STATE OF MAINE
DEPARTMENT OF MARINE RESOURCES
21 STATE HOUSE STATION
AUGUSTA, MAINE
04333-0021

JANET T. MILLS
GOVERNOR

PATRICK C. KELIHER
COMMISSIONER

August 28, 2020

Kimberly D. Bose, Secretary
Federal Energy Regulatory Commission
888 First Street, N.E.
Washington, D.C. 20426

RE: MDMR Response to the Ready for Environmental Analysis (REA) Preliminary Terms and Conditions, and Preliminary Fishway Prescriptions for the Shawmut Project (P-2322-069).

Dear Secretary Bose:

On July 1, 2020, the Federal Energy Regulatory Commission (Commission) filed a *Notice of Application Accepted for Filing and Ready For Environmental Analysis* (REA) for the Shawmut Project (P-2322-069) located on the lower Kennebec River in Maine. Enclosed are the Maine Department of Marine Resources (MDMR) comments on the Final License Application (FLA) and our recommended Terms and Conditions under 10(a) and 10(j) of the Federal Power Act.

On the basis of our management goals and activities, analysis of river-specific data, and a federal recovery plan, the MDMR finds the cumulative impacts of the four lowermost hydropower projects in the mainstem Kennebec River, including the Shawmut Project, will result in significant adverse impacts on the recovery of endangered Atlantic salmon and on the restoration of alewife, blueback herring, American shad, sea lamprey, and American eel to their historic habitat in the Kennebec River. The proposal by the licensee would preclude the ability to recover ESA listed Atlantic salmon in the entire Distinct Population Segment, even under improved marine survival conditions, and preclude our ability to meet State of Maine resource goals for other species. Therefore, our 10(a) recommendation is that the Shawmut Project be decommissioned and removed.

With this letter, the Department of Marine Resources is requesting to be an intervenor in this relicensing process.

Please contact Gail Wippelhauser at gail.wippelhauser@maine.gov or at 207-904-7962 if you have any questions.

Sincerely,

Patrick C. Keliher, Commissioner

cc: Sean Ledwin, Paul Christman, DMR
John Perry, Jason Seiders DIFW
Kathy Howatt, DEP
Anna Harris, Antonio Bentivoglio, USFWS
Sean McDermott, Jeff Murphy, Matt Buyoff, Don Dow. NOAA

Executive Summary

The State of Maine seeks to restore diadromous or "sea-run" fish species to historic habitats in sufficient numbers to meet ecological, economic, cultural, and biological objectives. The Kennebec River was once Maine's most productive river system, with vast populations of sea-run fish. For decades, impassible dams and poor fish passage performance have prevented sea-run fish from reaching historic spawning and rearing grounds in sufficient numbers to meet State goals. Since the 1993 Kennebec River Management Plan (1993 Plan) that called for the removal of the Edwards Dam was adopted, significant progress has been made towards State of Maine goals for these important resources. The removal of Edward Dam, ordered by the Federal Energy Regulatory Commission ("FERC" or "Commission"), fish passage requirements in the *Lower Kennebec River Comprehensive Hydropower Settlement* (1998 Settlement**)**, and years of work by the Maine Department of Marine Resources ("MDMR") have resulted in full restoration of historic habitats for Endangered Species Act (ESA) listed Atlantic and shortnose sturgeon, and the largest river herring (alewife and blueback herring) run in North America in the Sebasticook River, topping 5 million fish in some years.

The Kennebec River supports important recreational fisheries for striped bass and American shad and commercial fisheries for river herring and American eel and annually exports millions of juvenile and adult sea-run fish to Maine's coastal waters. Statewide, the striped bass fishery supported 3,110 jobs and generated $202-million dollars in revenue in 2016. In 2019, Maine's recreational fishermen landed 92,081 American shad. The lucrative American eel (elver) fishery was worth over $20 million dollars in 2018 and 2019. Statewide, the commercial harvest of river herring is a source of income for the municipalities with fishing rights, and as Atlantic herring stocks have plummeted, river herring have become an increasingly important bait for the lobster industry, valued at $485.4 million in 2019. Sea-run fish are an important part of the riparian and coastal environment, providing forage for eagles, seals, puffins, whales, cod, pollack, and other freshwater and marine species.

While significant progress has been made to restore mainstem habitats and tributaries in the Kennebec River, the 4 mainstem dams in the lower Kennebec River (Lockwood, Hydro-Kennebec, Shawmut, and Weston) continue to impede sea-run fisheries migrations for a number of important species. The lack of effective passage at these four dams, along with the presence of the impoundments created by the dams, has hindered the development of these fisheries and negatively impacted riverine habitat and the ecological health of the watershed and beyond.

Diadromous fish species require safe, timely, and effective access to high quality habitats at different life stages in order to successfully survive and reproduce. Hydroelectric projects often prevent or delay migrations or cause injury or mortality that contribute to population level declines. These adverse impacts can be mitigated by properly designed fishways, however many fishways fail to perform as intended, including fishways developed and operated utilizing USFWS Fish Passage Design Criteria (USFWS 2019). When there are a series of fishways within a migration corridor for a species, such as in the lower Kennebec River, the risks increase that one or more underperforming fishways will result in significant cumulative negative impacts to diadromous fish populations. This potential for cumulative impacts creates the need for highly effective fish passage at each of the dams that meet agency performance standards. Dam removal is the most effective fish passage strategy and reduces the cumulative impacts of multiple projects significantly, allowing for reduced performance standards per project. When the need to meet important energy objectives makes dam removal infeasible or undesirable, high standards of passage efficiency at upstream and downstream fishways and proper management of operations to facilitate fish passage are required. Species such as American shad and Atlantic salmon are often impacted significantly by just one improperly working fishway in a given watershed, which is a common circumstance in many of the large rivers in Maine today. American shad migrations and associated production potential are significantly reduced or eliminated due to poor passage at hydroelectric dams on the Kennebec, Androscoggin, Penobscot, and the St. Croix rivers amongst others. Fish passage failures at the Lockwood Project provide a cautionary tale as unexpectedly poor performance has left hundreds of returning endangered Atlantic salmon to die or spawn in subpar habitats below the project and likely tens or hundreds of thousands of American shad and other species to be blocked from historic habitats annually.

The State of Maine supports domestic hydropower as an important component of energy in the State and a renewable source of energy critical to meeting climate goals. However, the State also believes that the best approach to meet our management goals for the Kennebec River is to decommission and remove some or all of the dams in the Lower Kennebec and is in the process of developing an amendment to the 1993 Kennebec Management Plan to submit to FERC as a comprehensive plan that will include dam decommissioning and removal. MDMR, therefore, supports the request made by several fishing and environmental organizations that FERC analyze decommissioning and removal as an preferred option. Any potential lost generation at the lower Kennebec projects through a decommissioning and removal would be offset by strategic hydropower enhancements at projects that are not significant fish passage impediments and/or through new clean energy developments (e.g. grid-scale solar).

The Shawmut project represents less than 0.1% of the production of electricity in the State of Maine yet, if relicensed with underperforming fishways, would hasten the extinction of an iconic Maine species, Atlantic salmon, and could result in millions of sea-run fish not reaching historic habitats over the term of the license. The Shawmut Project should be considered for decommissioning and removal for the following reasons: the Project has relatively low energy production compared to Statewide renewable energy generation and to other hydroelectric dams owned by Brookfield in the Kennebec River; the Project site is complex and presents significant uncertainty regarding the ability to effectively pass fish at required standards; the Project reliance on unproven high passage performance at the other three projects in the lower Kennebec to ensure Atlantic salmon recovery and other species goals are achieved; and removal of this dam is feasible and reasonably practical, as determined by a Licensee distributed report entitled *Energy Enhancements and Lower Kennebec Fish Passage Improvements Study* (BWPH 2018) (FERC Accession #s 20190701-5155 and 20190701-5154). MDMR believes the Shawmut project is particularly suited for decommissioning and removal.

The licensing of the Shawmut hydroelectric project and associated fishway, if it proceeds, will necessitate high performance for fisheries resources. As has been suggested by FERC at previous projects, the lack of quantifiable and measurable performance standards has prevented resource agency recommendations for fish passage to be incorporated in recent licenses. In the event FERC determines that the Shawmut should be relicensed, rather than decommissioned and removed, MDMR has developed performance standards for three species, Atlantic salmon, American shad, and Sea lamprey, that are described and justified in our response to the REA. MDMR has also begun development of performance standards for alewife, blueback herring, and American eels, however, and MDMR understands there are initiatives by NOAA Fisheries and USFWS to advance those for this project. MDMR also provided comments on the REA and recommendations under 10(j) and 10(a). MDMR will outline these performance standards, along with recommend dam removals, in the amendment to the 1993 Kennebec Management Plan that MDMR is currently developing and acknowledges that restoring sea lamprey is a goal in the Kennebec River above the lower mainstem projects.

Comments on the Final License Application

The MDMR hereby submits our comments on the Final License Application (FLA) submitted by Brookfield White Pine Hydro LLC ("BWPH" or "Licensee"), in response to the Commission's July 1, 2020 Notice of Application Ready for Environmental Analysis.

1.Exhibit A
Project description 2.2 Proposed Structures

The FLA states on page A-5: "There are no new structures being proposed in this application. New upstream fish passage measures are being implemented at the Project as authorized under the current license. Future fish passage measures for the Project will be governed by the terms of a Species Protection Plan (SPP) that was filed with FERC on December 31, 2019." Similar statements about the fishway and the SPP are made throughout Exhibit E (for example, E-2-2-. E-2-4, E-3-1, E-3-2, E3-9, E-3-10, E-3-11, E-3-14, E-3-43, E-3-44, E-3-46, E-4-44, E-4-69, E-4-70, E-4-73, E-4-76, E-4-77, E-4-84, and E-4-85).

These statements are incorrect. On July 13, 2020, the Commission 1) determined that considering construction of the proposed new fishway at the Shawmut Project in the ongoing relicensing proceeding would allow for a more comprehensive evaluation of the effects of the relicensing action on the federally listed species and 2) rejected the proposed Species Protection Plan.

2. Exhibit E
3.0 Proposed Actions and alternative
3.2.4 Existing Environmental Measures

According to the FLA (page E-3-9), the Licensee currently implements the following measures at the Project:

1) Provides downstream passage for anadromous fish at the Project either through spillage, an existing Tainter gate, hinge gates, or passage through the units.
2) Provides downstream American eel passage at the Project by opening a Tainter gate and turning off units 7 and 8 for an 8-hour period at night for a 6-week period between September 15 and November 15 each year.

The description of the downstream passage facilities is incomplete. Elsewhere in the FLA (pages E-4-48, E-4-49, E-4-70), a plunge pool is mentioned. The FLA should include a detailed description of any plunge pool(s) (e.g. location, length, width, depth) that receive water discharged from the Tainter gate and, more importantly, the deep gate, which provides 425 cfs for the downstream passage of American eel.

3.3.1 Proposed Project Facilities

The proposed fishway is being evaluated under the ongoing relicensing process, and currently there are no additional proposed measures, because the SPP has been rejected by the Commission.

3.3.2 Proposed Project Operations

The FLA states "White Pine Hydro proposes no changes in the way the Shawmut Project is currently operated and will continue to operate the Shawmut Project as run-of-river such that Project outflows generally equal inflows, on a daily basis. To ensure run-of-river operation, White Pine Hydro proposes to maintain the impoundment level within 1 foot of the normal pond elevation of 112.0' during normal operations. Temporary and minor fluctuations while managing the pond level may occur while turning units on and off, opening gates, and inflating/deflating the rubber dam segments. The effects of the proposed project operation are discussed in this Exhibit E, Section 4.0. A proposed license condition for the new Project license with respect to run-of-river operation is as follows:
Except as temporarily modified by (1) approved maintenance activities, (2) extreme hydrologic conditions, as defined below, (3) emergency electrical system conditions, as defined below, or (4) agreement between the Licensee, the MDEP, and appropriate state and/or federal agencies, the Licensee shall operate the Project as run of river facility between elevations 112.0' (normal full pond) and 111.0', during normal operations.

"Extreme Hydrologic Conditions" means the occurrence of events beyond the Licensee's control such as, but not limited to, abnormal precipitation, extreme runoff, flood conditions, ice conditions or other hydrologic conditions such that the operational restrictions and requirements contained herein are impossible to achieve or are inconsistent with the safe operation of the Project.

"Emergency Electrical System Conditions" means operating emergencies beyond the Licensee's control which require changes in flow regimes to eliminate such emergencies which may in some circumstances include, but are not limited to, equipment failure or other temporary abnormal operating conditions, generating unit operation or third-party mandated interruptions under power supply emergencies, and orders from local, state, or federal law enforcement or public safety authorities."

MDMR is concerned about the current and proposed operation of the Shawmut Project. On several occasions in different years, MDMR biologists conducting sampling downstream of the Lockwood Project have reported that the Kennebec River flow dropped so suddenly that they were nearly stranded. The occurrences were not associated with a weather event and at least some of them have been confirmed by Brookfield to have been caused by operation of the rubber crest control structure at the Shawmut project. These flows are a public safety nuisance and disrupt recreational boating and fishing in the Kennebec River. Depending on when they occur, dramatic changes in flow may interfere with migration and fish passage, disrupt spawning behavior, or desiccate and kill eggs and larval fish in shallow water.

3.3.3 Decommissioning (page E-3-15 and E-3-16)

The MDMR supports the request made by several stakeholders that the Commission consider decommissioning and removal of the dam as an alternative to relicensing the Project. Our analysis indicates that the restoration of multiple anadromous species to the Kennebec River with the mainstem dams in place is only possible with extremely high upstream and downstream passage effectiveness. In Scoping Document 2 (SD2), the Commission argued that no fish passage restoration plans for the Kennebec River stipulate that removal of Shawmut dam is necessary to achieve restoration goals. While the 1993 Plan only recommended the removal of Edwards Dam, three hydropower facilities have been decommissioned and the dams removed in the past 20 years (Edwards, Fort Halifax and Madison Electric Works). MDMR is currently working on an amendment to the 1993 Plan for submission as a comprehensive plan for the Kennebec River that will recommend dam removal. Furthermore, the Licensee conducted a desk-top analysis (BWPH 2018) that considered multiple fish passage options, including decommissioning and dam removal, at each of the four mainstem projects (Lockwood, Hydro Kennebec, Shawmut, and Weston) and determined that the decommissioning and removal of Shawmut was feasible and reasonably practical. Based on the Atlantic salmon model described below, the ESA downlisting recovery goal of 2,000 spawners in the Salmon Habitat Recovery Unit (SHRU) likely cannot be met without the decommissioning and removal of the Shawmut Project. Therefore, the relicensing of this project, without significant and unprecedented performance improvements at Shawmut and the other three lower mainstem projects, will jeopardize the continued existence of ESA listed Atlantic salmon in the United States. Utilizing USFWS Fish Passage Guidelines (USFWS 2019) does not guarantee projects will perform at high standards to meet management goals. Fish passage success at engineered fishways is highly unpredictable and based on experiences from other projects, we have low confidence that the fishlift and downstream passage proposed will adequately function for all species at the performance we believe is required.

The Commission stated in SD2 that the project provides a viable, safe, and clean renewable source of power to the region. While hydropower is an important resource for the State of Maine, the four lowermost projects in the Kennebec River, including the Shawmut Project, have a disproportionately large impact on the natural resources in comparison to their authorized capacity because of their location relative to spawning and rearing habitat and population centers. According to data collected by the U.S. Energy Information Administration (2020), the average electricity generated annually from all sources in Maine from 2001 to 2019 was approximately 4.04 billion megawatt hours. For renewable sources in 2019, 0.27 billion megawatt hours were generated by hydroelectric facilities, whereas 0.45 billion megawatt hours were generated by other renewable sources, with other renewable sources increasing by 288% from 2001 to 2019. The Lockwood, Hydro-Kennebec, Shawmut, and Weston projects account for approximately 0.43% of annual electricity generation in Maine. Within Brookfield's portfolio of projects, we have estimated from annual generation reports for the years 2012-2017, that the Shawmut Project produced just 1.7% of gross hydroelectric generation in Maine and 6% of Brookfield Renewable's gross generation in the Kennebec River.

Other local sources of clean renewable energy will soon be available. A recent article in the Kennebec Journal (August 5, 2020) described a solar-electric development in the coming year that will result in 350 mW of generating capacity, which exceeds the entire hydropower generating capacity in the Kennebec River.

4.0 Environmental analysis
4.6.1.2 Fish Passage

According to the FLA, the 2016 Alewife Telemetry Study referenced on page E-4-48 was conducted to evaluate adult river herring behavior in the Kennebec River immediately downstream of the Shawmut Project. Specifically, the study was used to evaluate the preferential use of the tailwater regions to aid in the placement, entrance location, and design of the permanent upstream fishway.

It is our opinion that the behavior of river herring is not necessarily indicative of the behavior of American shad as evidenced by the large number of river herring versus the small number of American shad passed at the Lockwood Project. Furthermore, river flows were very low during the study period (May 19 – June 14, 2016), and the results may not be indicative of fish behavior during higher flows. The mean Kennebec River discharge was 3,805 cfs (range = 3,039-5,301) during May and 4,255 cfs (range = 2,944-6,944 cfs) during June. Based on monthly flow duration curves in the FLA, the mean values are exceeded 94% of the time during May and 74% of the time during June.

4.6.5 Cumulative impacts
4.6.5.2 Historic effects on diadromous fish

The FLA states "Kennebec River flows have also significantly benefitted from the coordinated operation of the upper basin storages, reregulation of flows at the Williams Project, and run-of-river operation of all the lower river hydropower projects, including Shawmut." MDMR understands that flow regulation may benefit electric generation and profits for the licensee, but this practice is likely detrimental to diadromous species that have evolved for thousands of years with natural, unregulated flows.

4.6.5.3 Anadromous fish Restoration Efforts

The bulleted list of major restoration accomplishments on page E4-83 is incorrect and incomplete. We provide a corrected and updated list in Table 1.

Page E-4-83 contains the following confusing statement: "There have been no efforts and no need to stock alewife in the river (as opposed to the stocking program in several of the lakes of the watershed), as river herring runs have increased significantly since the 1980s." In fact, MDMR continues to annually stock alewife into inaccessible lakes and ponds in the Sebasticook River drainage (China Lake, Douglas Pond, and Lovejoy Pond) and has been annually stocking Wesserunsett Lake (above Shawmut Project) since 1996. Since the interim trap-and truck facility at Lockwood became operational in 2006, MDMR has been stocking returning river herring (alewife and blueback herring) into spawning habitat above the Hydro Kennebec and Shawmut projects.

4.6.5.4 Species Protection Plan

The FLA on page E-4-84 states: "Since the ESA listing of the GOM DPS Atlantic salmon in 2009, federal anadromous fish restoration efforts for the Kennebec River basin have been focused primarily on Atlantic salmon, while the State of Maine continues its restoration efforts for river herring and American shad." This statement is incorrect. MDMR has an active ongoing restoration and monitoring program for Atlantic salmon that includes transporting adult Atlantic salmon upstream to spawning habitat in the Sandy River, conducting assessments (fry trapping and electrofishing) of early life stages, planting eyed-stage eggs in the Sandy River in winter, consulting on all study plans and fish passage designs, commenting on all study reports, participating in discussions for a Species Protection Plan, and participating in the Shawmut relicensing. The State of Maine and federal partners have spent millions of dollars to restore Atlantic salmon in the Kennebec River, with the lower mainstem dams, including the Shawmut project, being the largest threat and impediment to restoring the species.

The FLA on page E-4-84 states: "The ISPPs were developed through ESA Section 7 consultation with NMFS and the other federal and state fishery agencies and addressed upstream and downstream fish passage needs for Atlantic salmon, as well as for river herring, American shad and American eel (FPLE 2013, HK 2012)." This statement is not entirely correct. Upstream eel passage and downstream fish passage at the four lowermost projects were addressed and provided pursuant to the 1998 Settlement (Table 1).

The FLA on pages E-4-84 and E-4-85 states: "The BO issued by NMFS that specifically included the Shawmut Project, included a comprehensive analysis of the cumulative effects of the ISPPs on Atlantic salmon, as well as the other anadromous fish species of management interest (NMFS 2013)." "Because the ISPPs expired in 2019, on December 31, 2019, White Pine Hydro filed a final Species Protection Plan (SPP) for the four lower Kennebec River Projects (BWPH 2019). As with the ISPPs, the SPP was developed in consultation with the federal and state fishery agencies. The SPP builds on and continues the protection and restoration efforts undertaken through the ISPPs for Atlantic salmon, as well as the other diadromous fish species, including specific protection and enhancement measures for fish passage and fish passage operations at the Shawmut Project. As with the ISPPs, White Pine Hydro has requested that FERC approve the SPP and amend the four project licenses to include the terms of the SPP in the project licenses. It is anticipated that NMFS will issue a BO and ITS for the SPP. Once again, it is expected that NMFS will fully assess the cumulative effects of the SPP and SPP measures on Atlantic salmon and the other diadromous species of the Kennebec River."

These statements are misleading and incorrect. The July 19, 2013 BO did consider the impacts of the Lockwood Project on shortnose sturgeon and Atlantic sturgeon but did not include a comprehensive analysis of the cumulative effects of the ISPP on American shad, alewife, and blueback herring. The latter three species are briefly mentioned on five pages (page 15, 52, 54, 102, and 105). The ISPPs had a limited temporal scope and, in addition to setting a schedule for upstream passage at the Lockwood, Hydro Kennebec, Shawmut, and Weston projects, focused on assessing the effectiveness of existing passage facilities at these projects for Atlantic salmon. To date, there has been no analysis of the cumulative effects of the existing hydropower projects, including Shawmut, on Atlantic salmon and other diadromous species that inhabit the Kennebec River. The ISPP has expired, and the SPP, which was not supported by MDMR, has been rejected by the Commission. Therefore, there are no existing or proposed protection and enhancement measures for any of the lowermost four projects.

4.6.5.5 Fish passage

The FLA states on page E-4-85 "The primary cumulative effects on diadromous fish associated with the Lockwood, Hydro- Kennebec, Shawmut and Weston projects are migratory effects. Because 64% of the spawning habitat for Atlantic salmon lies above the Weston Project (primarily in the Sandy River), Atlantic salmon migration is particularly impacted by the migratory effects created by the four projects on the lower Kennebec. American shad and river herring are less affected by the mainstem river project dams, as there are significant quantities of spawning habitat located downstream of Lockwood, and the intervening mainstem reaches and tributaries between the Lockwood, Shawmut and Weston projects. Accordingly, the focus of the ISPPs and SPP developed for the four lower Kennebec River projects is on providing safe, effective and timely volitional passage to Atlantic salmon adults and smolts at all four projects. These same measures are expected to also improve passage conditions for the other anadromous species. The measures approved by the previous ISPP and FERC license amendments included three new upstream passage facilities, one each at Lockwood (in the bypass reach), Shawmut, and Weston. Improved passage conditions for American eel were also addressed. The measures proposed in the recently filed SPP are to operate the upstream fish passage facilities, improve the effectiveness of the downstream passages, and achieve a proposed performance standard for the passage of Atlantic salmon at all four projects."

The entire paragraph contains unsupported, misleading, or incorrect statements. There is no citation for the claim that 64% of the spawning habitat for salmon lies above the Weston Project; it is unclear how this number was derived and whether it refers to the Kennebec River or the Merrymeeting Bay SHRU. While a greater proportion of Atlantic salmon spawning habitat lies above the four mainstem projects (including 100% of the high-quality habitat that could support demographic recovery of salmon), approximately 60% of the American shad and blueback herring historic spawning habitat, a not insignificant amount, lies above the Lockwood and Hydro Kennebec projects (Table 2). The FLA does not mention sea lamprey. Most of the habitat for this species, which may be primarily a nocturnal migrant, lies above the Lockwood Project. Finally, upstream and downstream passage measures for American eel were operational well before the ISPP (Table 1).

The FLA states (E-4-86) "No upstream fish passage is presently provided on Cobbosseecontee or Messalonskee streams, although downstream passage and upstream eel passage is being developed at the American Tissue Hydroelectric Project in Gardiner, Maine (Cobbosseecontee

Stream). There are also no upstream passage facilities at many of the outlet dams on Kennebec basin ponds and lakes that support significant spawning habitat for river herring. Thus, continued operation of trap and transfer operations for alewife and blueback herring from the Lockwood fish life are an important component of MDMR's restoration and management efforts for these two species."

These statements incorrect or confusing. Messalonskee Stream has a steep gradient and was historically accessible only to the catadromous American eel. As required by their LIHI certification, the Licensee has provided upstream eel passage at all the dams, and currently is consulting with MDMR on downstream eel passage. Three dams, the second being the American Tissue Project, block the lower mile of Cobbosseecontee Stream. MDMR has been meeting with stakeholders (dam owners, City of Gardiner, Upstream, Cobbossee Water District) to advance fish passage in the Cobbosseecontee drainage. Alewife and blueback herring (collectively river herring) are similar in appearance, but alewife spawn in lakes and ponds while blueback herring spawn in rivers and streams. The Sebasticook River drainage contains about 89% of the alewife's historic spawning habitat above Augusta[1], and 45% of it is accessible. MDMR has been working with partners to provide passage into China Lake (Table 1), which will make an additional 16% of spawning habitat accessible (possibly by 2022). Considering the large number of returns to the Benton Falls Project, we expect that natural recolonization is possible as upstream spawning habitat is made accessible. Natural recolonization has been documented in the Penobscot River (alewife straying at least 52 miles). Safe, timely, and effective upstream and downstream fish passage at the Lockwood, Hydro Kennebec, Shawmut, and Weston projects would eliminate the need for stocking large numbers of American shad and blueback herring in the mainstem Kennebec River.

MDMR analysis of Cumulative impacts past, present, and future

In the following section, MDMR considers and analyzes the cumulative impacts the continued operation and maintenance of the Shawmut Project in combination with other hydroelectric projects and other activities in the Kennebec River basin have had and continue to have on migratory fish, including Atlantic salmon, American shad, blueback herring, alewife, American eel, and sea lamprey and on current and potential commercial and recreational fisheries. We consider the geographic scope, as described by the Commission in SD2, to include the Kennebec River basin, from the upstream Brassua Hydroelectric Project (FERC Project No. 2615) on the Moose River to the mouth of the Kennebec River at Merrymeeting Bay and the Atlantic Ocean, including mainstem Kennebec River dams and impoundments. Activities within this basin that may cumulatively affect these migratory fish species include the construction and operation of dams within the river basin, which have resulted in migratory barriers and loss of spawning habitat. We consider the temporal scope to include the past, present, and reasonably foreseeable future actions for the next 40-50 years and their effects on migratory fish and the fisheries they support. Our analysis focuses on upstream and downstream diadromous fish movement and access to habitat in the Kennebec River and its tributaries, including an evaluation of the Shawmut Project impoundment, along with other impoundments, to act as a barrier to fish movement in the river.

[1] Edwards Dam was located in Augusta.

When the Shawmut Project was licensed on January 5, 1981, eight native species of anadromous fish (shortnose sturgeon, Atlantic sturgeon, striped bass, Atlantic salmon, American shad, blueback herring, alewife, and sea lamprey) had been extirpated from significant amounts of historic spawning/nursery habitat in the Kennebec River watershed for more than 140 years due to the presence of 14 hydropower dams without fish passage. The State of Maine and its partners have made significant progress in the restoration of anadromous fish to some parts of the Kennebec River in the intervening years (Table 1).

Two important events were the passage of the Clean Water Act in 1976 and the removal of Edwards Dam in 1999. Removal of the dam allowed shortnose sturgeon, Atlantic sturgeon and striped bass free access to the remainder of their historic spawning habitat on the mainstem Kennebec River (Wippelhauser et al. 2015; Wippelhauser et al. 2017; Wippelhauser In review) and allowed American shad and blueback herring free access to about 21% of their historic spawning habitat (Table 2).

The catadromous American eel was never completed blocked from reaching freshwater growth habitat above the dams, because of the ability of small juveniles to ascend wetted surfaces (Solomon et al. 2004); however, their abundance was likely reduced. Yoder et al. (2006) conducted standardized boat electrofishing transects from Chops Point (26.9 miles downstream of former Edwards Dam) to the Wyman Dam (75 miles upstream of Edwards Dam) in 2002 and 2003, and reported that 1) the numerical abundance of American eel (all life stages combined) was highest (200-400 fish/km) between Waterville and Augusta including the segment affected by the Edwards Dam removal, and 2) numerical abundance declined to less than 50-100 eels/km upstream from the Lockwood Dam and young-of-year were absent. In addition, the highest average abundance and biomass of all fish combined occurred in the riverine segment between Waterville and Augusta, followed by the downstream tidal segments, and lastly by impounded river segments.

By 2003, MDMR and its partners had provided upstream fish passage at four non-hydropower dams in the Sebasticook River (Table 1; Guilford Dam, Sebasticook Lake, and Plymouth Pond), which in turn triggered construction of upstream passage at the Benton Falls Project and the Burnham Project. A fish lift at each of the projects became operational in 2006. After the Fort Halifax Dam was removed in 2008, the abundance of alewife and blueback herring in the Sebasticook River increased dramatically (Table 3). This self-sustaining run of river herring is the largest on the east coast (Wippelhauser submitted). Interim upstream fish passage (a fish lift terminating in a trap-and-truck facility) became operational at the Lockwood Project in 2006. Upstream and downstream passage for American eel was also provided at each of the projects between 1999 and 2011.

In contrast to these successes, the restoration of Atlantic salmon, American shad, alewife, and blueback herring to a significant amount of spawning habit (Table 2) above the Lockwood Project in the past 14 years has been disappointing. In addition, thousands of native sea lamprey continue to be blocked from upstream habitats. Permanent upstream passage at the Lockwood, Hydro Kennebec, Shawmut and Weston projects, which was to be triggered by passage of specific numbers of American shad, never came to fruition. The presence of popular recreational fishery for American shad below Lockwood dam, suggests that poor passage, not low abundance of shad below the project, is likely the reason triggers were not realized.

Atlantic salmon (page E-4-43)

The 1993 Plan calls for restoring anadromous species, including Atlantic salmon, to their historic habitat. MDMR initiated a restoration program for the Atlantic salmon in the Kennebec River in 2003 by stocking hatchery-reared fry into the Sandy River (Table 4). The restoration later transitioned to egg-planting (eyed-eggs are placed in man-made redds in winter) and natural reproduction by wild returning adults that are trapped at the Lockwood Project and trucked upstream to the Sandy River. In the last 4 years, most returning adults have been naturally reared wild fish (Table 4).

In 2009, the Distinct Population Segment (DPS) of the endangered Atlantic salmon was expanded, and critical habitat was delineated for three Salmon Habitat Recovery Units (SHRUs) within the expanded DPS: the Merrymeeting Bay SHRU, Penobscot Bay SHRU, and Downeast SHRU. The Merrymeeting Bay SHRU includes the Kennebec, Androscoggin, Sheepscot, Pemaquid, Medomak, and St. George watersheds. However, nearly all the high-quality spawning/rearing habitat in the Kennebec River is in the Sandy River, the Carrabassett River and upper Kennebec River. Access to this critically important, climate resilient habitat is blocked by all of these mainstem dams.

In 2019, the Recovery Plan for the Gulf of Maine Distinct Population Segment of Atlantic Salmon (*Salmo salar*) (Recovery Plan) was issued. The Recovery Plan includes abundance, productivity, and habitat criteria that must be met in the SHRUs for reclassification (from endangered to threatened) or delisting to occur. The Recovery Plan also assessed the primary threats to recovery and contains the following statement: ***"Dams (factor A):*** Upstream and downstream passage at dams deemed essential to the conservation of Atlantic salmon are improved by dam removal and/or through operational or structural changes. Dam removals and structural changes must provide access to spawning and nursery habitats…reduce direct and indirect mortality of upstream and downstream migrating salmon and provide for properly functioning critical habitat features."

In order to assess the impacts of the mainstem dams on Atlantic salmon, MDMR developed a life history model. Spawning habitat included the Sandy River (above 4 mainstem dams), the Carrabassett River (above 6 mainstem dams), and the upper Kennebec River (above 6 mainstem dams). The number of spawning fish able to return to these area was modeled assuming 1) low, average and high marine survival; 2) low and high freshwater production; 3) downstream mortality of smolts at each dam ranged from 1-5% 4) downstream mortality of smolts in the lower river was related to the number of dams passed; and 5) upstream passage effectiveness for adults ranged from 95-99%. Based on the model and the abundance requirement in the Recovery Plan for delisting, salmon abundance could only be met if downstream mortality at each of the 6 dams was ≤1% and if ≥99% of adults were able to pass upstream at each of the 6 dams.

The NMFS clearly foresaw the need for high performance standards. The BO states: "Data to inform downstream passage survival standards for Atlantic salmon smolts and kelts in the

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

The Shawmut whole station, baseline[2] survival rate of Atlantic salmon smolts computed from three years of testing (2012-2015) was 93.5%. Because this was lower than the 96% proposed in the ISPP, the Licensee in consultation with the agencies agreed to lower four hinged flashboard sections to increase total downstream passage flow from 420 to 650 cfs. However, no additional testing was conducted after this change was made.

Of the four lowermost mainstem project dams, only two have upstream fish passage facilities – the Lockwood and Hydro-Kennebec projects, and upstream passage efficiency has only been determined for Atlantic salmon at the Lockwood Project. In 2016, 20 wild adult Atlantic salmon that were captured in the fish lift were radio tagged and moved downstream. Sixteen of the 18 that returned to the project area were recaptured (89%), and the time from return to the project area to recapture was 0.7-111.2 days (mean=17 days). When the study was repeated in 2017, 13 of 19 (68%) tagged adult Atlantic salmon that returned to the project area were recaptured, and time to recapture was 3.3-123 days (mean=43.5). Due to the poor results, the study was discontinued.

American shad, blueback herring, and alewife

The 1993 Plan calls for restoring anadromous species to their historic range and restoring access to the mainstem Kennebec River is especially important for the restoration of American shad and blueback herring. While the removal of Edwards Dam provided access to about 21% of the historic spawning habitat of American shad and blueback herring, approximately 60% lies above the Lockwood Dam (Table 2). Four lakes and ponds above the Lockwood Project are historically accessible to alewife, and they account for 10% of the species historical spawning habitat in the watershed. Wesserunsett Lake and ponds in the Sandy River all lie above the Shawmut Project. MDMR estimates that the habitat above the Lockwood Project could produce at least 303,500 American shad, 1.8 million blueback herring, and 1.1 million alewife (Table 2).

American shad and river herring (blueback herring and alewife) populations in the Kennebec River support both recreational or commercial fisheries, and river herring are an important forage fish for striped bass. During the summer, recreational fishermen target American shad and striped bass in the reach between the confluence of the Kennebec and Sebasticook rivers and the Lockwood Project powerhouse. River herring are harvested commercially in the Sebasticook

[2] The baseline rate does not consider amount of time to pass the project.

River below the Benton Falls Project and in Seven Mile Stream, providing the Towns of Benton and Vassalboro with an additional source of income. This is the largest river herring harvest in the State of Maine and provides much needed bait for the lobster fishery.

Upstream fish passage on the Kennebec River at the Lockwood Project became operational in 2006 pursuant to the 1998 Settlement. It is considered an interim facility, because the fish lift does not connect to the headpond. Instead fish are trapped, lifted, sorted, sluiced into MDMR stocking trucks, and transported by MDMR to upstream to spawning areas where they are released. Also pursuant to the 1998 Settlement, permanent (swim-through) upstream passage at the Lockwood project and the Hydro Kennebec Project was to be operational two years after 8,000 American shad were captured in any single season at the interim facility at Lockwood or a biological assessment trigger was initiated for Atlantic salmon, alewife or blueback herring. The interim facility at Lockwood Project was never converted to a permanent upstream passage facility, because the trigger number was never met – the greatest number of American shad passed at Lockwood in a single year has been 830 fish (Table 3). This is perplexing, because MDMR has documented the presence of spawning American shad within 0.3 mi of the Project (Figure 1, Event 1), and adults were angled in the tailrace (Figure 1, Event 1, and Event 2&3) to capture fish for a radio telemetry study conducted by the Licensee in 2015. None of the tagged American shad were detected near the fishway entrance. Ultimately, the listing of Atlantic salmon and the resulting ISPP became the trigger for providing permanent upstream passage at the four mainstem dams.

In the Environmental Analysis of three recent relicensings (e.g. American Tissue FERC No. 2809-034; Barker Mills FERC No. 2808; Ellsworth FERC No. 2727-092), the Commission has not supported recommendations made by the resource agencies for effectiveness testing of all new fish passage facilities. The Commission offers two major reasons: 1) the resource agencies have not included any specific performance standards that would be used to test the effectiveness of the new downstream alosine passage facility or the new upstream eel passage facility, and 2) because the facilities would be designed, operated and maintained in accordance with the FWS Design Criteria Manual there is evidence these facilities would be effective.

Because of the importance of the Kennebec River to restoration of Americans shad and blueback herring, we will recommend effectiveness testing, and we propose performance standards in our TERMS and CONDITIONS to assess the results of the testing. Performance standards for American shad are based on modeling conducted by Dr. Daniel Stich, who originally developed the life cycle model for the Penobscot River in Maine (Stich 2018),and has a created a model for the Connecticut River. Results for the Penobscot River indicated that at least 95% of adults and juveniles must survive downstream passage at each dam and they must pass within 24 hours; at least 75% of adults must pass upstream within 48 hours.

American Eel

The 1998 Settlement required the KHDG dam owners (owners of Fort Halifax, Benton Falls, Burnham, Lockwood, Hydro Kennebec, Shawmut, and Weston) and MDMR, in consultation with NMFS and USFWS to undertake a three-year research project designed to determine: (a) the appropriate placement of upstream passage for American eel at each of the seven KHDG facilities and (b) appropriate permanent downstream fish passage measures. Today, all the projects have upstream and downstream passage for American eel.

Upstream Fish passage

There currently is an interim upstream eel passage facility at the Shawmut Project. The original upstream eel passage was installed in 2003 on the east side of the spillway, but it became ineffective when the rubber bladder was installed which eliminated leakage and made that location unattractive to upstream migrating eels. Beginning in 2010, a portable eel passage (6-foot long, 1-foot wide ramp with climbing substrate, a collection bucket and attraction water) has been installed annually between the first section of the hinged flashboards and the unit 1 tailrace. The release of water at this location to provide additional downstream passage for Atlantic salmon smolts very likely interferes with upstream eel passage (Table 4-20 see declines in 2016-2018). In 2019, a second upstream eel passage like the 2010 passage design, was installed adjacent to the forebay plunge pool.

Downstream passage

Downstream passage at the Shawmut Project currently is provided through a combination of a surface weir (sluice), a Tainter gate, and hinged flashboards. The 4-feet wide and 22-inch deep sluice is located on the right side of the intake structure next to Unit 6. When all stoplogs are removed, the sluice passes 30-35 cfs over the face of the dam and into a 3-feet deep plunge pool. The 7-foot high by 10-foot wide Tainter gate is located to the right of the sluice and can pass up to 600 cfs. The FLA does not state whether water released from the Tainter gate also passes over the dam and into the 3-foot deep plunge pool. The sluice and Tainter gate are operated from April 1-June 15 to pass Atlantic salmon smolts and kelts and from November 1 to December 31 (depending on ice and flow conditions). Four sections of hinged flashboards immediately adjacent to the canal headworks are opened for the smolt migration season and provide approximately 560 cfs of spill. Downstream passage is also provided over the spillway during period of high flow in excess of station capacity.

Downstream passage for American eel is provided by opening a deep gate (the Tainter gate) to pass approximately 425 cfs and turning off units 7 and 8 for 8 hours for a six-week period between September 15 and November 15. A study conducted by the Licensee in 2008 on the downstream passage of American eel at the Project found that passage via the deep gate increased with higher flow through the gate (58.3% at 207 cfs and 83.5% at 425 cfs) when Units 7-8 were turned off, immediate survival (not defined) increased with the higher flow, and immediate survival (not defined) of eels passing through Units 1-6 was 90% (9 of 10). Survival of eels not entering the forebay was not described. In 2009, NextEra Energy in consultation with resource agencies designed and constructed a plunge pool below the outlet of the deep gate. MDMR questions whether passing downstream migrating American eels via a flow of 425 cfs into a 3-foot deep plunge pool is safe.

MDMR analyzed historical silver eel harvest data (pounds per day) provided by commercial fishermen for seven sites in the Kennebec River watershed to determine whether the current shut down period is sufficient. The percent by weight of downstream migrating silver eels caught by month were: July (0.6%) August (16.5%), September (62.7%) , October (19.1%) and December (1.1%). Approximately 94% of the eels were caught between August 15 and October 31.

TERMS AND CONDITIONS

MDMR hereby submits our *Recommended Terms and Conditions for the Shawmut Hydroelectric Project (P- 2322)* in response to the Federal Energy Regulatory Commission's (FERC or Commission) July 1, 2020 Notice of Application Ready for Environmental Analysis. Comments and terms and conditions are supported by our agency mission for protecting and conserving diadromous species and their associated habitat.

1. Background

Eleven diadromous fish species are found in the Kennebec River watershed. These include spawning populations of the endangered shortnose sturgeon, Gulf of Maine Distinct Population Segment (GOM DPS) of Atlantic sturgeon, and GOM DPS of Atlantic salmon. The Kennebec River from its mouth to the Lockwood Project is designated as critical habitat for the GOM DPS of Atlantic sturgeon. The Kennebec River from its mouth to the Anson Project and the Sandy River are designated as critical habitat for the GOM DPS of Atlantic salmon. The Kennebec River supports spawning populations of the recreationally or commercially important American shad, blueback herring, alewife, striped bass, rainbow smelt, Atlantic tomcod, and sea lamprey and provides growth/foraging habitat for the catadromous American eel, which supports a lucrative commercial fishery.

2. Goals and Objectives

MDMR is a cabinet level agency of the State of Maine. MDMR was established to regulate, conserve, and develop marine, estuarine, and diadromous fish resources; to conduct and sponsor scientific research; to promote and develop marine coastal industries; to advise and cooperate with state, local, and federal officials concerning activities in coastal waters; and to implement, administer, and enforce the laws and regulations necessary for these purposes. MDMR is the lead state agency in the restoration and management of diadromous (anadromous and catadromous) species of fishes. MDMR's policy is to restore Maine's native diadromous fish to their historical habitat.

Our recommendations, terms and conditions are guided by the following state, interstate, and federal comprehensive management plans that have been approved by the Commission.

2.1 The Kennebec River Resource Management Plan[3]

Pertinent goals of the 1993 Plan are:

1. To restore and enhance populations of shortnose sturgeon, Atlantic sturgeon, striped bass, and rainbow smelt to historical habitat in the Kennebec River including the segment from Edwards Dam to the Milstar Dam (Lockwood Project) in Waterville by removing Edwards Dam.
2. To restore and enhance American shad populations in the Kennebec River by achieving an annual production of 725,000 shad above Augusta.

[3] MDMR is in the process of updating this plan.

3. To restore and enhance alewife populations in the Kennebec River by achieving an annual production of 6.0 million alewives above Augusta.

2.2 Recovery Plan for the Gulf of Maine Distinct Population Segment of Atlantic Salmon (*Salmo salar*)

The *Recovery Plan* identified dams, inadequacy of regulatory mechanisms related to dams, and low marine survival as major threats to the recovery of Atlantic salmon (USFWS and NMFS 2019). The plan contains the following criteria for reclassification or delisting of the Gulf of Maine Distinct Population Segment (GOM DPS) of Atlantic salmon:

Biological Criteria for Reclassification of the GOM DPS from endangered to threatened will be considered when all of the following biological criteria are met
1. Abundance: The DPS has total annual returns of at least 1,500 adults originating from wild origin, or hatchery stocked eggs, fry or parr spawning in the wild, with at least 2 of the 3 SHRUs[4] having a minimum annual escapement of 500 naturally reared adults.
2. Productivity: Among the SHRUs that have met or exceeded the abundance criterion, the population has a positive mean growth rate greater than 1.0 in the 10-year (two-generation) period preceding reclassification.
3. Habitat: In each of the SHRUs where the abundance and productivity criterion have been met, there is a minimum of 7,500 units of accessible and suitable spawning and rearing habitats capable of supporting the offspring of 1,500 naturally reared adults.

Biological Criteria for Delisting of the GOM DPS will be considered when all of the following criteria are met:
1. Abundance**:** The DPS has a self-sustaining annual escapement of at least 2,000 wild origin adults in each SHRU, for a DPS-wide total of at least 6,000 wild adults.
2. Productivity: Each SHRU has a positive mean population growth rate of greater than 1.0 in the 10-year (two-generation) period preceding delisting. *In addition,* at the time of delisting, the DPS demonstrates self-sustaining persistence, whereby the total wild population in each SHRU has less than a 50-percent probability of falling below 500 adult wild spawners in the next 15 years based on population viability analysis (PVA) projections.
3. Habitat: Sufficient suitable spawning and rearing habitat for the offspring of the 6,000 wild adults is accessible and distributed throughout the designated Atlantic salmon critical habitat, with at least 30,000 accessible and suitable Habitat Units in each SHRU, located according to the known migratory patterns of returning wild adult salmon. This will require both habitat protection and restoration at significant levels.

Dams and road stream crossings (factor A): A combination of dam removals, passage improvements at dams, passable road crossing structures, and removal or redesign of any other

[4] In 2009, the Distinct Population Segment (DPS) of the endangered Atlantic salmon was expanded, and critical habitat was delineated for three Salmon Habitat Recovery Units (SHRUs) within the expanded DPS: the Merrymeeting Bay SHRU, Penobscot Bay SHRU, and Downeast SHRU. The Merrymeeting Bay SHRU includes the Kennebec, Androscoggin, Sheepscot, Pemaquid, Medomak, and St. George watersheds.

instream barriers to fish passage provides salmon access to sufficient habitat needed to achieve the habitat criterion for reclassification

Dams (factor A): Upstream and downstream passage at dams deemed essential to the conservation of Atlantic salmon are improved by dam removal and/or through operational or structural changes. Dam removals and structural changes must provide access to spawning and nursery habitats (freshwater habitat that is categorized as accessible or fully accessible habitat will be counted toward meeting this recovery criterion), reduce direct and indirect mortality of upstream and downstream migrating salmon, and provide for properly functioning critical habitat features.

2.3 The Atlantic States Marine Fisheries Commission (ASMFC) is an Interstate Compact, ratified by the member states and approved by the U.S. Congress in 1942, to manage the states' shared migratory fishery resources and to cooperate in promoting and protecting Atlantic coastal fishery resources. Maine is an active member of ASMFC, and MDMR scientists represent the State on the Shad and River Herring Technical Committee and the American Eel Technical Committee.

Pertinent goals and objectives of the Shad and River Herring Fishery Management Plan (ASMFC 1985) are to:

- Improve habitat accessibility and quality, including addressing fish passage needs at dams and other obstructions, improving water quality, addressing river flow allocations to support habitat needs, and preventing mortality at water withdrawal facilities.
- Initiate stocking programs in historical alosine[5] habitat that do not presently support natural spawning migrations, expand existing stock restoration programs, and initiate new programs to enhance depressed stocks.

Pertinent goals and objectives of the American Eel Fishery Management Plan (ASMFC 2000) are to:

- Protect and enhance the abundance of American eel in inland and territorial waters of the Atlantic states.
- Contribute to the viability of American eel spawning populations.
- Protect and enhance American eel abundance in all watersheds where eel now occur.
- Where practical, restore American eel to those waters where they had historical abundance but may now be absent by providing access to inland waters for glass eel, elvers, and yellow eel and adequate escapement to the ocean for pre-spawning adult eel.

3. Background

3.1 Project Location

The Shawmut Project is an existing hydropower facility located in the Kennebec River in the towns of Skowhegan, Fairfield, Clinton, and Benton and in Kennebec County and Somerset County, Maine. It is the third of 10 FERC licensed dams on the main stem Kennebec River. In

[5] Alosine refer to fish in the Genus *Alosa*, such as American shad, alewife and blueback herring.

ascending order, the projects are Lockwood, Hydro Kennebec, Shawmut, Westin, Abenaki, Anson, Williams, Wyman, Moxie, and Moosehead.

3.2 Project description

The Shawmut Project consists of a concrete gravity dam, an enclosed forebay, an intake and headworks section, and two powerhouses. The dam is approximately 1,480-feet long and includes, from west to east, a non-overflow section adjacent to the forebay headworks structure, 380 feet of 4-foot high hinged flashboards, a 25-foot wide sluice, and a 730-foot long section topped with 3 sections of inflatable bladder, each 4.46-feet high. The headworks and intake structure are integral to the dam. The forebay intake section contains 11 headgates fitted with trash racks and 2 filler gates. The forebay is enclosed by 2 powerhouse structures. The intake section of the northern 1912 powerhouse (Units 1-6) has six openings and a continuous trash rack with 1.5-inch clear spacing which extends from elevation 115.0 ft down to elevation 88.0 ft. The southern 1982 powerhouse (Units 7 and 8) has 2 intakes, each fitted with a trash rack with 3.5-inch clear spacing that extends from elevation 115.25 ft to 88.0 ft. A 10-foot-high by 7-foot-wide Tainter gate and a 6-foot-high by 6-foot-wide deep gate lie between the two powerhouses. A narrow, angled strip of ledge/land (about 460-feet total length) separates the tailraces of the two powerhouses. The 1912 powerhouse contains six horizontal, four-runner, Francis-type turbines each with a hydraulic capacity of 674 cfs. The 1982 powerhouse contains two horizontal tube-type hydraulic turbines each with a hydraulic capacity of 1,200 cfs.

Project operation

According to the FLA, the Shawmut Project operates as a run-of-river facility and the impoundment experiences little fluctuation during normal operations, maintaining the pond level within a foot of the normal full pond elevation of 112.0 feet U.S. Geological Survey (USGS) datum. After maximum powerhouse capacity (6,690 cfs) is reached, excess water is spilled through the spillway sluice (capacity is 1,840 cfs). When flow exceeds the capacity of the spillway sluice, sections of the rubber dam are deflated, and the hinged flashboards are dropped, to pass additional water. The project units and spillway can pass approximately 40,000 cfs while maintaining a pond elevation of approximately 112.0 ft.

3.4 Project fishways

The Shawmut Project currently provides downstream fish passage for diadromous fish and upstream passage for juvenile (yellow) American eel. The effectiveness of existing downstream passage has only been tested for Atlantic salmon smolts (2013-2015) and adult American eels (2014-2015).

Downstream passage for anadromous species is provided through a combination of a surface weir (sluice), a Tainter gate, and hinged flashboards. The sluice and Taintor gate are operated from April 1-June 15 to pass Atlantic salmon smolts and kelts and from November 1 to December 31 (depending on ice and flow conditions). Downstream passage is also provided over the spillway during period of high flow in excess of station capacity. Four sections of hinged flashboards immediately adjacent to the canal headworks are opened for the smolt migration season and provide 560 cfs of spill.

Downstream passage for American eel is provided by opening a deep gate to pass approximately 425 cfs and tuning off unit for 7-8 hours during the night from September 15-November 15.

The original upstream eel passage was installed in 2003 on the east side of the spillway, but it became ineffective when the rubber bladder was installed which eliminated leakage, which was attractive the eels. In 2010, a portable eel passage was installed (6-foot long, 1-foot wide ramp with climbing substrate, a collection bucket and attraction water) between the first section of the hinged flashboards and the unit 1 tailrace. In 2019, a second upstream eel passage of the same design was installed adjacent to the forebay plunge pool.

3.5 Fish resources historical and current

The 1993 Plan contains detailed information about the biology, historical range, and historical and current (in 1993) fisheries for Atlantic salmon, American shad, blueback herring, alewife, rainbow smelt, shortnose sturgeon, Atlantic sturgeon, and striped bass in the Kennebec River. Biological information about two additional species considered herein, American eel and sea lamprey, and updated fisheries information can be found in NMFS (2017).

The Kennebec River, Maine's second largest drainage, historically supported large populations of the State's native anadromous species, which began to decline dramatically throughout Maine in the 1800s. In 1867, the Governor appointed two Commissioners of Fisheries under a legislative resolve to restore anadromous fish to the rivers and inland waters of the state. The Commissioners surveyed the fisheries in Maine's major river systems and concluded in their first report that the decline of anadromous species was caused by impassable dams, overfishing, and pollution of the water (Foster and Atkins 1867

The Shawmut Project is located within the documented or presumed historical range of Atlantic salmon, American shad, blueback herring, alewife, American eel, and sea lamprey (Table 5). Foster and Atkins (1868) and Akins (1887) stated that the original upstream limit of Atlantic salmon on the mainstem Kennebec River probably was about 12 miles above the Forks (confluence of the Kennebec and Dead River) and at Grand Falls on the Dead River. They further stated that Atlantic salmon ascended many miles in the Carrabassett River and the Sandy River, and these two river probably were their principal spawning grounds. Foster and Atkins (1868) and Akins (1887) reported that alewife and American shad ascended as far upstream as Norridgewock Falls, current location of the Abenaki and Anson projects, and into the lower part of the Sandy River. Blueback herring likely had the same range as the closely related alewife and American shad. The historic upstream limit of American eel and sea lamprey is not precisely known, but American eels currently are found in the Williams Project impoundment.

When the Shawmut Project was licensed on January 5, 1981, the five anadromous species had been extirpated from significant amounts of historic spawning/nursery habitat in the Kennebec River watershed for more than 140 years due to the presence of hydropower dams without fish passage. The catadromous American eel was still found throughout the watershed, although dams may have reduced their abundance compared to pre-colonial times.

MDMR has made significant progress in the restoration of anadromous fish to some parts of the Kennebec River in the intervening years. The removal of Edwards Dam in 1999 allowed shortnose sturgeon, Atlantic sturgeon and striped bass free access to all their historic habitat on the mainstem of the Kennebec River), allowed American shad and blueback herring free access to about 21% of their historic spawning habitat (Table 1, Table 2), and the reach now supports the greatest abundance and biomass of American eel above the head-of-tide (Yoder et al 2006).

Atlantic salmon

MDMR initiated a restoration program for the Atlantic salmon in the Kennebec River in 2003 by stocking hatchery-reared fry into the Sandy River (Table 4). The restoration later transitioned to egg-planting (eyed-eggs are placed in man-made redds in winter) and natural reproduction by wild returning adults that are trapped at the Lockwood Project and trucked upstream to the Sandy River. In the last 4 years, most returning adults have been naturally reared wild fish (Table 3).

In 2009, the Distinct Population Segment (DPS) of the endangered Atlantic salmon was expanded (74 FR 29344), and critical habitat was delineated for three Salmon Habitat Recovery Units (SHRUs) within the expanded DPS: the Merrymeeting Bay SHRU, Penobscot Bay SHRU, and Downeast SHRU. The Merrymeeting Bay SHRU includes the Kennebec, Androscoggin, Sheepscot, Pemaquid, Medomak, and St. George watersheds.

Because the expanded listing included the Kennebec River, Brookfield Renewable (the indirect parent company of the Licensees of the Lockwood, Hydro Kennebec, Shawmut, and Weston projects) developed Interim Species Protection Plans (ISPPs) that created new schedules for installation of upstream fish passage at the four dams, requirements for testing the effectiveness of existing downstream fish passage facilities, and minimal fish passage standards. In 2016, FERC amended the Shawmut Project license to include the terms of the ISPP, and thereby authorized installation and operation of fish passage facilities at the Shawmut Project, including a new upstream fish lift. Prior to the December 31, 2019 expiration of the ISPPs, Brookfield Renewable consulted with state and federal fishery agencies to develop a Species Protection Plan (SPP) to replace the ISPPs. The SPP was submitted to FERC on December 31, 2020, and was rejected by FERC on July 1, 2020 in response to letters from the resource agencies expressing their lack of support for the SPP. At this time, there is no take permit, no Biological Opinion, no proposed performance, and no reasonable and prudent measures to avoid, minimize, and mitigate project impacts on Atlantic salmon.

Performance Measure Methods

The MDMR goal for salmon recovery in the Merrymeeting Bay SHRU is to have a genetically viable Atlantic salmon population. While a sustained population of at least 500 naturally reared adults is at lower risk, according to a population viability analysis, using data from Maine Atlantic salmon populations, a census size of 2000 naturally reared adults would be the minimum needed to withstand downturns in marine survival (74 FR 29344).

In light of the goal to reach a viable population and delisting of Atlantic salmon, the MDMR conducted a desk top analysis utilizing the best available data, current research and knowledge of the watershed in order to set survival goals surrounding passage both upstream and down at each hydro facility from Madison to Waterville. Major assumptions of the analysis were similar to those utilized by Nieland et al. (2013; 2020) in their Dam Impacts Analysis Model for the Penobscot River:

- The number of salmon smolts produced by the Sandy River, Carrabassett River, and mainstem Kennebec downstream of the Williams Project was estimated from the following equations: low number = habitat units*1.0 smolts/unit (P. Christman, Sheepscot River Monitoring, MDMR) and high number = habitat unit*3 smolts/unit (Legault 2005, Orciari et al. 1994). Habitat units were modeled in 74 FR 29300.
- Downstream migrating smolts experienced natural in-river mortality of 0.0033%/km (Stevens et al. 2019) from the release point in each spawning area to the first dam, between dams, and downstream to the Augusta.
- Estuarine mortality was 0.00368/km for smolts that had passed 0 dams; 0.0087/km for fish that passed 2 dams; .0.115/km for fish that passed 4 dams; and 0.0145/km for fish that passed 6 dams (Stevens et al. 2019). The estuary extended from the head-of- tide at Augusta to the outlet of Merrymeeting Bay (The Chops).
- The estimates for marine survival used were Low = 0.5% and High = 4.0%. These estimates for marine survival, from smolt to 2-sea winter adult, were chosen based on tagging studies (Baum, 1983) and returns of hatchery smolts to Maine Rivers (Legault 2005). These estimates do not include river or estuary mortality.
- Smolt mortality was 4% or 1% at each dam.
- Upstream passage efficiency of adults was 95% or 99% at each dam.
- The analysis did not included delays at dams during upstream or downstream passage.

Performance measure results

According to the analysis, if portions of the Kennebec River were able to achieve production potential and passage survival at each of the six dams were sufficient, it would be possible to reach MDMR recovery goals. Of the scenarios analyzed, the goal of a minimum of 2000 adults returning to their home waters was possible under the “high” marine survival and “high” fresh water survival (Table 6.). Under “high” marine survival and “low” fresh water survival scenarios, it was also possible to reach a minimum of 500 adults returning to their home waters. In order to reach these minimums, smolt mortality needed to be 1% or less at each of the six dams and upstream efficiency needed to be 99% or better. The only other scenarios that appeared to show recovery abundances returning to the Kennebec River that were analyzed were when two or more dams were removed (Figure 2). Results of effectiveness testing of the existing downstream passage facilities at the lowermost four projects were nearly always below the 99% standard, and declined when adjusted for time to pass (Table 7. We conclude that the Shawmut project would need to be decommissioned and removed in order to satisfy the demographic species recovery criteria of 2,000 salmon (Table 6).

While this analysis indicates that is may be possible to achieve recovery goals if all projects in the Kennebec river perform at a high level, it is important to acknowledge the issue of passage delays. Smolts that are emigrating downstream need to reach the estuary in a timely manner due to temperature and physiological processes (McCormick et al. 1998). In addition, it is recognized that adult upstream passage delays can have substantial long-term effects. Adult salmon that spend excessive amounts of time in warm mainstem river waters will deplete fat reserves needed for both the upstream spawning migration and for returning to the ocean the following year (Rand and Hinch 1998; Naughton et al. 2005). Passage delays will need to be minimized in order to achieve recovery goals.

Performance Measures - Upstream and downstream passage

Adults salmon return to Maine's rivers during summer and can be exposed to high temperature events. High temperature increases the energetic cost of migration at the expense of energy stores necessary for continued upstream movement and reproduction; if thermal stress is severe, it can result in death (Pörtner and Farrell 2008; Jonsson and Jonsson, Elliott and Elliott 2010; Martins et al. 2015). Migratory delays cause by dams can compound the problem, preventing salmon from reaching suitable thermal refuge habitat necessary to withstand high summer temperatures (Hasler et al. 2012; Frechette et al. 2018). In the Kennebec River, suitable cool water habitat for adults exists only upstream of existing dams in headwater tributaries like the Sandy River. Minimizing delays caused by dams is imperative to ensure that salmon reach thermal refuge habitat in order to maximize the survival of fish and available energy stores for reproduction.

In order to meet population abundance goals of 2000 returning adults, Maine DMR requires upstream passage efficiency of 99% or higher with minimal delays.

To assess upstream passage efficiency and related migratory delay, MDMR requests that a three-year telemetry study be conducted at the Shawmut Hydroelectric Project, with a sample size of at least 40 adult Atlantic salmon per year.

In order to meet population abundance goals of 2000 returning adults, Maine DMR requires downstream passage mortality of .01 or less for projects on the Kennebec River with minimal delays.

To assess downstream passage efficiency and related migratory delay, MDMR requests that a three-year telemetry study be conducted at the Shawmut Hydroelectric Project, with a sample size of at least 250 Atlantic salmon smolts per year.

Accurately quantifying survival of upstream migrating adult salmon and mortality of downstream migrating smolts is critical for conservation efforts in the Kennebec River. MDMR recommends that a 3-year average of a point estimate, in contrast to a confidence interval, be used as the measure of passage efficiency. As was demonstrated in Moctezuma and Zydlewski (2020), a point estimate encourages studies to be carried out in a way that produces a high degree of specificity and sensitivity and, "the importance of [number of released individuals], and [probability of detection] in providing estimates that reflect reality". In other words, point estimates encourage better evaluations of fishway performance and project impacts.

American shad and river herring (alewife and blueback herring)

MDMR initiated a stocking program for American shad after the 1987 Settlement Agreement was signed. Between 1987 and 2007, MDMR stocked 7,879 adult American shad, approximately 37 million American shad fry, and 1987,176 American shad fingerlings into historical habitat above Edwards Dam (Table 8). After Edwards Dam was removed, two spawning areas were documented: about 0.3 mi downstream of the Lockwood dam and at the mouth of the Sebasticook River. Beach seine surveys conducted in most years between the head-of-tide and the confluence of the Sebasticook and Kennebec rivers confirm the presence of juvenile American shad (Wippelhauser submitted).

MDMR also initiated a stocking program for river herring after the 1987 Settlement was signed. Between 1987 and 2019, MDMR stocked 470,902 river herring from Edwards Project, 1,468,913 river herring Fort Halifax Project, and to date has stocked 1,359,536 from Lockwood Project into historical spawning/nursery habitat in the Kennebec River above the Edwards Dam.

Objectives of the 1993 Plan were to restore and enhance American shad and alewife populations in the Kennebec River by achieving an annual production of 725,000 shad and 6 million alewife above Augusta. The annual production was estimated based on: 1) the area of historically accessible spawning and nursery habitat area, 2) a production rate of annual adult returns per unit area, and 3) a spawning population composed of multiple year class of both species. This method has been utilized in other recent American Shad plans and studies including the Susquehanna River (SRAFRC 2010) and Connecticut River (CRASC 2017).

MDMR has updated the annual American shad production estimates using more accurate habitat areas (Table 2) and the most recent production estimates for the Connecticut River, a minimum target production rate of 203 adults/ha for the main stem (CRASC 2017). This value is derived from Connecticut River specific estimates for adult returns, composed of multiple age classes of both sexes, to the river mouth in relation to available habitat. The highest estimated adult shad return to the river mouth (1992), when divided by the number of hectares of all available main stem habitat to Bellows Falls, Vermont yields a return/production of 203 adults/ha. The updated goal is to restore a production of 303,000 adult American shad above the Lockwood Project and 261,000 above the Shawmut Project.

Although the 1993 Plan identified blueback herring as an anadromous species that had historically occupied the Kennebec River, there were no estimates of production/unit area available at the time. The recolonization of blueback herring in the Sebasticook River has allowed MDMR to estimate a maximum production of 1196 adults/acre, which is similar to our recently updated estimate of 988.4 alewife/acre. The updated goals are to restore 1.7 million blueback herring and 900,000 alewife above the Shawmut Project (Table 2).

The production numbers have been updated for alewife base on our recent review of commercially harvested runs. The updated goal is to restore 1.1 million alewife above the Lockwood and Shawmut projects (Table 2).

To ensure that restoration goals for the Kennebec River are met, the effectiveness of any new or modified upstream and downstream fish passage facilities at the Shawmut Project will have to be tested for adult and juveniles stages of Atlantic salmon, American shad, blueback herring, alewife, American eel, and sea lamprey. Similar testing will be required for any new upstream and downstream passage facilities at the Lockwood, Hydro Kennebec and Weston projects pursuant to conditions of those licenses (the 1998 Settlement).

Because effectiveness testing will be required for these facilities, we propose performance standards for American shad by which the testing will be evaluated in response to recent Commission filings. The Commission has not supported recommendations made by the resource agencies for effectiveness testing of all new fish passage facilities in the Environmental Analysis of three recent relicensings (American Tissue FERC No. 2809-034; Barker Mills FERC No. 2808; and Ellsworth FERC No. 2727-092). One of the reasons for the lack of support was that the resource agencies had not included any specific performance standards that would be used to test the effectiveness of the new upstream and downstream passage facilities.

Computer models have been utilized as an efficient method of assessing the effects of various upstream and downstream passage efficiencies (percent passed and time to pass) on population abundance, persistence, and age structure. Stich et al. (2018) developed a stochastic life-history based simulation model for the Penobscot River, which has been modified to develop standards for the Connecticut River. Exelon (2012) developed an American shad passage model for the Susquehanna River, but did not include a time to pass. Stich et al (2018) examined the sensitivity of modeled population metrics and probability of achieving specific management goals to inputs and found spawner abundance and percentage of repeat spawners were most sensitive to survival and migration delay at dams, marine survival, and temperature cues for migratory events. Recovery objectives related to abundance and spatial distribution of spawners were achievable under multiple scenarios, but high rates of upstream and downstream passage were necessary. The standards developed for the Penobscot River, Connecticut River, and Susquehanna River are surprisingly similar (Table 9). Despite differences in the number of dams being modeled and the configuration of the river system, the downstream passage efficiency needed to maintain a population of multi-age spawner range from a minimum of 80 to 98% passage efficiency within 24-48 hrs. Upstream passage efficiency ranged from a minimum of 75-80% within 24-48 hrs. Until such time that the Kennebec River can be modeled, we will use standards for the Connecticut River.

In order to meet population abundance goals of 261,000 returning adult shad, M DMR requires upstream passage efficiency of 75% or higher with minimal delays.

To assess upstream passage efficiency and related migratory delay, MDMR requests that a three-year telemetry study be conducted at the Shawmut Hydroelectric Project, with a sample size of at least 40 adult American shad per year.

In order to meet population abundance goals returning adults, Maine DMR requires downstream passage survival estimate of 90% or higher for projects on the Kennebec River with minimal delays.

To assess downstream passage efficiency and related migratory delay, MDMR requests that a three-year telemetry study be conducted at the Shawmut Hydroelectric Project.

Accurately quantifying survival of upstream migrating shad and mortality of downstream migrating adult and juvenile shad is critical for conservation efforts in the Kennebec River. MDMR recommends that a 3-year average of a point estimate, in contrast to a confidence interval, be used as the measure of passage efficiency. As was demonstrated in Moctezuma and Zydlewski (2020), a point estimate encourages studies to be carried out in a way that produces a high degree of specificity and sensitivity and, "the importance of [number of released individuals], and [probability of detection] in providing estimates that reflect reality". In other words, point estimates encourage better evaluations of fishway performance and project impacts.

The Shawmut Project will impact diadromous species in several ways. Alewife, blueback herring, American shad will not be able to migrate upstream to historic spawning habitat until upstream passage is available. Post-spawn adult river herring that have been stocked by MDMR, their offspring, and adult American eels on their spawning migration will be delayed, injured, or be killed when attempting to migrate downstream past the Project.

Sea Lamprey

Sea lamprey (*Petromyzon marinus*) is an important component of the native riverine ecosystem in Maine.

Restoring sea lamprey to their historic habitat is now recognized as beneficial for this important prehistoric species and also for the restoration and recovery of other sea run fish, particularly endangered salmon (Kircheis 2004). It is the goal of MDMR to restore sea lamprey to historic habitat above Shawmut dam.

Sea lamprey are capable of reaching small, high-gradient, headwater streams (Nislow and Kynard 2009). They spawn in gravel-cobble substrate, and the spawning process results in streambed modification and sediment transport (Nislow and Kynard 2009; Sousa et al. 2012; Hogg et al. 2016). Lamprey spawning activities condition the habitat for other species, including Atlantic salmon, by removing fines and reducing substrate embeddedness (Kircheis 2004). Given the high degree of embeddedness in Maine streams due to past land use practices, the role of lamprey as "ecosystem engineers" is particularly desirable (Kircheis 2004; Sousa et al. 2012). Detection of a radio-tag from a sea lamprey at Brownsville on the Pleasant River (a tributary of the Penobscot River) in August 2020 indicates that improving passage at dams has positive impacts on lamprey migratory range (MDMR, unpublished data).

Anadromous sea lampreys also serve as a conduit of nutrients between marine and freshwater systems. Semelparous adults contribute marine derived nutrients (MDN) to rivers, whereas filterfeeding ammocetes, (the juvenile life stage that spends up to eight years in stream sediments), export terrestrially derived nutrients into the marine environment (Beamish 1980, Kircheis 2004; Nislow and Kynard 2009; Weaver et al. 2018). Atlantic coastal streams are generally considered to be phosphorus-limited, although Sedgeunkedunk Stream in Maine was found to be both nitrogen and phosphorus limited (Weaver et al. 2016). Nislow and Kynard (2009) demonstrated that sea lamprey contributed phosphorus to a Connecticut River tributary at levels as great as 0.26 gm^{-2}. Sea lamprey spawning occurs in late spring and early summer, thus pulses of MDN from post-spawn lamprey carcasses occur after canopy formation reduces light penetration to the stream and concurrent with the emergence of macroinvertebrates and Atlantic salmon fry (Beamish 1980; Nislow and Kynard 2009; Weaver et al. 2015, 2016). Consequently, the influx of nutrients may help support stream food webs during a time when nutrients and energy flow might otherwise be limiting (Weaver et al. 2016). Further, sea lamprey are the sole semelparous species among the complex of sea run species that spawn in Maine's rivers. Gametes and metabolic waste from iteroparous species, such as Atlantic salmon, river herring, and shad do serve as a source of MDN, but carcasses of semelparous species are generally a more important source of nutrients, highlighting the importance of providing lamprey passage into critical habitat areas (Moore et al. 2011; Nislow and Kynard 2009).

Passage Season

Sea lamprey spawning in Maine begins in late May and extends into early summer and peaks at water temperatures of 17-19°C (Kircheis 2004). During the years 2014-2020, the earliest recorded sea lamprey was counted at the Milford Dam fish lift (Penobscot River) on 7 May (205 and 2016); lamprey have been recorded at Milford as late as 6 July (MDMR unpublished data). Lamprey on the Westfield River have been observed as early as 14 April during the years 2005 to 2019 (Caleb Slater, Massachusetts Division of Fisheries and Wildlife. Pers. Comm. Westborough, MA). For the years 1978-2018, lamprey were recorded at the Rainbow Dam fishway on the Farmington River, (a tributary of the Connecticut River) as early as 16 April (mean start date of 29 April) and as late as July 11 (mean end date of 24 June; CT DEEP Fisheries Division, unpublished data, Old Lyme, CT).

Given the long distances that sea lamprey must travel to reach spawning grounds while temperatures are favorable for spawning, we recommend that a sea lamprey passage season should begin no later than 1 May and extend to 30 July. As more information becomes available, this season can be adjusted.

Passage Timing

On the Connecticut River, Castro-Santos et al. (2016) reported that 64% of entries into fish passage structures occurred at night (i.e., between sunset and sunrise); in fact, entry rates were as much as 24.4 times greater at night. In a study on the River Mondego, (Portugal), Pereira et al. (2016) found that most detections of sea lamprey in a vertical-slot fish pass occurred at night, i.e., between dusk and dawn (88% in 2014 and 75% in 2015). Data from fish passage facilities in Connecticut indicate that in the early part of the upstream migration period, lamprey enter fish passes exclusively at night. As the run progresses, however, lamprey may enter at any time (Steve Gephard, CTDEEP Fisheries, pers. comm. Old Lyme, CT). At the Westfield River fish passage facility in Massachusetts, nearly all lamprey pass at night (Caleb Slater, Massachusetts Division of Fisheries and Wildlife. Pers. Comm. Westborough, MA). In 2020, lamprey passage occurred primary in the evening hours at the Milford fish lift, with some passage occurring in the early morning (e.g. 1am EST) (MDMR, unpublished data).

Given the strong propensity for lamprey to exhibit nocturnal movement patterns, fishways, including fish lifts, should be operated at night to allow for lamprey passage.

Upstream Passage Efficiency Rate

On the Connecticut River, the combined passage percentage for sea lamprey at Turner's Falls was 46.7%, whereas fish pass entry was 64.1% of tagged individuals (Castro-Santos et al. 2016). This is comparable to entry rates for Pacific lamprey at Bonneville (67%) and McNary Dams (61%) on the Columbia River (Johnson et al. 2012; Keefer et al. 2013a; 2013b). At Turner's Falls, failure to pass was predominantly associated with the fish pass entrance, so concerted improving ability for lamprey to enter fish ladders is likely to be a key aspect of ensuring overall passage success (Castro-Santos et al. 2016). Passage efficiency for a vertical-slot fish pass on the River Mondego, (Portugal), was determined to be 33% via PIT telemetry and 31% via radio-telemetry (Pereira et al. 2016). In 2020, 50 radio tagged sea-lamprey passed the Milford fish lift on the Penobscot River at 81% (MDMR, unpublished data).

Upstream Passage Efficiency Timing

Migratory delay comes at energetic costs to further upstream migration and subsequent reproduction, consequently, it is recommended that fish pass performance include not only target numbers or percentage of fish passing, but also metrics for movement rates and time to pass (Castro-Santos et al. 2009; Castro-Santos and Letcher 2010; Castro-Santos and Perry 2012; Castro-Santos et al. 2016). The overall energetic costs to migration and reproduction imposed by migratory delay will increase with the number of dams encountered and should be factored in when setting passage time performance standards.

Downstream Passage Efficiency

Sea-lamprey metamorphize as juveniles and swim downstream to feed in the ocean in the late fall and spring (Kircheis 2004). General movement is thought to occur at nighttime and during high flow events (Kircheis 2004). Given their small size at 100 mm to 200 mm (Kircheis 2004), turbine entrainment is possible without appropriately sized exclusion screening or other measures to bypass outmigrating sea lamprey.

Performance Standards

In order to effectively pass lamprey into historic habitats above Shawmut, Maine DMR requires upstream passage efficiency of 80% or higher with minimal delays of 48 hours or less. This performance was achieved at the Milford fish lift in 2020 and should therefore be a floor for minimum fish passage efficiency.

To assess upstream passage efficiency and related migratory delay, MDMR requests that a three-year telemetry study be conducted at the Shawmut Hydroelectric Project, with a sample size of at least 40 sea lamprey per year.

To assess downstream passage efficiency and related migratory delay of outmigrating sea-lamprey, MDMR requests that a three-year study be conducted at the Shawmut Hydroelectric Project, developed with MDMR and federal agencies.

Accurately quantifying survival of upstream migrating sea lamprey and mortality of downstream migrating juvenile lamprey is critical for conservation efforts in the Kennebec River. MDMR recommends that a 3-year average of a point estimate, in contrast to a confidence interval, be used as the measure of passage efficiency. As was demonstrated in Moctezuma and Zydlewski (2020), a point estimate encourages studies to be carried out in a way that produces a high degree of specificity and sensitivity and, "the importance of [number of released individuals], and [probability of detection] in providing estimates that reflect reality". In other words, point estimates encourage better evaluations of fishway performance and project impacts.

Terms and Conditions

Section 10(a) Consistency with Comprehensive Plans

Recommendation #1

The MDMR recommends that the Shawmut Project be decommissioned and removed. This recommendation is consistent with multiple comprehensive plans, our management goals and activities, and analysis of river-specific data. MDMR finds that the cumulative impacts of the four lowermost hydropower projects in the mainstem Kennebec River, including the Shawmut Project will result in significant adverse impacts on the recovery of endangered Atlantic salmon and on the restoration of alewife, blueback herring, American shad, sea lamprey, and American eel to their historic habitat in the Kennebec River.

Justification

Management authority for Atlantic salmon, American shad, blueback herring, alewife, American eel and sea lamprey lies with the State of Maine's Department of Marine Resources, the National Marine Fisheries Service (NMFS), and the U.S. Fish and Wildlife Service (USFWS). The Atlantic States Marine Fisheries Commission (ASMFC), a compact of the 15 Atlantic coast states, has management authority for American shad, blueback herring, alewife, and American eel.

Relevant documents that have been accepted as Comprehensive Plans by the Commission are:

U.S. Fish and Wildlife Service and NMFS. 2019. Recovery plan for the Gulf of Maine Distinct Population Segment of Atlantic salmon (*Salmo salar*). 74 pp.

Maine State Planning Office. 1993. Kennebec River resource management plan. Augusta, Maine. February 1993. 16 pp.

Atlantic States Marine Fisheries Commission. 1999. Amendment 1 to the Interstate Fishery Management Plan for shad and river herring. (Report No. 35). April 1999.

Atlantic States Marine Fisheries Commission. 2000. Technical Addendum 1 to Amendment 1 of the Interstate Fishery Management Plan for shad and river herring. February 9, 2000. 34

Atlantic States Marine Fisheries Commission. 2010. Amendment 3 to the Interstate Fishery Management Plan for shad and river herring, Arlington, Virginia. February 2010.

Atlantic States Marine Fisheries Commission. 2000. Interstate Fishery Management Plan for American eel (*Anguilla rostrata*). (Report No. 36). April 2000.

The Comprehensive Plans consider the economic and social value of diadromous fish for the public, and they collectively recognize the reduced abundance and reduced distribution of these species from habitat loss. The Comprehensive Plans all point to barriers (e.g. dams) that prevent these species from being able to migrate between growth habitat and spawning/nursery habitat in order to complete their life cycle. The Recovery Plan (USFWS 2019) states that dam removal might be necessary for the reclassification or delisting of the endangered Atlantic salmon. The 1993 Plan[6] (MSPO 1993) recommended the removal of Edwards Dam to restore and enhance

[6] The Kennebec River Management Plan is in the process of being amended.

populations of shortnose sturgeon, Atlantic sturgeon, striped bass, and rainbow smelt to historical habitat in the Kennebec River.

In our 10(j) Terms and Conditions for the Shawmut Project, MDMR has recommended new upstream and downstream fish passage facilities capable of passing Atlantic salmon, American shad, blueback herring, alewife, sea lamprey, and American eel. In developing performance standards for assessing the effectiveness of the new facilities, we have determined that passage efficiency needs to be nearly perfect to protect the endangered Atlantic salmon – a minimum of 99% upstream and downstream passage effectiveness with minimal delays (48 hours upstream and 24 hours downstream). We are not aware of any man-made fish passage facilities that consistently achieve this level of efficiency for any species (e.g. Table 7), including projects designed and operated using USFWS Fish Passage Criteria (USFWS 2019). We propose performance standards for assessing the facilities for American shad. At this time no standards have specifically been developed for the Kennebec River. Therefore, we have adopted standards from the Connecticut River, a minimum of 90% downstream within 24 hours and 75% upstream within 48 hours. We also propose performance standards for upstream sea-lamprey passage at 80% and within 48 hrs., which is a conservative standard achieved this spring/summer at Brookfield's facility at Milford on the Penobscot River. Standards for other species, such as alewife, blueback herring, and American eels and downstream passage standards for sea lamprey are in development and may be proposed by MDMR and/or federal agencies during this relicensing period.

Section 10(j) Recommendations

Recommendation #1 Upstream Passage for anadromous fishes

A. The Licensee shall be responsible for providing, operating, maintaining, and evaluating a volitional upstream fish passage facility at the Shawmut Project that shall be capable of passing a maximum of 1,535,000 blueback herring, 134,000 alewife, 177,000 American shad, 12,000 Atlantic salmon, and an unknown number of sea lamprey annually in a safe, timely, and effective manner (defined for two species in E,F, and G).

B. The upstream passage facility shall adhere to the USFWS design criteria (USFWS 2019).

C. The Licensee shall operate the upstream passage daily (24 hours/day) from April 1-July 30 and daily (daylight hours) from September 1- November 30.

D. After upstream passage becomes operational at the two downstream hydropower projects, the Licensee shall conduct three consecutive years of effectiveness testing using radio telemetry or an equivalent technique for each of the five species (Atlantic salmon, American shad, blueback herring, alewife, and sea lamprey). The study plans shall be developed in consultation with, and require approval by, the resource agencies and FERC. Annual reports that describe the study, its results, and conclusions should be submitted to the resource agencies by December 1st of each year the study is conducted. Based on the results of the annual reports, the resource agencies may require adjustments to the study methodology for the next year's evaluation.

E. The facility will be considered to be performing effectively if at least 99% of the adult Atlantic salmon that pass upstream at the next downstream dam (or approach within 200 m of the Shawmut powerhouse) pass upstream at the Shawmut Project within 48 hours.

F. The facility will be considered to be performing effectively if at least 75% of the adult American shad that approach within 200 m of the Shawmut Project powerhouse pass upstream at the Shawmut Project within 48 hours.

G. The facility will be considered to be performing effectively if at least 80% of the adult sea lamprey that approach within 200 m of the Shawmut Project powerhouse pass upstream at the Shawmut Project within 48 hours.

H. If the resource agencies determine the results of the study show that a given fish passage facility is not performing effectively, they may require changes to such facilities for the permittee to be in compliance with the performance standards described in these Terms and Conditions. Once the changes are implemented, the permittee shall undertake studies to demonstrate their effectiveness. The permittee shall submit a Plan for the agencies' approval for such additional study and the study must be conducted for a minimum of three (3) years, consistent with requirements provided in condition D and for the given species in conditions E, F, or G;

Justification

The Licensee is required by the existing license to provide upstream fish passage at the Project; however, the requirement is be evaluated and analyzed in the current relicensing process. The Licensee originally was required to construct a new upstream fish passage facility at the Shawmut Project in 2017 and begin operating it in 2018. In addition, the Licensee was to begin operating permanent downstream passage facilities at the time that upstream passage became operational. The upstream facility is now being considered for construction in 2021 and operational in 2022. We support the need for safe, timely, and effective upstream passage at this Project to meet our diadromous fish restoration goals of restoring these species to their historic habitat in historic abundance if known.

The Licensee has proposed to conduct up to two years of adult salmon studies to evaluate the performance of the new upstream passage facility. We find this completely inadequate. This is a new facility that will impact six species of diadromous fish for 40-50 years. Therefore, we have requested three years of testing for each species. Three years is required to encompass the natural variation in environmental conditions that impact effectiveness (e.g. flow). In a study that evaluated the effectiveness of upstream and downstream fish passage facilities required to mitigate the impacts of hydroelectric dams on migrating fish, FERC (2004) included the following recommendations, which are supported by the MDMR:

- The process of mitigating adverse environmental impacts should include an assessment of the effectiveness of the mitigation that is implemented.
- Monitoring of fish passage facilities could contribute not only to determining the site-specific effectiveness of the facility but also to evaluating its potential use at other sites
- Although studies of fish passage effectiveness occur more frequently now than 15 years ago, there remains a need for more information on effectiveness, especially of new technologies.

Section 10(j) Recommendation #2 Downstream passage

A. The Licensee shall be responsible for providing, operating, maintaining, and evaluating a volitional downstream fish passage facility at the Shawmut Project that shall be capable of passing adult and juvenile Atlantic salmon (kelts and smolts), adult and juvenile American shad, adult and juvenile blueback herring, adult and juvenile alewife, adult American eel (silver eel), and juvenile microphthalmia sea lamprey in a safe, timely and effective upstream passage (defined for two species in E,F, and G).

B. The downstream passage facility shall adhere to the USFWS design criteria (USFWS 2019).

C. The Licensee shall operate the downstream passage daily (24 hours/day)) from April 1 through November 30 also during nighttime hours from August 15 through October 31.

D. The Licensee shall conduct three consecutive years of effectiveness testing using radio telemetry or an equivalent technique for adult and juvenile Atlantic salmon, adult and juvenile American shad, adult and juvenile blueback herring, adult and juvenile blueback alewife, adult American eel, and microphthalmia sea lamprey. The study plans shall be developed in consultation with the resource agencies. The study plans shall be developed in consultation with, and require approval by, the resource agencies. Annual reports that describe the study, its results, and conclusions should be submitted to the resource agencies by December 1st of each year the study is conducted. Based on the results of the annual reports, the resource agencies may require adjustments to the study methodology for the next year's evaluation.

E. The facility will be considered to be performing effectively if at least 99% of the juvenile Atlantic salmon smolts that pass downstream at the next upstream hydropower dam (or approach within 200 m of the Shawmut spillway) pass downstream at the Shawmut Project within 24 hours.

F. The facility will be considered to be performing effectively if at least 95% of the adult and juvenile American shad that pass downstream at the next upstream hydropower dam (or within 200 m of the Shawmut spillway) pass the Shawmut project within 24 hours.

G. If the resource agencies determine the results of the study show that a given fish passage facility is not performing effectively, they may require changes to such facilities for the permittee to be in compliance with the performance standards described in these Terms and Conditions. Once the changes are implemented, the permittee shall undertake studies to demonstrate their effectiveness. The permittee shall submit a Plan for the agencies' approval for such additional study and the study must be conducted for a minimum of three (3) years, consistent with requirements provided in condition D and for the given species in conditions E, F, or G;

Justification

The Licensee has proposed to 1) install a fish guidance boom (e.g., Worthington boom) in the forebay (in front of Units 7 and 8) to direct downstream migrants to the existing downstream bypass; 2) continue to operate the existing downstream fish passage facility and maintain the forebay fish guidance boom; and 3) conduct up to three years of additional downstream passage studies to reevaluate smolt. We find this proposal inadequate. Except for the Worthington boom, this is an existing facility that will impact six species of diadromous fish for 40-50 years. It has never been tested for adult Atlantic salmon (kelts) nor adult and juvenile American shad, blueback herring, and alewife. It was minimally tested for adult American eels in 2015. As stated above, effectiveness testing is supported by FERC (2004). Furthermore, we have provided performance standards by which the passage effectiveness can be evaluated for Atlantic salmon, American shad, and sea lamprey.

The Licensee did not specifically mention downstream passage of American eel in its proposed environmental measures. The Licensee currently provides downstream passage for adult American eel "by opening a deep gate to pass approximately 425 cfs and tuning off unit for 7-8 hours during the night from September 15-November 15." The plunge pool which receives flow from the deep gate is not described anywhere in the FLA. MDMR has reviewed harvest data for the now closed commercial fishery of silver eels, and we have extended the passage season to be more protective.

Section 10(j) Recommendation #3 Upstream eel passage

A. The Licensee shall be responsible for providing, operating, maintaining, and evaluating a volitional upstream fish passage facility at the Shawmut Project that shall be capable of passing juvenile American eel (elvers and yellow eel) in a safe, timely and effective manner.
B. The Licensee shall continue using the existing upstream eel facilities until upstream and downstream fish passage recommended by MDMR has been operation for one year (shake down period).
C. After the shakedown period, the Licensee shall conduct siting studies, designed in consultation with the resource agencies, to determine the best location(s) for upstream eel passage.
D. The downstream passage facility shall adhere to the USFWS design criteria.
E. The Licensee shall operate the upstream passage from June 1 through September 15.
F. The Licensee shall conduct one year of monitoring to determine the number of American eels using the passage facility and the size distribution of the eels. The Licensee shall conduct one year of effectiveness testing to be designed in consultation with the agencies

Justification

The existing upstream passages for American eel are not volitional, and their ability to attract juvenile American eels may be compromised by changes in flow patterns if existing facilities and operations are changed.

Section 10(j) Recommendation #4 Stocking Plan

A. Within one year of license issuance, the Licensee shall develop a plan, in consultation with the USFWS, NMFS, MDMR, and the Penobscot Indian Nation, to acquire uniquely marked Atlantic salmon smolts (or other appropriate life stage) for stocking upstream of the Shawmut Project. These fish will serve as a source of imprinted adult fish (i.e., fish homing to areas upstream of Shawmut Dam) needed to support any required upstream effectiveness testing.

Justification

In order to conduct upstream adult salmon studies to determine passage efficiency for the Projects on the Lower Kennebec River (Lockwood, Hydro-Kennebec, Shawmut, Weston; all owned by the Licensee), the Licensee, in conjunction with the above-mentioned entities, will need to develop a plan. This plan will evaluate the best method to provide sufficient returning adults to make upstream passage efficiency studies meaningful at all four Projects. Juveniles will need to be stocked above the Project to provide imprinted adult fish. Significant numbers will need to be stocked to account for river and ocean mortality, so enough adults return and provide meaningful passage efficiency results. Procurement of fish for studies is the responsibility of the licensee.

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Table 1. List of major events leading to the restoration of diadromous species in the Kennebec River, Maine.

Year(s)	Major events
1987	**First Kennebec hydro Developers Group (KHDG) Settlement Agreement**
1987	MDMR initiates stocking of alewife and American shad into historic spawning habitat above Edwards Dam
1987-1997	MDMR stocks 1,849 adult American shad , 44.6 million Americas shad fry, and 197,176 American shad fingerlings into historic spawning habitat above Edwards
1987-2006	MDMR stocks 1.3 million river herring into historic habitat above Edwards
1992	Interim upstream passage (fish pump) installed at Edward Dam
1988-2006	Interim, downstream passage operational at Benton Falls, Fort Halifax, Burnham, Lockwood, Shawmut, and Hydro-Kennebec projects, respectively
1998	**Lower Kennebec River Comprehensive Hydropower Settlement (1998 Settlement)**
1999	Removal of Edwards Dam
1999	MDMR completes upstream fish passage at Stetson Pond (Sebasticook River)
1999-2011	Installation of upstream eel passage at seven KHDH Dams
2002	MDMR removes Guilford Dam and completes upstream passage at Plymouth Pond Dam (Sebasticook River)
2003	MDMR completes upstream passage at Sebasticook Lake (Sebasticook River)
2003	MDMR initiates salmon stocking (eggs, fry, returning adults) in Sandy River
2006	Fish lifts operational at Benton Falls and Burnham projects (Sebasticook River) and Lockwood Project (Kennebec River)
2006	Fish lift operational at Lockwood Project (Kennebec River)
2006	MDMR ceases stocking alewife into 6 accessible lakes and ponds
2006	Removal of Madison Electric Works Dam (Sandy River)
2008	Removal of Fort Halifax Dam (Sebasticook River)
2009	MDMR completes upstream passage at Webber Pond Dam (Seven Mile Stream)
2012-2013	Interim Species Protection Plans (ISPP) for Atlantic salmon for Kennebec River and Androscoggin River
2012-2014	Downstream passage efficiency studies for Atlantic salmon smolts at Lockwood, Hydro Kennebec, Shaw, and Weston
2016-2017	Upstream passage studies of adult Atlantic salmon at the Lockwood Project
2016	Fish lift operational at Hydro Kennebec Project
2017-2020	MDMR and partners remove Masse Dam (2017) and Lombard Dam (2018) and install fish passage at Ladd Dam (2019) and Box Mills Dam (2020) in Outlet Stream (Sebasticook River)
2018	A total of 5,580,111 river herring return to the Sebasticook River, the largest self-sustaining run on the east coast
2019	MDMR and partners complete upstream fish passage at Togus Ponds

Table 2. Amount of American shad, blueback herring, and alewife spawning habitat (source 1997 FEIS) in the Kennebec River above Edwards Dam (removed in 1999) and estimated production of adults of each species.

Habitat description	Surface area (ha)	% of total area	American shad production	Blueback herring production	Alewife production
Kennebec-ED to LO	524	20.9	106,332	626,461	
Kennebec-LO/HK to SH	212	8.4	42,966	253,135	
Kennebec SH to WE	512	20.4	103,965	612,514	
Kennebec WE to AB	415	16.5	84,215	496,156	
Sandy to Rt 4 bridge	356	14.2	72,345	426,223	
Sebasticook to EB-WB	489	19.5	99,212	584,515	
Wesserunsett Lake	585				578,400
Sandy (4 lakes)	474				468,400
Totals			509,035	2,999,004	1,046,800

Table 3. Total number of river herring, estimated number of river herring that were alewife and blueback herring based on biological sampling, American shad, and striped bass captured at the Fort Halifax Project (FH), Benton Falls Project (BF) and Lockwood Project (LO).

Site	Year	Total river herring	Alewife	Blueback Herring	American Shad	Striped Bass
FH	2000	137,658	137,658			
FH	2001	142,845	142,155	690		
FH	2002	151,574	150,743	831		
FH	2003	131,633	131,616	17		
FH	2004	143,697	143,663	34		
FH	2005	81,576	81,265	311		
FH	2006	46,960	43,865	3,095		
FH	2007	458,491	457,464	1,027		
FH	2008	401,059	388,692	12,367		
BF	2009	1,327,861	1,263,015	64,846	9	
BF	2010	1,628,187	1,201,559	426,628	3	4
BF	2011	2,751,473	2,537,226	214,247	54	
BF	2012	1,703,520	1,499,216	204,304	163	1
BF	2013	2,272,027	1,964,613	307,414	113	14
BF	2014	2,379,428	1,784,425	595,003	26	22
BF	2015	2,158,419	1,725,165	433,254	48	3
BF	2016	3,128,753	2,131,789	996,964	18	3
BF	2017	3,547,698	2,339,419	1,208,279	65	314
BF	2018	5,579,901	4,201,838	1,378,063	26	3
BF	2019	3,287,701	2,086,545	1,201,156	114	169
LO	2006	3,152				83
LO	2007	4,534			30	
LO	2008	90,940	89,121	1,819		
LO	2009	45,428				10
LO	2010	75,072	59,363	15,709	28	4
LO	2011	31,066				8
LO	2012	156,428				11
LO	2013	95,314				31
LO	2014	108,256	73,883	34,373	1	22
LO	2015	89,496	55,433	34,063	26	33
LO	2016	206,941	88,463	118,478	830	214
LO	2017	238,481	73,595	164,886	201	137
LO	2018	238,953	145,267	93,686	275	109
LO	2019	182,987	118,921	64,066	22	

Table 4. Number of Atlantic salmon fry and eggs stocked in the Sandy River, and number of returning adults captured at the Lockwood Project and trucked to the Sandy River.

Year	Number of fry stocked	Number of eggs stocked	Total number of adult returns	Total naturally reared returns	Proportion naturally reared
2003	39,000				
2004	55,000	12,000			
2005	30,000	18,000			
2006	6,500	41,800	15	5	
2007	15,400	18,000	16	8	0.50
2008		245,500	21	8	0.38
2009		166,494	33	11	0.33
2010		567,920	5	3	0.60
2011		859,893	64	43	0.67
2012		920,888	5	4	0.80
2013		691,857	8	7	0.88
2014		1,159,330	18	16	0.89
2015		274,383	31	29	0.94
2016		619,364	39	39	1.00
2017		447,106	40	40	1.00
2018		1,227,353	11	10	0.91
2019		917,613			
Total	145,900	8,187,501	306	223	

Table 5. Historic and currently accessible anadromous spawning habitat and catadromous growth habitat in the Kennebec River watershed. The Lockwood Project was constructed at Taconic Falls and the Abenaki and Anson projects were constructed at the Norridgewock Falls. is the current location of the Lockwood Project

Species	Historic range	Current accessible range
Rainbow smelt	Mainstem to Lockwood Dam	Mainstem to Lockwood Dam
Atlantic tomcod	Mainstem to head-of tide	Mainstem to head-of tide
Shortnose sturgeon	Mainstem to Taconic Falls	Mainstem to Taconic Falls
Atlantic sturgeon	Mainstem to Taconic Falls	Mainstem to Taconic Falls
Striped bass	Mainstem to Taconic Falls; Sebasticook River short distance	Mainstem to Taconic Falls; Sebasticook River short distance
American shad	Mainstem to Norridgewock Falls; Sandy River to Rt 4	Mainstem to Lockwood Dam (truck stocking upstream)
Blueback herring	Mainstem to Norridgewock Falls; Sandy River to Rt 4	Mainstem to Lockwood Dam (truck stocking upstream)
Alewife	Mainstem to Norridgewock Falls; Sandy River to Rt 4	Mainstem to Lockwood Dam (truck stocking upstream)
Atlantic salmon	Mainstem to confluence of Kennebec and Dead River; Carrabassett River; Sandy River	Mainstem to Lockwood Dam (truck stocking upstream)
Sea lamprey	Unknown- similar to salmon	Mainstem to Lockwood Dam
American eel	Unknown- past Williams	Williams Project

Table 6. Estimated adult returns to the Kennebec River given realistic scenarios of marine survival (M) and freshwater (FW) productivity as a function of number of mainstem dams on the river. Four dam scenario assumes Shawmut and Lockwood have been removed. Two dam scenario assumes Weston, Shawmut, Kennebec Hydro, and Lockwood have been removed.

Scenario	Downstream mortality/dam	Upstream mortality/dam	Low FW Surv./Low M Surv.	Low FW Surv./High M Surv.	High FW Surv./Low M Surv.	High FW Surv./High M Surv.
Six dams	0.01	0.01	84	670	209	2,011
Six dams	0.04	0.05	64	515	161	1,544
Four dams	0.04	0.05	100	789	249	2,395
Two dams	0.04	0.05	136	1,090	341	3,270

Table 7. Baseline and adjusted downstream passage efficiencies for Atlantic salmon smolts.

Project	Year	Baseline efficiency	Adjusted efficiency
Weston	2013	0.957	
Shawmut	2013	0.963	
Hydro Kennebec	2013	0.941	
Lockwood	2013	1.000	
Weston	2014	0.895	0.875
Shawmut	2014	0.936	0.895
Hydro Kennebec	2014	0.980	0.900
Lockwood	2014	0.977	0.947
Weston	2015	0.997	0.660
Shawmut	2015	0.906	0.838
Hydro Kennebec	2015		
Lockwood	2015	0.980	0.888

Table 8. Number of American shad adults, fingerlings, and fry stocked into the Kennebec River (KE) or the Sebasticook River (SE) between 1987 and 2007. Adults were obtained from the Kennebec River, Narraguagus River (NA), Connecticut River (CO), Saco River, (SA), and Merrimack River (ME).

Year	Source	Adults released	Fry released (KE)	Fry released (SE)	Fingerlings released
1987	KE	16			
1987	NA	183			
1988	CO	616			
1989	NA	174			
1989	CO	444			
1989	KE	1			
1990	NA	36			
1990	CO	568			
1991	CO	639			
1992	CO	994			
1993	CO	880	186,000		16,000
1994	CO	898	51,000		15,600
1995	CO	1,518	388,000		27,841
1996	CO	462	599,990	320,000	3,070
1997	CO	420	1,484,908	474,313	60,261
1997	SA		459,241		
1998	CO		1,348,937	725,420	27,907
1999	CO		2,020,838	839,068	13,141
2000	CO		3,346,727	500,004	27,685
2001	ME		1,489,913	618,879	6,671
2002	ME		5,671,856	1,034,207	
2003	ME		5,989,358	1,857,184	
2004	ME		4,931,174	510,962	
2005	ME		1,105,343		
2006	CO		262,131		
2007	ME		7,937,841	422,518	
	Total	7,849	37,273,257	7,302,555	198,176

Table 9. American shad passage standards for the Connecticut, Penobscot, and Susquehanna river systems.

River	Standard	Species/stage	Percent passed
Connecticut	Downstream	all stages American shad	≥95% within 24 hrs
Penobscot	Downstream	all stages American shad	≥90% within 24 hrs
Penobscot	Downstream	all stages American shad	≥98% within 48 hrs
Susquehanna	Downstream	adult Alosines	≥80%
Susquehanna	Downstream	juvenile Alosines	≥95%
Susquehanna	Downstream	Adult American eel	≥85%
Connecticut	Upstream	adult American shad	≥75% within 48 hrs
Penobscot	Upstream	all stages American shad	≥75% within 24 hrs
Penobscot	Upstream	all stages American shad	≥80% within 48 hrs
Susquehanna	Upstream	adult American shad	≥75%
Susquehanna	Upstream	adult American shad	≥75%

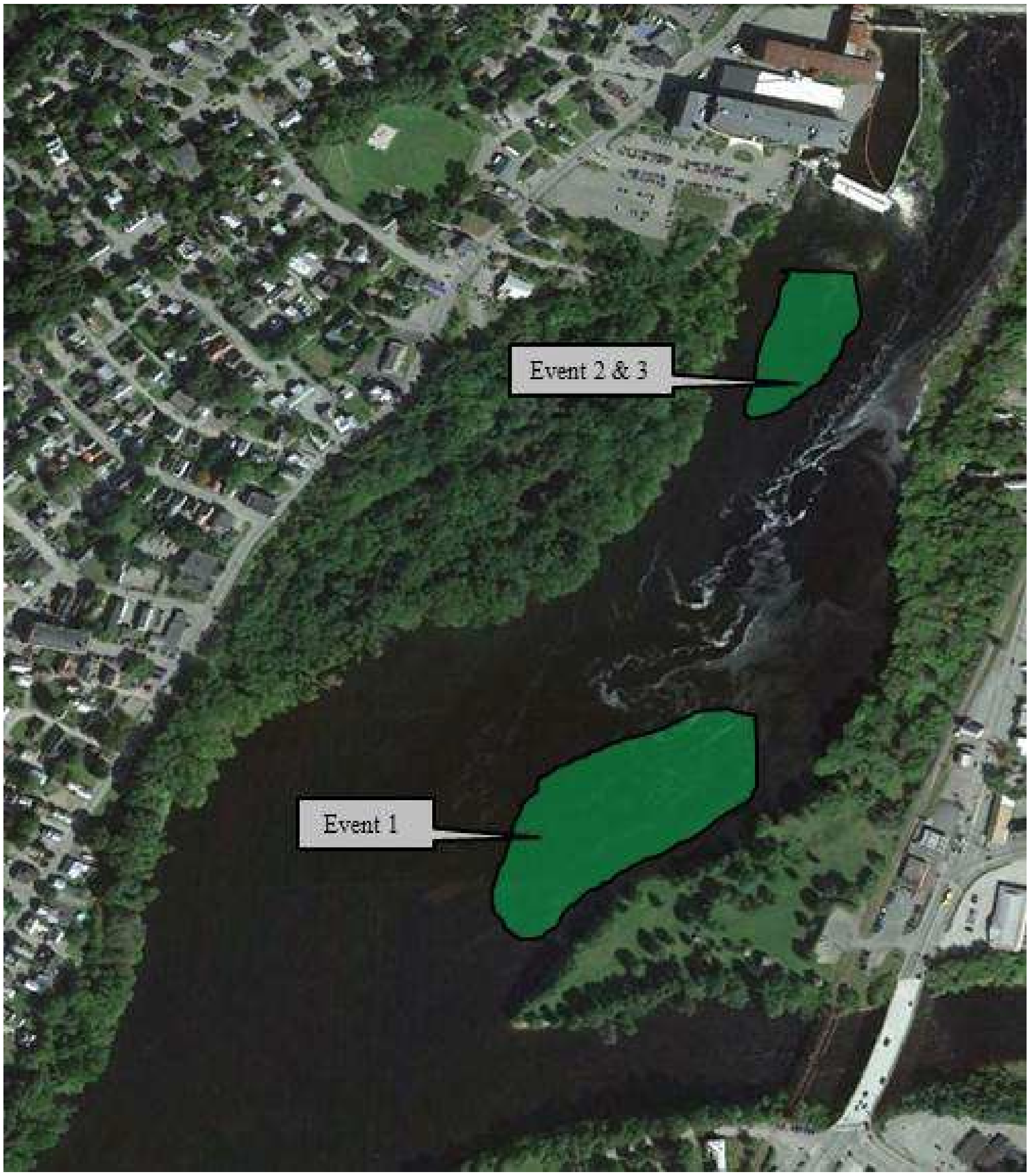

Figure 1. Aerial view of the Lockwood Project tailrace showing locations (green polygons) where American shad were captured for a radio telemetry study in 2015.

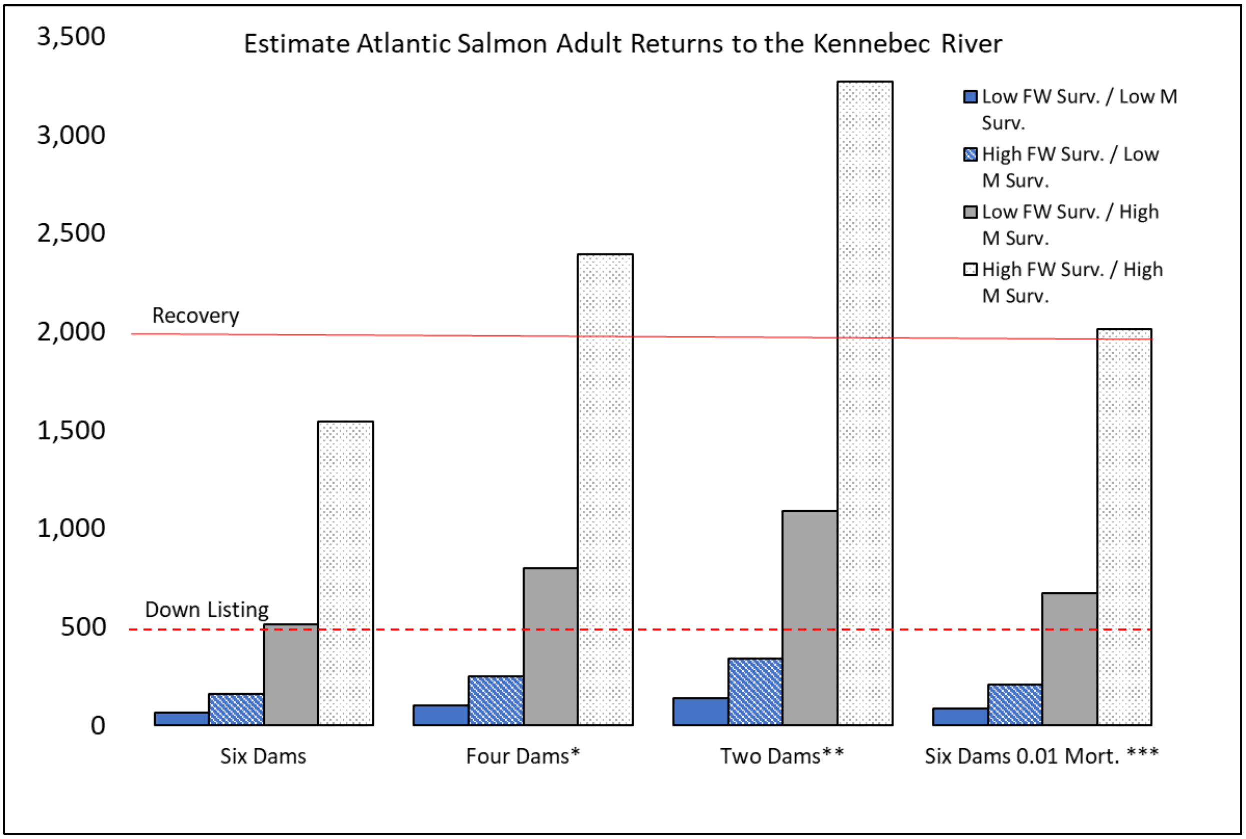

Figure 2: Estimated adult returns to the Kennebec River given realistic scenarios of marine survival and freshwater productivity as a function of number of mainstem dams on the river. For all dams downstream passage morality was set at .04 and upstream at .05 except in the Six Dam scenario where .01 was used. *Four dam scenario assumes Shawmut and Lockwood have been removed. **Two dam scenario assumes Weston, Shawmut, Kennebec Hydro, and Lockwood have been removed. *** Six dam scenario with .01 mortality for upstream and downstream passage at each dam. Recovery here is represented as the numerical target for abundance yet other criteria must also be met (USFWS and NMFS 2019).