGIN TO THE KENNEBEC RIVER 2006-2018

	HATCHERY ORIGIN				WILD ORIGIN				
YEAR	1SW	2SW	3SW	REPEAT	1SW	2SW	3SW	REPEAT	TOTAL
2006	4	6	5	0	3	2	0	0	15
2007	2	5	0	0	2	6	0	0	16
2008	6	15	1	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
2013	0	1	0	0	0	7	0	0	8
2014	0	2	0	0	3	13	0	0	18
2015	0	2	0	0	3	26	0	0	31
2016	0	0	0	0	1	38	0	0	39
2017	0	0	0	0	3	25	2	0	40
2018	0	1	0	0	3	7	0	0	11

Source: USASAC 2019.

4.2 ATLANTIC STURGEON AND SHORTNOSE STURGEON

Atlantic and shortnose have been documented below the Lockwood Project and elsewhere in the lower Kennebec River. The status of the populations of Atlantic sturgeon and shortnose sturgeon in the Kennebec River is unknown at this time, but in the Status Review of Atlantic sturgeon, it was noted that the Merrymeeting Bay estuary may provide significant habitat for both species (Atlantic Sturgeon Status Review Team 2007).

Prior to the removal of Edwards Dam in 1999, Atlantic and shortnose sturgeon had no access to the river between Edwards Dam and Lockwood Dam. Today, sturgeon have access to the full range of their historic Kennebec River habitat, as Ticonic Falls, the site of the Lockwood Project, is the historical limit of upstream migration for sturgeon on the Kennebec River (NMFS and USFWS 1998)

Because both sturgeon species have access to the Lockwood Project, the Licensee developed and implemented a Sturgeon Handling Plan. The handling plan requires that if sturgeon are found in the fish lift, then certain procedures are implemented. In addition, the Licensee undertakes certain measures to ensure no sturgeon become stranded in the bypass reach during annual (for flashboard replacement) or maintenance drawdowns of the impoundment. All of these procedures are detailed in the Sturgeon Handling Plan included in the SPP (Appendix A).

Since Lockwood fish lift operations began in 2006, no sturgeon have been captured in the fish lift. Since 2003, no sturgeon have been observed to be stranded during periods of lowered river flows and impoundment levels, as a result of Project operations or maintenance.

5.0 POTENTIAL EFFECTS FROM EXISTING CONDITIONS ON LISTED SPECIES

5.1 ATLANTIC SALMON

Hydroelectric projects can affect Atlantic salmon in a variety of ways including hydrologic alteration, habitat alteration, migratory impediment, entrainment/impingement, and water quality. The four Kennebec Projects are all operated as run-of-river projects so have little effect on river hydrology.

Water quality at all four Projects is good both upstream and downstream of the dams, and Project waters at all four Projects meet state water quality standards. The Lockwood, Hydro-Kennebec, and Weston projects have all been issued water quality certifications by the Maine Department of Environmental Protection (MDEP). Water quality at the Shawmut Project was recently evaluated as part of the ongoing FERC relicensing effort, and the study data shows that project waters meet the state standards.5

Currently, the portion of the Kennebec River in which the Projects are located serves as an upstream and downstream migration corridor to and from suitable spawning and rearing habitat. It is not known how much the Project dams and impoundments have altered spawning and rearing habitat.

There is limited documented salmon spawning and rearing habitat downstream of the Lockwood Project (NMFS 2013). There is some spawning and rearing habitat between the four Projects primarily in tributaries such as Wesserunsett Stream, which joins the Kennebec River mainstem between the Shawmut and Weston projects. But, the majority of the spawning and rearing habitat in the Kennebec River basin lies upstream of the Weston Project in the Sandy River and other major tributaries.

The 2013 BO states that 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.

[5]In a letter dated December 3, 2018 the Maine Department of Environmental Protection concluded that the Shawmut Project impoundment and tailwaters meet applicable water quality standards.

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) 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 pre-spawn 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 pre-spawn 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.

Thus, the life stages of Atlantic salmon affected by the Projects include adults migrating upstream to spawn and downstream migrating smolts and kelts (Fay et al. 2006). Some of the effects of the Projects on returning Atlantic salmon adults have already been reduced through provision of upstream fish passage facilities (fish lifts) at Lockwood and Hydro-Kennebec, and trap and truck operations from Lockwood. However, while trap and truck operations can be highly effective at moving migrating salmon to upstream spawning areas (Sigourney et.al. 2015), such operations potentially can also result in adverse impacts including injury, disorientation, disease, mortality, delay in migration, and interruption of the homing instinct. (NMFS 2013). The effects of the Projects on returning adult Atlantic salmon are being further reduced through provision of additional authorized upstream fish passage facilities that are in the process of being designed and installed at Lockwood (bypass volitional fishway), Shawmut (fish lift), and Weston (fish lift). Effects to downstream migrating smolts and kelts have been similarly mitigated through the provision of downstream fish bypass facilities at Weston, Shawmut, Hydro-Kennebec and Lockwood.

Because the primary effects to Atlantic salmon associated with the Lockwood, Hydro-Kennebec, Shawmut and Weston projects are migratory effects, the focus of the SPP is on continuing to provide safe, effective and timely volitional passage to Atlantic salmon adults and smolts at all four Projects. The measures proposed in the SPP include continued operation of the existing upstream fishways at Lockwood (fish lift) and Hydro-Kennebec (fish lift) and three new upstream passage facilities at Lockwood (bypass volitional fishway), Shawmut (fish lift), and Weston (fish lift). The SPP also includes measures to improve the effectiveness of the existing downstream passages at all four Projects.

To help ensure that the facilities and measures proposed by the Licensee in the SPP are successful in mitigating the effects to upstream and downstream migration by Atlantic salmon adults and juveniles, the SPP also includes a set of upstream and downstream passage effectiveness performance standards and goals as follows:

- Downstream Salmon Smolt Passage Standard – The objectives of safe and effective passage outlined in the SPP are considered to be met for the four Projects when a cumulative (“end-of-pipe”) station survival of at least 84.9% is achieved[6]. Achievement of the standard will be based on an average of three years of smolt passage performance data, wherein the individual whole station survival estimates are cumulatively calculated from Weston through Lockwood, as tested following the implementation of the downstream fish passage facilities and measures proposed for the Lockwood, Hydro-Kennebec, Shawmut and Weston Projects.
- Upstream Adult Salmon Passage Standard – The objectives of safe and effective passage outlined in the SPP are considered to be met for the four Projects when a cumulative (“top-of-pipe”) passage rate of at least 81.4% is achieved[7]. Achievement of the standard will be based on an average of two years of quantitative adult passage performance study data wherein the individual whole station survival estimates are cumulatively calculated from Lockwood through Weston, as tested following the implementation of the upstream fish passage facilities and measures proposed for the Lockwood, Hydro-Kennebec, Shawmut and Weston Projects.

In addition, the SPP establishes a goal for timely downstream passage of Atlantic salmon smolts through the Projects such that Atlantic salmon smolts through all four projects with a cumulative project residence time of no more than 96 hours.[8]

[6] The 84.9% smolt downstream passage standard is based on the cumulative calculation of an average individual whole station smolt survival rate of 96% per project, consistent with the standards established for hydroelectric project dams in the Downeast and the Penobscot Bay SHRUs.
[7] The 81.4% adult whole passage standard is based on the cumulative calculation of an average individual passage rate of 95% per project, consistent with projects in the Downeast and Penobscot Bay SHRUs.
[8] Within each study year following the implementation of the downstream fish passage facilities and measures proposed for Lockwood, Hydro-Kennebec, Shawmut and Weston, residence time for each individual test smolt will be calculated as the duration of time from first detection at the point 200 meters upstream of each dam to a point

5.2 ATLANTIC AND SHORTNOSE STURGEON

It is not known how frequently sturgeon may be in the Lockwood Project area. However, because sturgeon are so rarely captured in the Lockwood fish lift, it seems that they infrequently occur in the Lockwood Project tailwaters. Thus, normal Lockwood Project operations should have minimal effect on shortnose and Atlantic sturgeon, or their habitat. There is the potential for sturgeon to be captured in the Lockwood fish lift, or otherwise encountered during Project maintenance activities; for example, during dewatering of the draft tubes for turbine inspection or maintenance activities. However, the likelihood of this occurring is low due to the limited number of sturgeon in the project area. For sturgeon that are captured in the fish lift, there is also a possibility that sturgeon could be affected by handling during the sorting process.

Because both sturgeon species have access to the Lockwood Project powerhouse draft tubes and existing fish lift, the Licensee has developed and implemented a Sturgeon Handling Plan. The handling plan requires that if sturgeon are found in the fish lift or elsewhere in project facilities, that certain procedures are implemented as follows:

- For each sturgeon detected, the weight, length, and condition of the fish are recorded.
- Fish are scanned for PIT tags.
- River flow, bypass reach minimum flow, and water temperature are recorded.
- If alive and uninjured, the sturgeon are immediately returned downstream using specified handling techniques.
- The licensee reports any live, uninjured sturgeon removed and returned to the river below the Project dam to NMFS within 24 hours.
- If any injured sturgeon are found, the Licensee reports it to NMFS immediately.
- Injured fish are photographed and measured, if possible, and the reporting sheet is submitted to NMFS within 24 hours.
- If the fish is badly injured, the fish is retained by the Licensee until notified by NMFS with instructions regarding potential rehabilitation.
- If any dead sturgeon are found, the Licensee reports it to NMFS within 24 hours.
- Any dead specimens or body parts are photographed, measured, scanned for tags, and all relevant information is recorded.

downstream of each dam. The cumulative residence time for all smolts determined to have passed downstream at all four projects will be calculated as the sum of the four residence duration values. Achievement of the downstream salmon smolt timing goal will be based on a three-year average equal to or greater than 96% of individuals passing through all four projects with a cumulative project residence time of no more than 96 hours.

- Specimens are stored in a refrigerator by the Licensees until NMFS can obtain them for analysis.

Sturgeon may also occur in the Lockwood Project bypass reach. In May 2003, an adult sturgeon, believed to be a shortnose sturgeon, was rescued from a bypass reach pool at the base of Lockwood Dam during annual flashboard replacement. The annual lowering of the Lockwood Project impoundment required to replace flashboards can disrupt bypass flows for short periods (a few hours). During this time, fish could become stranded in isolated pools in the bypass reach. The handling plan includes measures to ensure safe handling of any sturgeon stranded during this period and commits the Licensee to undertaking the following measures to ensure no sturgeon become permanently stranded in the bypass reach during annual (for flashboard replacement) or periodic maintenance drawdowns of the impoundment.

- Designated employees and fish lift operation staff monitor the pools below the dam while the flashboards at the project are replaced.
- If shortnose or Atlantic sturgeon become stranded in the Lockwood bypass reach, the Licensee returns them to the river downstream.
- For each fish removed from the pool, the weight, length, and condition of the fish is recorded.
- Fish are scanned for PIT tags.
- River flow, bypass reach minimum flow and water temperature are recorded.
- If stranded but alive and uninjured, the sturgeon are moved to the river below the Ticonic Falls in an area that provides egress.
- The Licensee reports to NMFS within 24 hours any live, uninjured sturgeon that are removed and relocated back to the river.
- If any injured sturgeon are found, the Licensee reports it to NMFS immediately.
- Injured fish are photographed and measured, if possible, and a reporting sheet is submitted to NMFS within 24 hours.
- If the fish is badly injured, the fish is retained by the Licensees, if possible, until it can be turned over to a NMFS recommended facility for potential rehabilitation.
- If any dead sturgeon are found, the Licensee reports it to NMFS within 24 hours.
- Any dead specimens or body parts are photographed, measured, scanned for tags and all relevant information is recorded.
- Specimens are stored in a freezer by the Licensee until NMFS can obtain them for analysis.

6.0 PROPOSED SPP ACTIONS AND EFFECTS ANALYSIS

6.1 PROPOSED SPP

The Lockwood, Hydro-Kennebec, Shawmut and Weston hydroelectric projects all occur within the range of the endangered GOM DPS Atlantic salmon, and all four are located entirely in designated critical habitat for the species. The continued operation of the Projects may have adverse effects on the GOM DPS of Atlantic salmon and its designated critical habitat. In addition, the Lockwood Project is in designated critical habitat for threatened Atlantic sturgeon and within the known range of endangered shortnose sturgeon.

Because the Projects are located within designated critical habitat of these listed species, FERC is required to engage in endangered species consultation with the USFWS and NMFS pursuant to Section 7 of the Endangered Species Act (ESA) when a federal action is pending. Section 7 of the ESA mandates that federal agencies consult with the Secretaries of Commerce (through NMFS) and Interior (through USFWS), to determine whether a proposed action is likely to jeopardize listed species and/or adversely affect designated critical habitat for such species.

In 2013, the Licensee proactively initiated Section 7 consultation ahead of any pending federal action, such as relicensing of the projects, by filing Interim Species Protection Plans (ISPP) for these projects. Because the ISPPs for the projects expire in 2019, the Licensee is required to file a final SPP for the four Projects.

In consultation with NMFS, USFWS, MDMR and MDIFW the Licensee has developed an SPP for incorporation of the applicable portions into the FERC project licenses for the four Projects. In anticipation of preparing and filing an SPP for the four Kennebec Projects in 2019, the Licensee initiated a series of collaborative meetings in 2018 with federal and state fishery agencies including NMFS, USFWS, MDMR, and MIDFIW, to review the status of the upstream and downstream passage at the four Projects, and to discuss measures, standards, and monitoring that would be appropriate for inclusion in the SPP. Meetings between the Licensee and the agencies were held approximately monthly between May and October 2018, and again between February and May 2019.

The purpose of the SPP is to identify certain measures to be undertaken by the Licensee at the Projects to avoid and minimize effects related to the continued operation of the Projects, and to protect the listed species and their habitats. Amendment of the FERC project licenses to incorporate the applicable portions of the SPP will 1) protect the listed species in the project areas, and 2) allow the development by NMFS of an Incidental Take Statement (ITS) to account for any unavoidable "take" of each species.

The SPP is valid for the term of each of the Project licenses and includes specific measures to be undertaken over time to provide safe, effective and timely upstream and downstream passage measures for Atlantic salmon and to protect critical habitat for Atlantic salmon, Atlantic sturgeon and shortnose sturgeon.

The SPP being proposed by the Licensee outlines certain commitments and measures for the protection of GOM DPS of Atlantic Salmon at the Projects. Atlantic salmon will be protected through a combination of enhanced upstream and downstream passage, avoiding and minimizing delay, injury and predation, and protection of critical migration habitat in the Project areas. The SPP also includes measures for protecting listed shortnose sturgeon and Atlantic sturgeon at the Lockwood Project. The Licensee is requesting that FERC initiate a single, comprehensive consultation for all three species (Atlantic salmon, Atlantic sturgeon, and shortnose sturgeon) with NMFS and all four projects. Accordingly, it is anticipated that NMFS will issue a single Biological Opinion (BO) for all species and projects of Licensee considered in the SPP.

The following sections discuss the anticipated effects of the proposed SPP measures on Atlantic salmon. Similarly, measures to be undertaken to protect shortnose sturgeon and Atlantic sturgeon at the Lockwood Project are discussed in Section 6.4.

6.2 UPSTREAM PASSAGE FOR ATLANTIC SALMON

6.2.1 LOCKWOOD

The Lockwood fish lift has been operational since 2006. Prior to 2016, assessment of adult salmon usage of the fish lift was based primarily on fish lift captures and observation of adult salmon near the fishway entrance and in the tailwater area. Underwater cameras have been used to observe fish behavior at the fish lift entrance as well as to detect fish presence and initiate lifts, as necessary. Over time, modifications have been made to the entrance and attraction flows to improve attraction of fish (including salmon) into the fish lift entrance.

In 2016 and 2017, the Licensee conducted Atlantic salmon adult radio-telemetry studies of upstream passage at the Lockwood Project. In both years, a total of 20 adult salmon were tagged at Lockwood. In 2016, 16 of the 18 test fish which returned to the Project area were recaptured in the fish lift. In 2017, 14 of the 20 test fish were recaptured in the fish lift. When both the 2016 and 2017 study years are considered, a total of 30 of 38 (79%) of tagged adult salmon which returned to the Lockwood Project area were recaptured at the fish lift. The results of the 2016 and 2017 adult salmon studies also confirmed that some fish were finding the Lockwood bypass channel and ascending the dam. Of the 20 adults tagged in 2017, two ascended the bypass reach and were able to pass upstream of the dam into the Lockwood impoundment (Normandeau 2018).

Because studies and observations demonstrate that adult Atlantic salmon are being attracted into the Lockwood bypass reach, in August 2017, after consultation with the fisheries agencies, the Licensee requested a change in approach to providing volitional upstream passage at the Lockwood Project. Specifically, results of the 2016 and 2017 Atlantic salmon studies indicated attraction to the bypass reach during times of spill. Discussion regarding these studies resulted in a change of focus to designing and constructing a fish passage facility in the Lockwood bypass reach as a means to provide volitional passage at the Project.

Consistent with this approach, the Licensee has revised its plans for previously authorized volitional passage to be provided via a permanent volitional fishway in the bypass reach. This fishway is undergoing final design and the facility will be constructed and operational by May 2022. The design of the volitional fishway is being developed in consultation with the fishery agencies and is being sized to accommodate the anticipated run of Atlantic salmon, American shad and river herring. The Licensee has provided several conceptual designs for agency review. As of the date of this Draft BA, consultation with the agencies regarding the design of the facility is still ongoing, but has been narrowed to three options; a nature-like fishway, vertical slot, or ice harbor fishway.

All three of the designs being considered for the Lockwood bypass are known to be highly efficient for upstream passage of Atlantic salmon and returning adult Atlantic salmon will be provided volitional passage to the river upstream of Lockwood Dam via this passage facility. As noted previously, based on two years of adult salmon studies, the estimated efficiency of the existing upstream fish lift is 79%. Provision of volitional passage via a bypass reach fishway is expected to significantly increase upstream fish passage efficiency and reduce adult upstream migration delay by providing the fish with a second upstream passage route, and by reducing the potential for adult salmon to be inadvertently delayed in the bypass reach. With the continued operation of the bypass reach volitional fishway, as provided for in the SPP, the Lockwood Project is expected to allow successful passage of more than 95% of adult Atlantic salmon. As discussed in the following section on downstream passage, the new volitional upstream passage facility will also provide downstream migrating smolts and kelts with another downstream passage route.

Construction of the previously authorized Lockwood bypass volitional fishway will result in some short-term effects to Atlantic salmon migration habitat which will be minimized through implementation of the conditions of the 2013 BO issued by NMFS July 19, 2013. Of the three alternative fishway designs (Nature Like Fishway (NLF), vertical slot and ice harbor) currently being considered, the NLF is expected to have the largest footprint, and the greatest construction area within anticipated cofferdams (Alden, 2019). It is estimated that the construction of an NLF fishway will have a total footprint (upstream and downstream of the dam) of up to 145,000 ft2. In turn, an NLF of this size would result in a construction area within the cofferdams of about 200,000 ft2. The NLF fishway will also require excavation of an estimated 700 ft2 of river bed material, and 10,000 ft2 of fill placed in the river bed. The ice harbor and vertical slot fishway designs both have a smaller overall footprint, and correspondingly smaller areas of potential excavation and/or fill. However, any of the three fishway designs will involve a small amount of permanent impact associated with ledge removal and the placement of fill. It is also anticipated that a small amount of riverine habitat will be temporarily or permanently affected by the construction of cofferdams and the placement of fill. Implementation of the terms and conditions included in the July 2013 BO for the authorized volitional fishway construction at Lockwood will minimize any short-term impacts to Atlantic salmon migration habitat. These conditions include in-water work restrictions, adherence to Best Management Practices, and pollution and sediment controls. In-water work will be minimal, and to the extent possible will occur outside of the smolt and kelt outmigration periods and within the confines of a dewatered cofferdam. Because in-water work will be minimal and will occur during periods when flow in the bypass reach is very low, and because it is likely that sturgeon use of the bypass reach is limited to periods of high flow in the reach, it is not anticipated that the planned fishway construction will affect shortnose or Atlantic sturgeon.

Under the proposed SPP, the Licensee will continue to operate the Lockwood fish lift during Atlantic salmon migration periods between May 1-October 31. The Licensee will operate the fish lift, trap, sort, and truck facility for Atlantic salmon until permanent volitional passage is installed in the bypass reach. Per MDMR protocol, the Licensee will not operate the lift to capture/move salmon when river water temperatures are greater than 24.5 C.

Once the volitional bypass fishway is installed, the long-distance trucking component of the fish lift at Lockwood is expected to be discontinued, and all fish captured at Lockwood will be released upstream of the Lockwood dam, with the exception of undesirable or invasive species which will be removed or returned to the river below Lockwood dam. The trucking facilities will continue to be available for agency use for the management of Atlantic salmon, American shad and river herring. The availability of the trap and sort facilities at the Lockwood fish lift will continue to allow the capture of adult salmon, if needed in furtherance of the restoration efforts, for such purposes as scientific studies, brood stock, and/or direct transport to quality spawning habitat, as determined by the fishery agencies. Continued operation of the trap and sort facilities at the Lockwood fishway will allow some management of invasive and undesirable species at Lockwood.

Under the SPP the Licensee will undertake the following measures for the Lockwood fish lift and bypass volitional fishway:

- The Licensee will operate permanent volitional passage for Atlantic salmon in the Lockwood bypass reach as previously approved by the FERC license amendment(s). Volitional fish passage will be installed and operational by a target date of May 2022.
- Consult with the agencies and update the Fish Passage Operations and Maintenance Plan for the Project to include the existing fish lift and the bypass reach facility as well as the Fish Stranding Plan and Sturgeon Handling Plan.

In the interim and/or to be continued following completion of the Lockwood bypass reach fish passage facility, the Licensee proposes to:

- Continue to operate the Lockwood fish lift annually during Atlantic salmon migration periods (May 1 through October 31) until completion of the bypass reach fishway and pending effectiveness testing.
- Not operate the lift to capture/truck salmon when river water temperature is greater than 24.5 C.
- Coordinate with MDMR to ensure that the trucking component of the fish lift at Lockwood will continue to be operated for Atlantic salmon, American shad and river herring.
- Undertake measures necessary to keep the Lockwood fish lift in good operating condition. If the fish lift malfunctions or becomes inoperable during the migration period, the fish lift will be repaired and returned to service as soon as it can be safely and reasonably done.
- Maintain records of all fish trapped and/or moved via the fish lift.
- Relocate, if necessary, the upstream eel passage facility in consultation with the agencies.

To date, the Licensee has conducted 2 years of adult salmon radio telemetry studies at the Lockwood Project to evaluate the effectiveness of the main channel fish lift for upstream passage of Atlantic salmon. When the results of both the 2016 and 2017 study years are considered, a total of 30 of 38 (79%) of tagged adult salmon which returned to the Lockwood Project area were recaptured at the fish lift.

Once the Lockwood bypass volitional fishway has been installed and is operational, and the fish lifts being installed at the Shawmut and Weston Projects are also operational, under the SPP the Licensee is proposing to conduct up to two years of additional qualitative studies to evaluate the effectiveness of the upstream passage through all four Projects. The studies the Licensee is proposing will utilize up to 20 adult Atlantic salmon each year, of Kennebec origin, captured at the Lockwood fish lift. The studies the Licensee is proposing are considered qualitative because of the limited number of test fish available for study. Based on a statistical power analysis conducted by the University of Maine (Maynard et al, 2012) to support upstream passage study designs for the Penobscot River Species Protection Plan, a sample size of greater than 200 adult salmon is needed in order to reduce the likelihood of committing Type I and/or Type II statistical errors during analysis of the data. Any studies using less than 200 fish are to be considered qualitative studies. The adult upstream passage studies will commence in the first full season after the last of the proposed upstream fishways is completed in 2023.

Under the SPP, the Licensee further proposes that at such time that there are 200 returning adult salmon, of Kennebec origin, available for study use, the Licensee will conduct a comprehensive quantitative upstream passage study to evaluate if the cumulative upstream passage standard of 81.4% is being achieved. The study will be carried out in consultation with the fishery agencies including NMFS, USFWS, MDMR, and MDIFW.

The conduct of both qualitative and quantitative studies of adult salmon upstream passage will be highly beneficial to Atlantic salmon. The studies will help determine the efficiency and effectiveness of the upstream fish lifts at all four Projects and the bypass volitional fishway at the Lockwood Project. Telemetry information will also be useful in understanding fish behavior in and near the fishways, including observations of any problems associated with fishway entrances, attraction flows, and fishway operational concerns. Taken as whole, the information collected via the proposed upstream passage studies will help improve fishway efficiency and effectiveness, will reduce migratory delay, and will ensure the fishways provide safe, effective and timely volitional passage for returning adult Atlantic salmon.

As part of an adaptive management approach, if, after completion and testing of these measures, the upstream passage performance standard has not been met, the Licensee will consult with the agencies regarding potential additional measures, such as minor structural or operational modifications, to be undertaken to further improve upstream passage at the Lockwood Project, as outlined in the SPP.

6.2.2 HYDRO-KENNEBEC

The Hydro-Kennebec Project has an installed volitional fish lift facility. The fish lift was installed and became operational in September 2017. Startup and shake down of the fish lift was conducted in September and October 2017.

The installed Hydro-Kennebec fish lift is designed to volitionally pass fish into the headpond and is not configured to trap, sort, or truck fish. Once volitional fish passage is installed at the Lockwood bypass (2022), the Licensee will:

- Consult with the agencies regarding how the Hydro-Kennebec fish lift will be operated and update the Fish Passage Operations and Maintenance Plan for the Project

In the interim, the Licensee is proposing the following measures to enhance upstream passage of Atlantic salmon at the Hydro-Kennebec Project:

- The Licensee will operate the existing lift in coordination with MDMR. The Licensee anticipates that MDMR will provide guidance for the duration and frequency of lift operation following camera observations of salmon at the fishway entrance, attempt to capture the salmon, and, if caught, turn them over to MDMR to be trucked to the Sandy River.
- The Licensee will not operate the lift to capture/truck salmon when river water temperatures are greater than 24.5 C.

To date, no studies have been conducted to specifically evaluate the effectiveness of the Hydro-Kennebec fish lift for Atlantic salmon. Two salmon that were tagged at Lockwood during the 2017 adult salmon study were eventually captured at the Hydro-Kennebec fish lift in September and October 2017 and trucked by MDMR to the Sandy River. However, until such time that the upstream fish lifts are operational at the Shawmut and Weston projects, the fishery agencies do not want any Atlantic salmon passed into the mainstem river upstream of the Hydro-Kennebec Project, as there is essentially no spawning habitat between the Hydro-Kennebec and Shawmut dams.

Once the fish lifts planned for the Shawmut and Weston projects and the fishway planned for the Lockwood bypass reach are operational, the Licensee proposes in the SPP to conduct additional studies to evaluate the effectiveness of the upstream fish passage through the reach containing all four Projects, including the Hydro-Kennebec fish lift, for adult Atlantic salmon. Given the current low number of salmon returning to the Kennebec River, the Licensee and agencies do not anticipate that there will be enough adult salmon available in the initial years of the SPP to conduct a quantitative evaluation of upstream passage efficiency for the new facilities. Therefore, as described in the previous section regarding Lockwood, the Licensee is proposing to conduct up to two years of qualitative adult salmon radio telemetry studies, using up to 20 Kennebec origin fish each year. For reasons discussed previously, the initial two years of study will be qualitative in nature, as there likely will not be enough returning adult salmon (200 needed) to conduct statistically valid, quantitative studies of upstream passage through all four Projects. However, the SPP specifies that once there are 200 returning adult salmon of Kennebec origin available for study use, the Licensee will conduct a comprehensive quantitative upstream passage study of the Hydro-Kennebec Project (along with the other three Projects) to evaluate if the cumulative upstream passage standard is being achieved. The study will be carried out in consultation with the fishery agencies.

The conduct of both qualitative and quantitative studies of adult salmon upstream passage will be highly beneficial to Atlantic salmon. The qualitative studies will help initially determine the efficiency and effectiveness of the upstream fish lift at the Hydro-Kennebec Project. Telemetry information will also be useful in understanding fish behavior in and near the fishway, including observations of any problems associated with fishway entrances, attraction flows, and fishway operational concerns. Once sufficient numbers (at least 200) of adult Atlantic salmon, of Kennebec origin, are available for doing a quantitative assessment of the reach containing all four Projects, the proposed quantitative study will provide a means of evaluating whether the cumulative upstream passage performance standard of 81.4% is being achieved. Achievement of the standard will be based on an average of two years of adult passage performance data wherein the individual whole station survival estimates are cumulatively calculated from Lockwood through Weston. As at Lockwood, the information collected via the proposed upstream passage qualitative and quantitative studies will help improve Hydro-Kennebec fishway efficiency and effectiveness, will reduce migratory delay, and will ensure the fishways provide safe, effective and timely volitional passage.

As part of an adaptive management approach, if, after completion and testing of these measures, the upstream passage performance standard has not been met, the Licensee will consult with the agencies regarding potential additional measures, such as minor structural or operational modifications, to be undertaken to further improve upstream passage at the Hydro-Kennebec Project, as outlined in the SPP.

6.2.3 SHAWMUT

The Shawmut Project currently has no upstream passage facilities. A previously authorized fish lift for the Shawmut Project is currently in the final design phase, construction of the fish lift will commence in 2020, and the fish lift will be fully installed and operational in May 2021. In the interim, the SPP specifies that the Licensee will continue to utilize trap and truck operations from the Lockwood fish lift to provide upstream passage for Atlantic salmon the Shawmut Project.

As authorized under the ISPP, the Licensee is completing final design of a new upstream passage fish lift facility for the Shawmut Project. The fish lift is designed to accommodate 12,000 Atlantic salmon, 177,000 American shad, 1,535,00 blueback herring, and 134,000 alewives (NMFS correspondence December 32, 2016). The final fish lift design will be approved by the fishery agencies. Fish lift construction will be completed such that the fishway is ready for shakedown and testing at the start of the upstream migration season in May 2021.

Construction of the fish lift at Shawmut may have some short-term effects on Atlantic salmon, though the effects of the construction are likely to be restricted to the habitat immediately downriver of the Shawmut Project. Shortnose and Atlantic sturgeon will not be affected by fish lift construction because neither species is present in the vicinity of the Shawmut Project, and construction effects will be limited to the immediate Shawmut tailwater area.

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 for out-migrating smolts between April and June and out-migrating 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). Under the SPP, interim upstream fish passage at the Shawmut Project will continue to be provided via trapping and trucking pre-spawn Atlantic salmon from Lockwood upriver to spawning and rearing habitat in the Sandy River. Therefore, no pre-spawn Atlantic salmon will be in the vicinity of the Shawmut Project at the time of fish lift construction.

Implementation of the terms and conditions included in the July 2013 BO for the authorized fish lift construction at Shawmut will minimize any short-term impacts to Atlantic salmon migration habitat for out-migrating smolts and kelts. These conditions include in-water work restrictions, adherence to Best Management Practices, and pollution and sediment controls. In-water work will be minimal, and to the extent possible will occur outside of the smolt and kelt outmigration periods or within the confines of a dewatered cofferdam. By ensuring in-river construction occurs outside of the outmigration period effects to out-migrating smolts and kelts will be minimized.

Once the fish lift is operational the Licensee proposes the following measures to enhance upstream passage of Atlantic salmon at the Shawmut Project:

- The Licensee will operate the fish lift, as previously authorized in the FERC license approving the ISPP. The fish lift will be installed and ready for operation by a target date of May 2021[9].
- The Licensee will consult with the fishery agencies regarding how the Shawmut fish lift will be operated and develop a Fish Passage Operations and Maintenance Plan for the Project to include a Fish Stranding Plan.
- Relocate, if necessary, the upstream eel passage facility in consultation with the agencies.

Once the fish lifts planned for the Shawmut and Weston projects and the volitional fishway planned for the Lockwood bypass reach are operational, under the SPP the Licensee proposes to conduct adult salmon radio telemetry studies to evaluate the effectiveness of the Shawmut fish lift for adult Atlantic salmon. Specifically, as described in the previous sections regarding Lockwood and Hydro-Kennebec, the Licensee is proposing to conduct up to two years of qualitative adult salmon radio telemetry studies, using up to 20 Kennebec origin fish each year. For the reasons discussed previously, the initial 2 years of study will be qualitative in nature, as there will likely not be enough fish returning adult salmon (200 needed) to conduct statistically valid, quantitative studies. However, the SPP specifies that once there are 200 returning adult salmon, of Kennebec origin, available for study use, the Licensee will conduct a comprehensive quantitative upstream passage study of the Shawmut project (along with the other three projects) to evaluate if the cumulative upstream passage standard is being achieved. The study will be carried out in consultation with the agencies.

The conduct of both qualitative and quantitative studies of adult salmon upstream passage will be highly beneficial to Atlantic salmon. The qualitative studies will help initially determine the efficiency and effectiveness of the new upstream fish lift at the Shawmut Project. Telemetry

[9] The Licensee has completed design of a new upstream passage fish lift facility for the Shawmut Project. The fish lift is designed to accommodate 12,000 Atlantic salmon, 177,000 American shad, 1,535,00 blueback herring, and 134,000 alewives (NMFS correspondence December 32, 2016).

information will also be useful in understanding fish behavior in and near the fishway, including observations of any problems associated with fishway entrances, attraction flows, and fishway operational concerns. Once sufficient numbers (at least 200) of adult Atlantic salmon, of Kennebec origin, are available for doing a quantitative assessment of the reach containing all four projects, the proposed quantitative study will provide a means of evaluating whether the cumulative upstream passage performance standard of 81.4% is being achieved. Achievement of the standard will be based on an average of two years of adult passage performance data wherein the individual whole station survival estimates are cumulatively calculated from Lockwood through Weston. As at Lockwood and Hydro-Kennebec, the information collected via the proposed upstream passage qualitative and quantitative studies will help improve Shawmut fishway efficiency and effectiveness, and will ensure the fishways provide safe, effective and timely volitional passage.

As part of an adaptive management approach, if, after completion and testing of these measures, the upstream passage performance standard has not been met, the Licensee will consult with the agencies regarding potential additional measures, such as minor structural or operational modifications, to be undertaken to further improve upstream passage at the Shawmut Project, as outlined in the SPP.

6.2.4 WESTON

The Weston Project currently has no upstream passage facilities. A previously authorized fish lift for the Weston Project is currently in the design phase, construction of the fish lift will commence in 2021, and the fish lift will be fully installed and operational in May 2022. In the interim, the SPP specifies that the Licensee will continue to utilize trap and truck operations from the Lockwood fish lift to provide upstream passage for Atlantic salmon past the Weston Project.

As authorized under the ISPP, the Licensee is completing the design of a new upstream passage fish lift facility for the Weston Project. The fish lift is being designed to accommodate 11,300 Atlantic salmon, 106,000 American shad, 922,000 blueback herring, and 51,600 river herring (NMFS correspondence December 32, 2016). The final fish lift design will be approved by the fishery agencies. Fish lift construction would be completed such that the fishway is ready for shakedown and testing at the start of the upstream migration season in May 2022.

Construction of the fish lift at Weston may have some short-term effects on Atlantic salmon, though the effects of the construction are likely to be restricted to the habitat immediately downriver of the Weston Project facilities. Shortnose and Atlantic sturgeon will not be affected by fish lift construction because neither species is present in the vicinity of the Weston Project, and construction effects will be limited to the immediate Weston tailwater area.

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 out-migrating smolts between April and June and out-migrating 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 Weston project involves trapping and trucking pre-spawn Atlantic salmon from Lockwood upriver to spawning and rearing habitat in the Sandy River. Therefore, no pre-spawn Atlantic salmon will be in the vicinity of the Weston Project at the time of construction.

Implementation of the terms and conditions included in the July 2013 BO for the authorized fish lift construction at Weston will minimize any short-term impacts to Atlantic salmon migration habitat for out-migrating smolts and kelts. These conditions include in-water work restrictions, adherence to Best Management Practices, and pollution and sediment controls. In-water work will be minimal, and to the extent possible will occur outside of the smolt and kelt outmigration periods and within the confines of a dewatered cofferdam. By ensuring in-river construction occurs outside of the outmigration period effects to out-migrating smolts and kelts will be minimized.

Once the fish lift is operational the Licensee proposes the following measures to enhance upstream passage of Atlantic salmon at the Shawmut Project:

- The Licensee will operate the fish lift, as previously authorized by the FERC license amendment(s) approving the ISPP. The fish lift will be installed and operational by a target date of May 2022[10].

[10] The Licensee has conceptual design of a new upstream passage fish lift facility for the Weston Project. The fish lift will be designed to accommodate 11,300 Atlantic salmon, 106,000 American shad, 922,000 blueback herring, and 51,600 river herring. Final fish lift design will be completed in 2020.

- The Licensee will consult with the fishery agencies regarding how the Weston fish lift will be operated and develop a Fish Passage Operations and Maintenance Plan for the Project to include a Fish Stranding Plan.

Once the fish lifts planned for the Shawmut and Weston projects and the volitional fishway planned for the Lockwood bypass reach are operational, under the SPP the Licensee proposes to conduct adult salmon radio telemetry studies to evaluate the effectiveness of the Weston fish lift for adult Atlantic salmon. Specifically, as described in the previous sections regarding Lockwood, Hydro-Kennebec, and Shawmut, the Licensee is proposing to conduct up to two years of qualitative adult salmon radio telemetry studies, using up to 20 Kennebec origin fish each year. For the reasons discussed previously, the initial 2 years of study will be qualitative in nature, as there will likely not be enough fish returning adult salmon (200 needed) to conduct statistically valid, quantitative studies. However, the SPP specifies that once there are 200 returning adult salmon, of Kennebec origin, available for study use, the Licensee will conduct a comprehensive quantitative upstream passage study of the Weston project (along with the other three projects) to evaluate if the cumulative upstream passage standard is being achieved. The study will be carried out in consultation with the agencies.

The conduct of both qualitative and quantitative studies of adult salmon upstream passage will be highly beneficial to Atlantic salmon. The qualitative studies will help initially determine the efficiency and effectiveness of the proposed upstream fish lift at the Weston Project. Telemetry information will also be useful in understanding fish behavior in and near the fishway, including observations of any problems associated with fishway entrances, attraction flows, and fishway operational concerns. Once sufficient numbers (at least 200) of adult Atlantic salmon, of Kennebec origin, are available for doing a quantitative assessment of the reach containing all four projects, the proposed quantitative study will provide a means of evaluating whether the cumulative upstream passage performance standard of 81.4% is being achieved. Achievement of the standard will be based on an average of two years of adult passage performance data wherein the individual whole station survival estimates are cumulatively calculated from Lockwood through Weston. As at Lockwood, Hydro-Kennebec, and Shawmut, the information collected via the proposed upstream passage qualitative and quantitative studies will help improve Weston fishway efficiency and effectiveness, will reduce migratory delay, and will ensure the fishways provide safe, effective and timely volitional passage.

As part of an adaptive management approach, if, after completion and testing of these measures, the upstream passage performance standard has not been met, the Licensee will consult with the agencies regarding potential additional measures, such as minor structural or operational modifications, to be undertaken to further improve upstream passage at the Weston Project, as outlined in the SPP.

6.3 DOWNSTREAM STREAM PASSAGE FOR ATLANTIC SALMON

The Licensee has conducted a number of downstream smolt passage studies at the four Kennebec River Projects, including most recently four years of study under the provisions of the Project ISPPs (2012-2015). Table 6-1 summaries the Atlantic salmon smolt studies conducted by the Licensee during 2012-2015 at the Lockwood, Hydro-Kennebec, Shawmut and Weston projects, under the provision of the ISPPs. The results of the studies are summarized in Table 6-2 which provides 3-year average results for smolt studies conducted over the period 2012-2015. Table 6-2 includes whole station survival estimates based on 3-year averages, and also provides robust estimates for passage route utilization and survival based on all smolts released upstream of a particular project.

TABLE 6-1 SUMMARY OF DOWNSTREAM SMOLT PASSAGE STUDIES CONDUCTED ON KENNEBEC PROJECTS 2012-2015

STUDY YEAR	STUDY REPORT NAME	STUDY DESCRIPTION
2012	*Downstream bypass effectiveness for the passage of Atlantic salmon smolts at the Hydro-Kennebec Project, Kennebec River, Maine* (Normandeau 2012).	Radio-tagged, hatchery-reared Atlantic salmon smolts were released into the Kennebec River upstream of the Hydro-Kennebec Project during the spring 2012 outmigration period to evaluate the effectiveness of the existing downstream bypass structure. Smolt passage data from that release group was coupled with downstream passage data for smolts released below the project (see Normandeau 2012b) to generate an estimate of

STUDY YEAR	**STUDY REPORT NAME**	**STUDY DESCRIPTION**
		dam passage survival using a paired release-recapture model.
2012	*Downstream bypass effectiveness for the passage of Atlantic salmon smolts at the Weston, Shawmut, and Lockwood Projects, Kennebec River, Maine* (Normandeau 2012b)	Radio-tagged, hatchery-reared Atlantic salmon smolts were released into the Kennebec River upstream of the Weston and Lockwood Projects during the spring 2012 outmigration period to evaluate the effectiveness of the existing downstream bypass structures at Weston, Shawmut and Lockwood.
2013	*Evaluation of Atlantic salmon passage at the Weston, Shawmut, Hydro-Kennebec, and Lockwood Projects, Kennebec River and Brunswick Project, Androscoggin River, Maine, Spring 2013* (Normandeau 2013)	Smolt passage during the spring 2013 outmigration period was assessed using an array of stationary radio-telemetry receivers installed at the Weston, Shawmut, Hydro-Kennebec, and Lockwood, Projects. Radio-tagged, hatchery-reared Atlantic salmon smolts were released upstream and downstream of each Project to facilitate the use of a paired release-recapture model for estimation of dam passage survival.
2014	*Evaluation of Atlantic salmon passage at the Weston, Shawmut, Hydro-Kennebec, and Lockwood Projects, Kennebec River and Brunswick Project, Androscoggin River, Maine, Spring 2014* (Normandeau 2014)	Smolt passage during the spring 2014 outmigration period was assessed using an array of stationary radio-telemetry receivers installed at the Weston, Shawmut, Hydro-Kennebec, and Lockwood, Projects. Radio-tagged, hatchery-reared Atlantic salmon smolts were released upstream and downstream of each Project to facilitate the use of a paired release-recapture model for estimation of dam passage survival.

STUDY YEAR	STUDY REPORT NAME	STUDY DESCRIPTION
2015	*Evaluation of Atlantic salmon passage at the Weston, Shawmut, and Lockwood Projects, Kennebec River and Pejepscot and Brunswick Projects, Androscoggin River, Maine, Spring 2015* (Normandeau 2015)	Smolt passage during the spring 2015 outmigration period was assessed using an array of stationary radio-telemetry receivers installed at the Weston, Shawmut, and Lockwood, Projects. Radio-tagged, hatchery-reared Atlantic salmon smolts were released upstream and downstream of each Project to facilitate the use of a paired release-recapture model for estimation of dam passage survival.

TABLE 6-2 CURRENT DOWNSTREAM SMOLT PASSAGE ROUTES (PERCENT UTILIZATION) AND WHOLE STATION SURVIVAL RATES (BASED ON 3-YEARS, 2012-2015)

PROJECT	ROUTE	% UTILIZATION[3]	% SURVIVAL[1,2]
Lockwood (2013-2015)	Downstream Bypass	25.0%	98.5%
	Powerhouse		
	Units 1-6	6.6%	98.8%
	Unit 7	7.7%	90.6%
	Spill (Bypass Reach)	57.0%	100.0%
	WHOLE STATION	-	98.6%
Hydro-Kennebec (2012-2014)	Downstream Bypass	39.3%	97.9%
	Powerhouse		
	Unit 1	22.0%	93.2%
	Unit 2	5.3%	82.2%
	Spill	30.6%	100.0%
	WHOLE STATION	-	94.7%
Shawmut (2013-2015)	Downstream bypass	38.7%	97.4%
	Powerhouses		
	Units 1-6	11.6%	92.1%
	Units 7-8	21.1%	93.1%
	Hinged board spill[4]	5.2%	86.7%
	Spillway[4]	21.4%	100.0%
	WHOLE STATION	-	93.5%
Weston	Downstream Bypass	42.8%	92.8%

PROJECT	ROUTE	% UTILIZATION[3]	% SURVIVAL[1,2]
(2013-2015)	Powerhouse	30.6%	98.3%
	Spill (North Channel)	23.6%	94.7%
	WHOLE STATION	-	95.0%

Notes:

[1] Route-specific percent (%) survival values are based on the full number of radio-tagged smolts determined to have utilized a particular route regardless of release location (i.e., values for Shawmut represent smolts released upstream and downstream of Weston as well as immediately upstream of Shawmut). These values are adjusted to account for background mortality in the section of river between the dam and first downstream receiver.

[2] Whole-station survival values represent the three year average at each project location based upon the subset of smolts released immediately upstream of each dam and adjusted for background mortality using passage success of the concurrent subset of smolts released immediately downstream of each dam.

[3] The percent (%) utilization represents the percentage of smolts utilizing a particular route over the three-year study period. Note that totals do not sum to 100% as during some years individuals which approached the project may have failed to pass or did so undetected.

[4] Hinge board spill only available during final release of 2014 study and 2015 study year and refers to smolts passing via the three sections opened adjacent to the power canal. Spillway refers to smolts passing via the central log sluice or Obermeyer sections (not distinguished).

Due to the limited availability of adult salmon, downstream passage studies for kelts in the Kennebec are limited to a single pilot study which was conducted at Lockwood during the late-fall and early-winter 2007 (Normandeau 2008). Downstream passage data collection was limited to eleven hatchery-reared Atlantic salmon kelts that were released either just upstream of Lockwood or directly into the Lockwood power canal. The limited observations during this study indicated that 60% of out-migrating kelts passed downstream via spill into the bypassed reach with the remaining fish entering the power canal. Once in the power canal, kelts utilized the downstream bypass (50%) and the single Kaplan unit (Unit 7; 50%).

6.3.1 LOCKWOOD

The Lockwood Project has an installed downstream passage facility consisting of a 10-foot-deep floating guidance boom leading to a bypass gate located in the power canal. Based on the results of the recent smolt studies, it has been determined that existing downstream passage facility is very effective, with a three-year average station survival rate for Atlantic salmon smolts at the Lockwood Project of 98.6% (see Table 6-2). Because downstream passage effectiveness and survival rates are meeting the performance standard, no specific modifications to the existing Lockwood downstream passage facilities are proposed by the Licensee in the SPP. However, the

Licensee will continue to operate the existing downstream passage facility at Lockwood, and will undertake the following operational measures:

- Continue to operate the Lockwood canal bypass gate and floating guidance boom for utilization by adult and juvenile Atlantic salmon, April 1 through December 31, as river conditions allow.
- Ensure that the canal 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.
- When river flow at the Project exceeds about 5,660 cfs, flow in excess of operating turbine capacity (except for pond fluctuations allowed by the license) will be spilled in accordance with the Project's high-water guidelines unless it is determined through consultation with NMFS that additional spill is needed for downstream passage.

Continued operation of the downstream passage facilities at Lockwood as proposed in the SPP will continue to provide out-migrating smolts with safe, timely and effective passage. Three-year average results for smolt studies conducted over the period 2013-2015 are summarized in Table 6-2. The Lockwood results demonstrate that the majority of smolts pass the Lockwood Project via spill into the bypass reach (57.0%) and that the survival rate for these fish is 100%. The downstream bypass at Lockwood is utilized by 24.4% of smolts, with a survival rate of 98.5%. Some smolts pass via Unit 7 (7.7%) with a survival rate of 90.6%; while the remaining 66% of smolts pass through units 1-6, with a survival rate of 98.8%. The resulting whole stations survival estimate for Lockwood, based on three-year average data is 98.6%.

As demonstrated through study (and shown in Table 6-2), it is recognized that spill at the Lockwood Project is an important means of downstream passage for both adult and juvenile Atlantic salmon. The Project turbine capacity is about 5,660 cfs and flows in excess of turbine capacity are generally spilled into the bypass reach. Additional spill during low river flow years could further facilitate downstream smolt passage. However, once the bypass reach fishway is installed, additional spill in the bypass may be counter-productive as it could interfere with effective operation of the new upstream fishway. In addition, the upstream fishway itself may provide smolts and kelts with yet another safe downstream passage route. Nonetheless, once the bypass volitional fishway is completed, to further facilitate downstream passage by means of

Lockwood project spill, in the SPP the Licensee proposes to consult with the agencies to develop a plan for additional spill during low river flow years for a two-week period during the peak Atlantic salmon smolt outmigration season. Combined, these additional measures are expected to further increase whole station survival for downstream passage of Atlantic salmon smolts at Lockwood.

To demonstrate that the Lockwood Project is continuing to provide safe and effective downstream passage for smolts, in the SPP the Licensee proposes to conduct up to three years of additional smolt studies designed to evaluate whole station survival, and the overall contribution of Lockwood to achieving the cumulative ("end-of-pipe") performance standard for Atlantic salmon smolts for the four Projects. The studies will be designed in consultation with the agencies and will utilize methods that are acceptable to both the Licensee and agencies. The studies will be designed to provide a reasonable estimate of whole station survival for salmon smolts. The joint probability of the four station-specific survival estimates will generate the cumulative ("end of pipe") estimate for each study year. The average of the cumulative estimates for the three study years will be evaluated relative to the downstream salmon smolt station survival standard. The individual performance of the Lockwood Project will also be assessed during these comprehensive studies. Conduct of additional smolt studies following completion of the bypass reach upstream fish passage facility will ensure that the Lockwood Project is providing safe and effective passage for smolts.

The Licensee's proposal to operate the Lockwood bypass facilities will also benefit Atlantic salmon kelt downstream passage at the Lockwood project. While there are not currently enough returning adult Atlantic salmon to conduct studies of downstream kelt passage, it is likely that kelts are currently afforded effective downstream passage at Lockwood. Further, as noted previously, the construction of a new bypass reach volitional fishway will provide downstream migrating kelts with an additional safe passage route.

6.3.2 HYDRO-KENNEBEC

The Hydro-Kennebec Project has an installed downstream passage facility consisting of a 10-foot-deep floating guidance boom leading to a deep gated bypass slot and plunge pool. The Licensee has conducted a number of downstream passage studies at the Hydro-Kennebec

Project, including most recently three years of study under the provisions of the ISPP (2012-2014). The results of those studies for the Hydro-Kennebec Project are summarized in Table 6-2. As shown, based on the results of those studies, it has been determined that the existing downstream passage facility is very effective, and the three-year average station survival rate for Atlantic salmon smolts at the Hydro-Kennebec Project is 94.7%.

However, because downstream passage effectiveness and survival rates may be improved to help meet the proposed cumulative performance standard, in the SPP the Licensee proposes to undertake certain modifications to the downstream passage facility and its operation at the Hydro-Kennebec Project to improve the overall effectiveness of the passage facilities. Specifically, the SPP includes the following proposed measures:

- Structurally modify the existing guidance boom to close the gap between the guidance boom and the forebay wall/downstream bypass entrance.
- Continue to operate the downstream bypass and floating guidance boom for utilization by adult and juvenile Atlantic salmon, April 1 through December 31, as river conditions allow.
- Ensure that the bypass is open and operating to pass the maximum flow of 4% 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.

Continued operation of the downstream passage facilities at Hydro-Kennebec with the proposed modifications will provide out-migrating smolts with safe, timely and effective passage. Three-year average results of smolt studies conducted over the period 2012-2014 for the Hydro-Kennebec Project demonstrate that 39.3% of smolts are currently using the downstream bypass, and that these fish have a 97.9% survival rate. Other passage routes being utilized by smolts at Hydro-Kennebec include spill (30.6%) with a survival rate of 100% and Unit 1 passage (22.0%) with a survival rate of 93.2%. A small percentage of smolts (5.3%) pass the Project via Unit 2 with a lower survival rate of 82.2%. These results suggest that increases in whole station survival rates can be achieved by either increasing the portion of smolts utilizing the downstream bypass or finding ways to further restrict fish from passing through Unit 2. The Licensee’s proposal in the SPP to close the gap between the existing guidance boom and the powerhouse wall should prevent fish from moving through the gap and passing through the turbines, thereby increasing the percentage of fish using the downstream bypass.

The Licensee retained Normandeau Associates to conduct a desktop assessment for a range of theoretical guidance boom effectiveness rates following the structural modification to close the gap in the Hydro-Kennebec forebay guidance boom. The desktop model evaluated station survival over a range of Kennebec River flow conditions from 25% up to 75% exceedance. The model assumed the distribution of smolt passage follows a 1:1 ratio proportional to the distribution of river flow between spill and non-spill routes. A range of theoretical downstream bypass effectiveness rates from 70-99% were incorporated to represent potential effects from the modified boom. Smolts approaching the project and not assumed to pass via spill or the downstream bypass were proportioned between Units 1 and 2 using ratio data from all radio-tagged individuals passing via those two routes at Hydro-Kennebec during the 2012-2014 field studies. Survival rates at all passage routes were estimated using the route-specific rates summarized in Table 6-2. Based on the assumptions summarized here, the expected station survival for Atlantic salmon smolts at Hydro-Kennebec will exceed 96% under median flow conditions and with a downstream bypass effectiveness rate of 90%. Thus, with this modification, the whole stations survival rate for downstream passage of Atlantic salmon smolts at Hydro-Kennebec is expected to increase sufficiently for the four Projects to collectively meet the proposed cumulative performance standard in the SPP.

To demonstrate that the proposed modification to the Hydro-Kennebec downstream bypass guidance boom has improved the overall effectiveness of the passage facilities, in the SPP the Licensee proposes to conduct up to three years of additional smolt studies designed to evaluate whole station survival and the overall contribution of Hydro-Kennebec to achieving the cumulative (“end-of-pipe”) performance standard for Atlantic salmon smolts for the four Projects. The studies will be designed in consultation with the agencies and will utilize methods that are acceptable to both the Licensee and agencies. The studies will be designed to provide a reasonable estimate of whole station survival for salmon smolts. The joint probability of the four station-specific survival estimates will generate the cumulative (“end of pipe”) estimate for each study year. The average of the cumulative estimates for the three study years will be evaluated relative to the downstream salmon smolt station survival standard. The individual performance of the Hydro-Kennebec Project will be assessed during these comprehensive studies. Conduct of additional smolt studies following completion of the proposed modifications to the downstream passage facilities at Hydro-Kennebec will ensure that the modifications have increased the whole station survival for Atlantic salmon smolts at the project, and that the Project is providing safe and effective passage for smolts.

The proposed modification to the guidance boom at Hydro-Kennebec is also expected to improve Atlantic salmon kelt passage at the Project. While there are not currently enough returning adult Atlantic salmon to conduct studies of downstream kelt passage, it is likely that closing the gap in the guidance boom will improve kelt passage by ensuring that more downstream migrating kelts are directed to the bypass.

6.3.3 SHAWMUT

Downstream passage for Atlantic salmon at Shawmut is provided through a combination of a sluice, Tainter gate and opened hinged flashboards. The sluice is located on the right-hand side of the intake structure next to Unit 6. The sluice is 4-feet-wide by 22-inches-deep and can be manually adjusted by adding or removing stoplogs. With all stoplogs removed the sluice passes between 30 and 35 cfs of water flow which is discharged over the face of the dam into a 3-foot-deep plunge pool connected to the river. The Tainter gate located next to the sluice measures 7-feet-high by 10-feet-wide and can pass up to 600 cfs.

The results of downstream smolt studies conducted in 2012, 2013, 2014 and 2015 found passage effectiveness and station survival at Shawmut varied considerably depending on river flows, Project operations, and gate openings. Three-year average estimates of percent utilization of various passage routes, and the survival rate associated with each route are provided in Table 6-2. On average, 38.7% of smolts were found to utilize the downstream bypass, and the majority of those did so via the Tainter gate when it was operated wide open (600 cfs). Fish passing through the sluice or Tainter gate had a survival rate of 97.4%. In addition, it was found that opening the three sections of hinged flashboards adjacent to unit 1 (passing approximately 420 cfs) helped to increase the percent of smolts bypassing the powerhouse, with 5.2% of smolts using the hinged flashboard openings. However, these fish had a lower survival rate (86.7%) than fish using the sluice gate or Tainter gate (100%). Smolt passage via turbine units 7-8 was found to be 21.1% with a survival rate 93.1%; while passage via units 1-6 was 11.6% with a survival rate of 92.1%. On whole, the studies found that the 3-year station survival estimate for salmon smolts at Shawmut was 93.5%.

Based on 2012-2015 study results and the Licensee's different tests of adding downstream passage through the Tainter gate and lowered flashboard sections, it was concluded that the lowering of one more hinged flashboard section (for a total of four sections), raising the flow from (420 cfs to 560 cfs) should provide adequate flow to allow additional smolts to pass via this route. NMFS, by letter dated May 22, 2017, concluded that the additional measures are expected to result in whole station survival rates of more than 95%.

Because downstream passage effectiveness and survival rates may be improved to help meet the proposed cumulative performance standard, in the SPP the Licensee proposes to undertake certain modifications to the downstream passage facility and its operation at the Shawmut Project to improve the overall effectiveness of the passage facilities. Specifically, the SPP includes the following proposed measures:

- Install a guidance boom (e.g., Worthington boom) in the forebay in front of Units 7 and 8. The proposed boom will have a depth of 10 feet, be made of rigid panels with ½ inch perforations (48% opening).
- Continue to operate the forebay bypass gate for utilization by adult and juvenile Atlantic salmon April 1 through December 31, as river conditions allow.
- Ensure that the forebay bypass gate is operated to maintain a flow of 6% of station unit flow through the gate.
- Continue to provide a flow of 600 cfs through the Tainter gate for the smolt passage season.
- 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.

In the interim period, until the fish boom is installed, the Licensee is also proposing the following measure to enhance downstream passage of Atlantic salmon at the Shawmut Project:

- Drop four sections of hinged flashboard (passing about 560 cfs in total) for the month of May during the smolt passage season.

Continued operation of the downstream passage facilities at Shawmut with the proposed modifications will provide out-migrating smolts with safe, timely and effective passage. The results of studies conducted in 2012-2015 and summarized in Table 6-2, suggest that increases in whole station survival rates can be achieved by increasing the portion of smolts utilizing the downstream bypass (sluice or Tainter gate). The Licensee's proposal in the SPP to install a guidance boom to help direct the fish to the bypass gates should significantly increase the portion of smolts using the bypass, thereby increasing the survival rate of a larger portion of smolts.

The Licensee retained Normandeau Associates to conduct a desktop assessment to evaluate the theoretical installation of a guidance boom in the Shawmut forebay in front of Units 7 and 8. The desktop model evaluated station survival over a range of Kennebec River flow conditions from 25% up to 75% exceedance. The model assumed the distribution of smolt passage follows a 1:1 ratio proportional to the distribution of river flow between spill and power canal routes. Analysis of generational discharge reported by Brookfield operations at the time of downstream passage for radio-tagged Atlantic salmon smolts in the Shawmut power canal during the 2013-2015 study years indicated that the overall effectiveness of the existing downstream bypass was inversely related to total generation (i.e., as generation flows increase the effectiveness of the forebay tainter gate decreases). For each model run associated with this analysis, the bypass effectiveness rate for the theoretical guidance boom was represented by the sum of the observed rate of effectiveness for the forebay Tainter gate (under a no-boom condition) plus 53% of the proportion of smolts fated to pass downstream via the turbine units. Smolt turbine passage was reduced in proportion to the rates of entrainment observed among all radio-tagged individuals passing via either the Francis (Units 1 through 6) or propeller units (Units 7 and 8) at Shawmut during the 2013-2015 field studies. The 53% guidance boom effectiveness rate was based on the overall rate observed for all radio-tagged smolts which entered the power canal at Lockwood during the 2013-2015 studies. Survival rates at all passage routes were estimated using the route-specific rates summarized in Table 6-2. Based on the assumptions summarized here the expected station survival for Atlantic salmon smolts at Shawmut will range from 96-96.3% across the range of flow conditions considered. Thus, with the proposed installation of the guidance boom, the whole stations survival rate for downstream passage of Atlantic salmon smolts at Shawmut is expected to increase sufficiently for the four projects to collectively meet the proposed cumulative performance standard in the SPP.

To demonstrate that the proposed addition of a guidance boom to the Shawmut downstream bypass system has improved the overall effectiveness of the downstream passage facilities, in the SPP the Licensee proposes to conduct up to three years of additional smolt studies designed to evaluate whole station survival at the Shawmut Project, and the overall contribution of Shawmut to achieving the cumulative ("end-of-pipe") performance standard for Atlantic salmon smolts for the four Projects. The studies will be designed in consultation with the agencies and will utilize methods that are acceptable to both the Licensee and agencies. The studies will be designed to provide a reasonable estimate of whole station survival for salmon smolts. The joint probability of the four station-specific survival estimates will generate the cumulative ("end of pipe") estimate for each study year. The average of the cumulative estimates for the three study years will be evaluated relative to the downstream salmon smolt station survival standard. The individual performance of the Shawmut Project will be assessed during these comprehensive studies. Conduct of additional smolt studies following completion of the proposed modifications to the downstream passage facilities at Shawmut will ensure that the modifications have increased the whole station survival for Atlantic salmon smolts at the project, and that the project is providing safe and effective passage for smolts.

The proposed guidance boom at Shawmut is also expected to improve Atlantic salmon kelt passage at the Project. While there are not currently enough returning adult Atlantic salmon to conduct studies of downstream kelt passage, it is likely that the guidance boom will improve kelt passage by ensuring that more downstream migrating kelts are directed to the bypass gates.

6.3.4 WESTON

The Weston Project has a downstream passage facility consisting of an existing sluice gate located on the South Channel dam and a 10-foot-deep floating guidance boom. The Licensee evaluated the effectiveness of the Weston bypass in 2012 after the boom was installed in 2011, and again in 2013-2015. In 2012, downstream bypass usage data were collected via radio telemetry techniques for smolts at the Weston Project using bypass flows equaling 6%, 4%, and 2% of actual powerhouse flows. Estimated whole station survival at the Weston Project increased from 90% to 94% under median river conditions and from 88% to 94% under low flow river conditions.

During the spring of 2013, 2014 and 2015, the Licensee again evaluated whole station survival per the ISPP. A summary of the results of downstream smolt studies conducted in these years is provided in Table 6-2. As shown, on average, smolt use of the downstream bypass at Weston was 42.8% with a survival rate of 92.8%. Smolts were also found to pass via the powerhouse (30.6%) with a very high survival rate of 98.3%, and via spill at the North Channel dam (23.6%) with a survival rate of 94.7%. Overall, the studies found that the 3-year average whole station survival estimate at Weston was 95.0%.

Because downstream passage effectiveness and survival rates may be improved to help meet the proposed cumulative performance standard, in the SPP the Licensee proposes to undertake certain modifications to the downstream passage facility and its operation at the Weston Project to improve the overall effectiveness of the passage facilities. Specifically, the SPP includes the following proposed measures:

- Continue to operate the existing (and modified) bypass and floating guidance boom for utilization by adult and juvenile Atlantic salmon from April 1 through December 31, as river conditions allow.
- Ensure that the bypass/sluice gate is operated to maintain a flow of 6% of station unit flow for at least 8 hours per day from April 1 through June 15 for smolts, and between September 15 and December 1 for kelts and eels.
- 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.
- Modify the existing downstream bypass to increase survival. Detailed components of the improvements to be made will be developed in consultation with the agencies, and may include such modifications as smoothing, slope modification, and ledge removal to deepen the plunge pool at the downstream end of the sluice. Improvements shall be reasonable and acceptable to both the Licensee and agencies. Downstream bypass improvements will be undertaken during the construction of the preciously approved upstream fish lift, and will be completed and operational by May 2022.

Continued operation of the downstream passage facilities at Weston with the proposed improvements to the existing bypass will provide out-migrating smolts with safe, timely and effective passage. While the details of the bypass improvements have yet to be worked out between the Licensee and the fishery agencies, the proposal to make modifications such as smoothing, slope modification, and ledge removal to deepen the plunge pool at the downstream end of the sluice are expected to increase the survival rate of smolts using the bypass, and thereby increase the whole station survival rate.

The Licensee retained Normandeau Associates to conduct a desktop assessment to evaluate a range of potential route-specific survival rates for the downstream bypass at Weston following modification. For the purposes of this analysis, specific modifications were not identified but their implementation was assumed to increase route-specific survival over that observed during the 2013-2015 studies. The desktop model evaluated station survival over a range of Kennebec River flow conditions from 25% up to 75% exceedance. The model assumed the distribution of smolt passage follows a 1:1 ratio proportional to the distribution of river flow between spill and non-spill routes. Smolts approaching the Weston Project and not assumed to pass via spill were proportioned between the downstream bypass and turbine units using ratio data from all radio-tagged individuals passing via those two routes at Weston during the 2013-2015 field studies. Survival rates for spill and the turbine units were estimated using the route-specific rates summarized in Table 6-2. The survival rate for the downstream bypass was modeled for values between 94 and 99% effectiveness (representing an increase over the 92.8% observed during the 2013-2015 studies). Based on the assumptions summarized here the expected station survival for Atlantic salmon smolts at Weston will exceed 96% under median flow conditions and with a downstream bypass survival rate of 96%.

To demonstrate that the proposed modifications to the bypass at Weston has improved the overall effectiveness passage facilities, in the SPP the Licensee proposes to conduct up to three years of additional smolt studies designed to evaluate whole station survival at the Weston Project, and the overall contribution of Weston to achieving the cumulative (“end-of-pipe”) performance standard for Atlantic salmon smolts for the four Projects. The studies will be designed in consultation with the agencies and will utilize methods that are acceptable to both the Licensee and agencies. The studies will be designed to provide a reasonable estimate of whole station survival for salmon smolts. The joint probability of the four station-specific survival estimates will generate the cumulative (“end of pipe”) estimate for each study year. The average of the cumulative estimates for the three study years will be evaluated relative to the downstream salmon smolt station survival standard. The individual performance of the Weston Project will be assessed during these comprehensive studies. Conduct of additional smolt studies following completion of the proposed modifications to the downstream passage facilities at Weston will ensure that the modifications have increased the whole station survival for Atlantic salmon smolts at the Project, and that the Project is providing safe and effective passage for smolts.

The proposed modifications to the existing bypass at Weston are also expected to improve Atlantic salmon kelt passage at the Project. While there are not currently enough returning adult Atlantic salmon to conduct studies of downstream kelt passage, it is anticipated that the improvements to the Weston bypass will improve kelt passage by ensuring that kelts have safer and more effective passage through the bypass.

Because bypass improvements will be made during construction of the upstream fish lift, there will be no construction affects on Atlantic salmon associated with the bypass modifications.

6.3.5 Cumulative Standards and Passage Timing Goals

6.3.5.1 Atlantic Salmon Smolts

In the SPP the Licensee is proposing a cumulative ("end of pipe") performance standard for Atlantic salmon smolts. As proposed, the downstream smolt performance standard for the four Projects will be considered to be met when a cumulative ("end-of-pipe") station survival of at least 84.9% is achieved. The 84.9% cumulative smolt performance standard is based on the cumulative calculation of an average individual whole station survival rate of 96% per project. As proposed in the SPP, achievement of the standard will be based on an average of three years of smolt passage performance data, wherein the individual whole station survival estimates are cumulatively calculated from Weston through Lockwood, as tested following the implementation of the downstream fish passage facilities and measures proposed for Lockwood, Hydro-Kennebec, Shawmut and Weston.

Although the cumulative standard proposed in the SPP for downstream Atlantic salmon smolts is based on the concept of successfully passing 96% of smolts at each of the four Projects, the cumulative standard has significant advantages over individual station standards. The primary advantage is that the cumulative standard is aimed at providing salmon smolts with the highest overall success rate for safely passing all four Kennebec Projects. It also allows the fishery agencies and the Licensee more flexibility in determining where to focus efforts on improving downstream passage effectiveness in order to achieve the overall standard. This will benefit the species by allowing available resources and passage performance measures to be utilized to derive the most improvement in cumulative passage rates, regardless of where (which Project) those measures are implemented.

Downstream smolt passage data collected at each of the four Projects (Lockwood, Hydro-Kennebec, Shawmut, and Weston) during the 2012-2015 whole station survival field studies was used to inform on the predicted outcome of the proposed measures described for each Project location in Sections 6.3.1 – 6.3.4.

Lockwood

As described in Section 6.3.1, the three-year average station survival rate for Atlantic salmon smolts at the Lockwood Project was 98.6% (Table 6-2). Because downstream passage effectiveness and survival rates are meeting the performance standard, no specific modifications to the existing Lockwood downstream passage facilities are proposed by the Licensee in the SPP. The Licensee proposes to continue to operate the Project such that the downstream bypass gate is set at 6% of station flow, the guidance boom is installed in a timely manner and is in good condition and when river flow at the Project exceeds 5,660 cfs, flow in excess of operating turbine capacity will be spilled in accordance with the Project's high-water guidelines. As was demonstrated during the 2013-2015 in-river studies, adherence to these operating guidelines should result in whole station survival in excess of 96%.

Hydro-Kennebec

As described in Section 6.3.2, in the SPP the Licensee has proposed to structurally modify the existing guidance boom to close the gap between the boom and the forebay wall/downstream bypass entrance. A predictive model was constructed to evaluate whole station survival at Hydro-Kennebec under a range of theoretical downstream bypass effectiveness rate values following those modifications. Table 6-3 provides a description of each parameter, the range or point value used in the model, and the source data from which model parameters were obtained. Rates related to route-specific survival, downstream bypass effectiveness and turbine entrainment were all based on the pooled set of passage data for radio-tagged Atlantic salmon smolts released upstream of Hydro-Kennebec during the 2012-2014 field evaluations.

An assumption of the predictive whole station survival model for Hydro-Kennebec was the 1:1 ratio of out-migrating smolts to the distribution of river flow between spill and generation at the Project. Prior to modeling whole station survival, the set of passage records for radio-tagged smolts passing Hydro-Kennebec during 2014 was reviewed and hourly operational records were used to assign a value of spill and powerhouse discharge at the time of passage for each individual. Hourly operational data was not available for the smolt passage studies during 2012 and 2013 and radio-tagged smolts passing the Project during 2015 were not identified to passage route. The available subset of smolts were subsequently binned into one of ten groups based on the percentage of river flow being spilled at the time of downstream passage (i.e., 0-10%, 10-20%, 20-30%, etc.). The resulting linear regression for the percentage of smolts passing on spill relative to each flow percentage group provided some support for the assumption of the 1:1 fish-spill ratio ($R^2 = 0.59$). The total number of smolts available at Hydro-Kennebec for this analysis was 326 individuals. River flow during the 2014 study year limited downstream passage events to periods where the proportion of river passing via spill ranged from 30-80%.

During the modeling effort, river flow and the downstream bypass effectiveness rate were allowed to vary. River flows ranged from the 90% to 10% exceedance conditions for May (prorated for Lockwood; 4,000 cfs to 20,500 cfs). The downstream bypass effectiveness rate was allowed to vary from the observed 59% up to a theoretical 99%. As the bypass rate was modeled upwards, the combined rate of entrainment at Units 1 and 2 was decreased by the same percentage. That decrease was made at the same proportion as the observed rates at the two units (e.g., an increase in bypass effectiveness of 10% resulted in a 10% reduction for turbine entrainment, specifically an 8% reduction at Unit 1 and a 2% reduction at Unit 2).

Under median river flows (i.e., 50% exceedance condition) and an assumed downstream bypass effectiveness rate of 80% (i.e., the midpoint of existing and 99%), the predicted whole station survival for out-migrating smolts at Hydro-Kennebec is 94.0%.

Shawmut

As described in Section 6.3.3, in the SPP the Licensee has proposed the installation of a floating guidance boom in the Shawmut forebay in front of Units 7 and 8. A model was constructed to predict whole station survival at Shawmut with the proposed boom installed. Table 6-4 provides a description of each parameter, the range or point value used in the model, and the source data from which model parameters were obtained. Rates related to route-specific survival were all based on the pooled set of passage data for radio-tagged Atlantic salmon smolts released at all points upstream of Shawmut during the 2013-2015 field evaluations.

One assumption of the predictive whole station survival model for Shawmut was the 1:1 ratio of out-migrating smolts to the distribution of river flow between spill and the forebay canal at the Project. Prior to modeling whole station survival, the full set of passage records for radio-tagged smolts passing Shawmut was reviewed and hourly operational records were used to assign a value of spill and powerhouse discharge at the time of passage for each individual. Smolts were subsequently binned into one of ten groups based on the percentage of river flow being spilled at the time of downstream passage (i.e., 0-10%, 10-20%, 20-30%, etc.). The resulting linear regression for the percentage of smolts passing on spill relative to each flow percentage group provided support for the assumption of the 1:1 fish-spill ratio (R2 = 0.90). The total number of smolts passing at Shawmut during periods with concurrent generation and spill available for this analysis was 529 individuals. This number of fish resulted in adequate sample sizes among the various spill ratio categories.

Additional review of the 2013-2015 smolt outmigration data from the Shawmut forebay canal suggested that the effectiveness of the existing downstream bypass (i.e., the forebay tainter gate) was impacted by the volume of generation. The total number of downstream passage events for smolts in the forebay canal was binned by 500 cfs increments of generational discharge (1,500 cfs up to 6,700 cfs) as recorded for their time of passage. For each 500 cfs generational discharge group, the downstream bypass effectiveness rate and turbine (Francis and propeller) entrainment rates were determined. In general, the effectiveness of the existing downstream passage at Shawmut was greater at lower generational flows than when the station was operating under higher or maximum generation levels.

During the modeling effort a series of Kennebec River flow conditions were evaluated. Modeled flows ranged from the 90% exceedance condition at Shawmut during May (4,250 cfs) up the 10% exceedance condition (21,750 cfs). The distribution of smolt egress from the forebay canal among the three potential routes (downstream bypass, Francis units and propeller units) was allowed to vary based on the level of river flow available to support generation. The assumed 47% reduction in smolt passage via the propeller units attributable to the installed guidance boom was reallocated between the downstream bypass and Francis units following the ratio of downstream bypass and Francis unit usage estimated during the 2013-2015 field studies. Under median river flows (i.e., 50% exceedance condition) the predicted whole station survival for out-migrating smolts at Shawmut is 96.2%.

Weston

As described in Section 6.3.4, in the SPP the Licensee has proposed to perform modifications to the existing downstream bypass which are intended to improve upon the route-specific survival rate observed during the 2013-2015 field evaluations (i.e., 92.8%; Table 6-2). A predictive model was constructed to evaluate whole station survival at Weston under a range of theoretical downstream bypass survival rates following those modifications. Table 6-5 provides a description of each parameter, the range or point value used in the model, and the source data from which model parameters were obtained. Rates related to route-specific survival, downstream bypass effectiveness and turbine entrainment were all based on the pooled set of passage data for radio-tagged Atlantic salmon smolts released upstream of Weston during the 2013-2015 field evaluations.

One assumption of the predictive whole station survival model for Weston was the 1:1 ratio of out-migrating smolts to the distribution of river flow between spill and generation at the project. Prior to modeling whole station survival, the full set of passage records for radio-tagged smolts passing Weston were reviewed and hourly operational records were used to assign a value of spill and powerhouse discharge at the time of passage for each individual. Smolts were subsequently binned into one of five groups based on the percentage of river flow being spilled at the time of downstream passage (i.e., 0-20%, 20-40%, 40-60%, 60-80%, or 80-100%). The resulting linear regression for the percentage of smolts passing on spill relative to each flow percentage group provided some support for the assumption of the 1:1 fish-spill ratio (R2 =

0.59). The total number of smolts available at Weston for this analysis was 230 individuals and sample sizes in the various spill ratio categories were skewed towards the 0-20%, 40-60% and 60-80% classifications.

During the modeling effort, river flow and the downstream bypass effectiveness rate were allowed to vary. River flows ranged from the 90% exceedance condition at Weston during May (4,000 cfs) up the 10% exceedance condition (20,500 cfs). Under median river flows (i.e., 50% exceedance condition) and an assumed downstream bypass survival rate of 96.4% (a 3.6% increase over existing; midpoint of existing and 99%), the predicted whole station survival for out-migrating smolts at Weston is 97.2%. The theoretical bypass survival rate considered here (i.e., 96.4%) is lower than the observed rates for smolt passage during the 2012-2015 field studies at Shawmut (97.4%), Hydro-Kennebec (97.9%) and Lockwood (98.5%).

As shown in Table 6-6, the expected performance of the proposed measures in terms of smolt whole station survival rates, under median flow conditions, ranges from 98.6% to 94.0%, with a cumulative end of pipe survival rate of 86.7%. Based on these results, the Licensee expects its proposed measures to enhance downstream passage at the four Projects to achieve the cumulative standard.

TABLE 6-3 PARAMETERS USED AS INPUT FOR MODELING ATLANTIC SALMON SMOLT WHOLE STATION SURVIVAL AT HYDRO-KENNEBEC

PARAMETER	DESCRIPTION	RANGE OR VALUE	SOURCE
River Flow	Kennebec River flow duration values at Lockwood during May	10, 25, 50, 75, 90th percentiles (22,000-4,250 cfs)	Normandeau 2012 - Appendix B, prorated flow duration curves prepared by NMFS using data from time period 1979-2010
Station Capacity		7,922	
Spill Probability	Ratio of the distribution of smolt passage at Hydro-Kennebec via spill or powerhouse relative to the distribution of river flow via spill or powerhouse	1:1 ratio	Data derived from Normandeau 2015

PARAMETER	DESCRIPTION	RANGE OR VALUE	SOURCE
Spill Survival Rate	Route-specific survival rate derived from 253 radio-tagged Atlantic salmon smolts passing Hydro-Kennebec via spill during the 2012-2014 in-river studies	100.0%	Data derived from Normandeau 2013; 2014; 2015
Downstream Bypass Survival Rate	Route-specific survival rate derived from 357 radio-tagged Atlantic salmon smolts passing Hydro-Kennebec via the downstream bypass during the 2012-2014 in-river studies	97.9%	Data derived from Normandeau 2013; 2014; 2015
Turbine Unit 1 Survival Rate	Route-specific survival rate derived from 182 radio-tagged Atlantic salmon smolts passing Hydro-Kennebec via Unit 1 during the 2012-2014 in-river studies	93.2%	Data derived from Normandeau 2013; 2014; 2015
Turbine Unit 2 Survival Rate	Route-specific survival rate derived from 44 radio-tagged Atlantic salmon smolts passing Hydro-Kennebec via Unit 2 during the 2012-2014 in-river studies	82.2%	Data derived from Normandeau 2013; 2014; 2015
Bypass Effectiveness Rate	Percentage of 551 smolts approaching Hydro-Kennebec powerhouse which used the downstream bypass during the 2012-2014 in-river studies	59.0%	Data derived from Normandeau 2013; 2014; 2015
Unit 1 Entrainment Rate	Percentage of 551 smolts approaching Hydro-Kennebec powerhouse which used Unit 1 during the 2012-2014 in-river studies	33.0%	Data derived from Normandeau 2013; 2014; 2015

PARAMETER	DESCRIPTION	RANGE OR VALUE	SOURCE
Unit 2 Entrainment Rate	Percentage of 551 smolts approaching Hydro-Kennebec powerhouse which used Unit 2 during the 2012-2014 in-river studies	8.0%	Data derived from Normandeau 2013; 2014; 2015

TABLE 6-4 PARAMETERS USED AS INPUT FOR MODELING ATLANTIC SALMON SMOLT WHOLE STATION SURVIVAL AT SHAWMUT

PARAMETER	DESCRIPTION	RANGE OR VALUE	SOURCE
River Flow	Kennebec River flow duration values at Shawmut during May	10, 25, 50, 75, 90th percentiles (21,750-4,250 cfs)	Normandeau 2012 - Appendix B, prorated flow duration curves prepared by NMFS using data from time period 1979-2010
Station Capacity		6,700 cfs	Normandeau 2012
Spill Probability	Ratio of the distribution of smolt passage at Shawmut via spill or forebay canal relative to the distribution of river flow via spill or forebay canal	1:1 ratio	Data derived from Normandeau 2014; 2015; 2016
Downstream Bypass Survival Rate	Route-specific survival rate derived from 273 radio-tagged Atlantic salmon smolts passing Shawmut via the downstream bypass during 2013-2015 in-river studies	97.4%	Data derived from Normandeau 2014; 2015; 2016
Spill Survival Rate	Route-specific survival rate derived from 188 radio-tagged Atlantic salmon smolts passing Shawmut via spill during 2013-2015 in-river studies	98.0%	Data derived from Normandeau 2014; 2015; 2016
Francis Unit Survival Rate	Route-specific survival rate derived from 82 radio-tagged Atlantic salmon smolts passing Shawmut via the Francis units during 2013-2015 in-river studies	92.1%	Data derived from Normandeau 2014; 2015; 2016

PARAMETER	DESCRIPTION	RANGE OR VALUE	SOURCE
Propeller Unit Survival Rate	Route-specific survival rate derived from 149 radio-tagged Atlantic salmon smolts passing Shawmut via the propeller units during 2013-2015 in-river studies	93.1%	Data derived from Normandeau 2014; 2015; 2016
Bypass Effectiveness Rate	Percentage of smolts which entered the Shawmut forebay during the 2013-2015 in-river studies (n=502) and utilized the downstream bypass under a range of generational conditions (1,500-6,700 cfs discharge)	36.4-66.7%	Data derived from Normandeau 2014; 2015; 2016
Francis Entrainment Rate	Percentage of smolts which entered the Shawmut forebay during the 2013-2015 in-river studies (n=502) and utilized the Francis units under a range of generational conditions (1,500-6,700 cfs discharge)	4.9-29.4%	Data derived from Normandeau 2014; 2015; 2016
Propeller Entrainment Rate	Percentage of smolts which entered the Shawmut forebay during the 2013-2015 in-river studies (n=502) and utilized the propeller units under a range of generational conditions (1,500-6,700 cfs discharge)	11.1-50.0%	Data derived from Normandeau 2014; 2015; 2016
Worthington boom effectiveness rate	Reported average bypass effectiveness rate for Worthington boom in the Lockwood forebay canal during the 2013-2015 in-river studies	53.0%	Normandeau 2016 (Table 9-19)

TABLE 6-5 PARAMETERS USED AS INPUT FOR MODELING ATLANTIC SALMON SMOLT WHOLE STATION SURVIVAL AT WESTON

PARAMETER	DESCRIPTION	RANGE OR VALUE	SOURCE
River Flow	Kennebec River flow duration values at Weston during May	10, 25, 50, 75, 90th percentiles (4,000-20,500 cfs)	Normandeau 2012 - Appendix B, prorated flow duration curves prepared by NMFS using data from time period 1979-2010
Station Capacity		6,000 cfs	Normandeau 2012
Spill Probability	Ratio of the distribution of smolt passage at Weston via spill or powerhouse relative to the distribution of river flow via spill or powerhouse	1:1 ratio	Data derived from Normandeau 2014; 2015; 2016
Spill Survival Rate	Route-specific survival rate derived from 70 radio-tagged Atlantic salmon smolts passing Weston via spill during 2013-2015 in-river studies	93.1%	Data taken from Normandeau 2014; 2015; 2016 and summarized in Normandeau 2016 (Table 9-7)
Downstream Bypass Survival Rate	Route-specific survival rate derived from 127 radio-tagged Atlantic salmon smolts passing Weston via the downstream bypass during 2013-2015 in-river studies	92.8%	Data taken from Normandeau 2014; 2015; 2016 and summarized in Normandeau 2016 (Table 9-7)
Turbine Survival Rate	Route-specific survival rate derived from 91 radio-tagged Atlantic salmon smolts passing Weston via the turbine units during 2013-2015 in-river studies	98.3%	Data taken from Normandeau 2014; 2015; 2016 and summarized in Normandeau 2016 (Table 9-7)
Bypass Effectiveness Rate	Proportion of smolts approaching Weston powerhouse which used the downstream bypass during the 2013-2015 in-river studies (127 out of 218 individuals)	58.3%	Data derived from Normandeau 2014; 2015; 2016
Turbine Entrainment Rate	Proportion of smolts approaching Weston powerhouse which used the turbine units during the 2013-2015 in-river studies (91 out of 218 individuals)	41.7%	Data derived from Normandeau 2014; 2015; 2016

TABLE 6-6 PREDICTED STATION PERFORMANCE FOLLOWING IMPLEMENTATION OF THE PROPOSED MEASURES AT LOCKWOOD, HYDRO-KENNEBEC, SHAWMUT AND WESTON FOR A RANGE OF KENNEBEC RIVER CONDITIONS

PROJECT	PROPOSED MEASURE	RIVER CONDITION (I.E., PERCENT EXCEEDANCE FOR MAY)					NOTES
		90%	75%	50%	25%	10%	
Weston	Modify downstream bypass. (Detailed modifications to be developed with agencies and possibly including smoothing, slope change, ledge removal).	0.965	0.972	0.972	0.957	0.954	Assumes modifications increase bypass survival from baseline of 92.8% to 96.4%
Shawmut	Install guidance boom (e.g., Worthington boom) in forebay (in front of Units 7 and 8) to direct downstream migrants to the bypass gate(s).	0.974	0.960	0.962	0.963	0.964	Assumes that effectiveness of the power canal boom will be equivalent to that of the Lockwood boom (i.e., 53% effective during the 2013-2015 field studies)
Hydro-Kennebec	Close existing gap between the Worthington boom and the forebay wall/downstream bypass entrance.	0.932	0.932	0.940	0.965	0.976	Assumes modifications increase bypass effectiveness from baseline of 59% to 80%
Lockwood	Intentional spill in low flow years (up to 50% of inflows) & Unit 1 prioritization	0.986	0.986	0.986	0.986	0.986	Assumes current (and proposed) operational strategy at Lockwood will be effective at previously demonstrated rate over a range of Kennebec River flows
Estimated End of Pipe Passage		**0.864**	**0.857**	**0.867**	**0.877**	**0.885**	

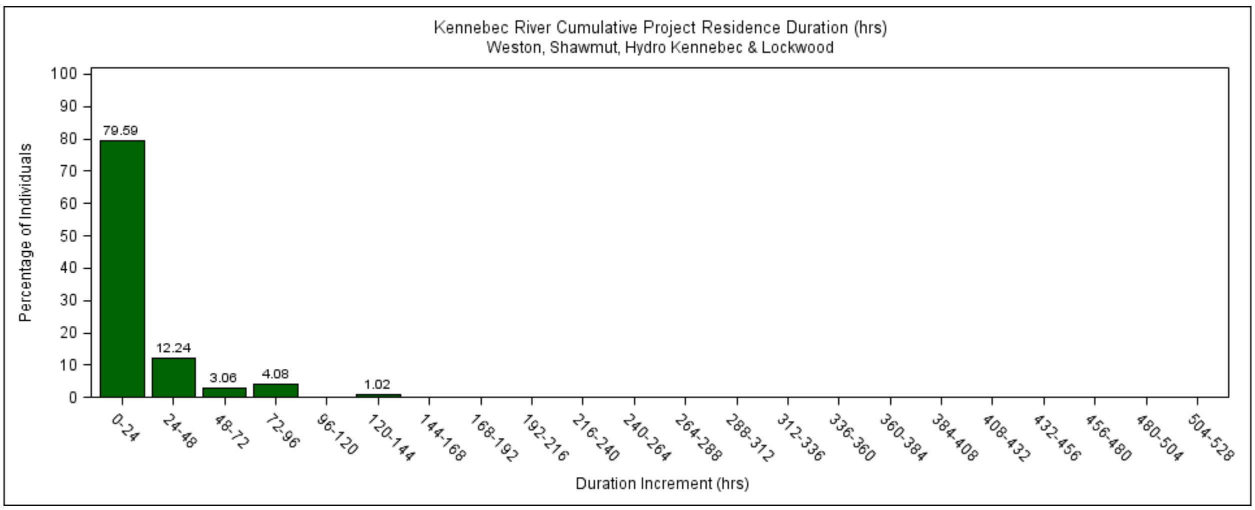
In addition to the proposed cumulative whole station survival standard, the SPP also includes a goal for the timing of smolt passage through the four Projects. Specifically, the goal of the SPP is to pass Atlantic salmon smolts through all four Projects with a cumulative project residence time of no more than 96 hours. The SPP specifies that achievement of this goal will be evaluated through the proposed smolt studies whereby residence time for each individual smolt will be calculated as the duration of time from first detection at the point 200 meters upstream of each Project dam to a point downstream of each dam. The cumulative residence time for all smolts determined to have passed downstream at all four Projects will be calculated as the sum of the four residence duration values. Achievement of the downstream salmon smolt timing goal will be based on a three-year average equal to or greater than 96% of individuals passing through all four Projects with a cumulative project residence time of no more than 96 hours.

Previously, NMFS and USFWS have considered time of passage when evaluating compliance with downstream passage performance standards (and associated ITS limit) for hydroelectric projects in Maine for GOM DPS Atlantic salmon. In applying such standards, NMFS has considered smolts that do not pass a hydroelectric project within the allowable limit as “mortalities” and have included such fish in the overall estimate of whole station survival (which is compared to the performance standard).

Although dams are known to delay upstream and downstream passage of salmonids, applying a specific time of passage requirement (e.g., 24 hours) implicitly assumes that delay is exclusively caused by the dam or ineffective passage facilities (FERC 2018). However, other factors, including extreme high or low water temperatures and river flow can also delay migration (FERC 2018). In its Final Environmental Assessment (FEA) for the Mattaceunk Project in Maine, FERC concluded that there is some evidence supporting the negative effects of delay in smolts, generally, but that the specific duration of delay that can lead to negative consequences for smolts is not well understood. Overall, FERC found that there is no evidence to indicate that smolts that do not pass a dam within 24 hours will experience excessive mortality or that such delays necessarily affect survival once the smolts reach the estuary (FERC 2018). Accordingly, FERC concluded that there is no justification of a specific 24 hour passage criteria.

Although smolt movement through a river system may be influenced by factors other than just passage through hydropower project dams and facilities, in the Kennebec, radio-tagged smolt passage results from the 2014-2015 study years provide some information about time of passage through the four Projects. As shown in Figure 6-1, of the nearly 100 radio-tagged smolts released upstream of Weston and confirmed to have successfully passed downstream of Lockwood, approximately 99% did so in 96 or fewer hours of cumulative project residence duration at the four dams. This result provides support for the timing goal proposed in the SPP for Kennebec River salmon smolts and suggests that timely downstream passage is already being achieved at the four Kennebec Projects. The proposals included in the SPP for improvements to downstream passage facilities at the Hydro-Kennebec, Shawmut and Weston Projects would be expected to further increase the rate of downstream passage by smolts from Weston through Lockwood.

FIGURE 6-1 DISTRIBUTION OF THE CUMULATIVE RESIDENCE DURATIONS FOR RADIO-TAGGED SMOLTS OBSERVED AT THE WESTON, SHAWMUT, HYDRO-KENNEBEC AND LOCKWOOD PROJECTS DURING THE 2013 AND 2014 STUDY YEARS



6.3.5.2 ATLANTIC SALMON ADULTS

In the SPP the Licensee is proposing a cumulative (“top of pipe”) performance standard for upstream migrating Atlantic salmon adults. The upstream adult performance standard for the four Projects will be considered met when a cumulative (“top-of-pipe”) passage of at least 81.4% is achieved. The 81.4% cumulative adult performance standard is based on the cumulative calculation of an average successful passage rate of 95% per project. Achievement of the standard will be based on an average of two years of adult passage performance data, whereby the individual whole station survival estimates are cumulatively calculated from Weston through Lockwood, as tested following the installation of the previously authorized upstream fish passage facilities at Lockwood (bypass volitional fishway), Shawmut (fish lift) and Weston (fish lift).

Although the cumulative standard proposed in the SPP for upstream migrating adult Atlantic salmon is based on the concept of successfully passing 95% of adults at each of the four Projects, the cumulative standard has significant advantages over individual station standards. As with the downstream passage cumulative standard for smolts, the primary advantage is that the cumulative upstream standard is aimed at providing adult salmon with the highest overall success rate for safely passing all four Kennebec Projects. It also allows the fishery agencies and the Licensee more flexibility in determining where to focus efforts on improving upstream passage effectiveness in order to achieve the overall standard. This will benefit the species by allowing available resources and passage performance measures to be utilized to derive the most improvement in cumulative passage rates, regardless of where (which Project) those measures are implemented. The Licensee is proposing to operate the upstream fishways until October 31 annually to provide sufficient time for adult salmon to migrate to spawning areas in the Kennebec watershed.

As discussed in the previous sections, in the SPP the License is proposing to conduct two years of qualitative adult salmon studies, once the proposed upstream fishways at Lockwood (bypass reach), Shawmut and Weston have all been completed. The proposed studies would utilize at least 20 adult salmon, of Kennebec origin, that would be captured at Lockwood, radio-tagged, released below each of the Projects. These initial studies will provide information on the effectiveness of the upstream fishways at each of the Projects, but the numbers of fish used in the studies will be insufficient to develop statistically valid estimates of cumulative passage success. Once there are sufficient returning adult salmon to conduct a study using at least 200 adult salmon, as proposed in the SPP, another two years of adult studies will be undertaken, and the results of those quantitative studies should be sufficient to evaluate adult salmon upstream passage success in comparison to the cumulative standard.

6.4 LOCKWOOD STURGEON HANDLING PLAN

The Licensee has developed and will implement, as part of its SPP, a sturgeon handling plan to provide for safe handling of any Atlantic or shortnose sturgeon that may be encountered at the Lockwood Project by personnel during fish lift operations or in the event of stranding during periodic dewatering of the draft tubes (Appendix A of the Draft SPP). Implementation of this plan promotes the protection of Atlantic and shortnose sturgeon in the event they are encountered at the Project. This plan may be revised in consultation with the agencies when the upstream and downstream passage measures proposed for the Lockwood Project and described in the previous sections are implemented at the Project to ensure continued protection of Atlantic and shortnose sturgeon.

7.0 DETERMINATION OF EFFECTS

Based on the analyses contained in this Draft BA, the determination of effect of the proposed SPP measures for Atlantic salmon (and its designated critical habitat), shortnose sturgeon, and Atlantic sturgeon is provided below.

7.1 ATLANTIC SALMON

Based on the existence of the Lockwood, Hydro-Kennebec, Shawmut and Weston Projects, continued implementation of fish passage measures and facilities previously authorized under the ISPPs and related amendments of FERC licenses, implementation of the proposed actions and protection measures outlined in the SPP, and on the information regarding the likely presence of GOM DPS Atlantic salmon in the Project area, their biology and habitat requirements, this Draft BA concludes that the action is likely to adversely affect (LAA) a small proportion of GOM DPS Atlantic salmon at the Projects.

The LAA determination for the Lockwood, Hydro-Kennebec, Shawmut and Weston Projects is based on the likelihood that a small portion of upstream migrating adult salmon may not pass at each station (5% at each project or 18.5%cumulatively) resulting primarily in harassment (forced straying to downstream habitats) or a small amount of mortality (direct or indirect); and that injury or mortality could occur to a small portion (4% at each project or 15.1% cumulatively) of downstream migrating GOM DPS Atlantic salmon smolts. The Licensee will continue to manage the four Projects to avoid or minimize this effect through the continued implementation of the upstream fishways previously authorized under the ISPPs and the fish protection and enhancement measures outlined in the SPP.

The Licensee foresees no overall destruction or adverse modification of critical habitat, though there will be continued effects to the migratory primary constituent elements (PCEs) of the critical habitat designated for Atlantic salmon (see discussion in Section 1.0). The measures to promote restoration of GOM DPS Atlantic salmon in the Kennebec River, as reflected in this document, have resulted in improvements to upstream and downstream fish passage measures at the Lockwood, Hydro-Kennebec, Shawmut and Weston Projects over the years, as well as the design, construction and operation of previously authorized upstream fish passage facilities at Lockwood (bypass volitional fishway), Shawmut (fish lift), and Weston (fish lift). Additional measures proposed in the SPP, including operation of new facilities, improvements to and continued operation of existing facilities, monitoring, consultation, and a commitment to a collaborative and adaptive management approach, will lead to improvement of migratory PCEs for GOM DPS Atlantic salmon.

The Proposed Action developed herein, including the amendment of the FERC licenses and implementation of the proposed SPP, is expected to minimize adverse effects to Atlantic salmon and its critical habitat.

7.2 SHORTNOSE STURGEON AND ATLANTIC STURGEON

Due to the limited occurrence of sturgeon species at the Lockwood Project, normal operations and modifications described in the SPP to protect Atlantic salmon would have minimal or no effect on shortnose sturgeon or Atlantic sturgeon. There is a possibility that sturgeon could be captured in the fish trap and handled during the sorting process, or stranded in the bypass reach, or trapped during planned dewatering of the draft tubes for turbine inspection or maintenance activities. If any of these occur, Licensee staff would take the steps specified in the Sturgeon Handling Plan (Appendix A of the SPP) to return the sturgeon to the river downstream of the Project. Implementation of the sturgeon handling plan will provide for safe handling of any Atlantic or shortnose sturgeon that may be encountered by personnel during fish lift operations or maintenance activities. However, the handling of any sturgeon collected in the fishway or stranded in the bypass reach would constitute a take under ESA. Therefore, the Proposed Action is likely to adversely affect (LAA) a small number of sturgeon at the Lockwood Project.

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