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

GOVERNOR

PATRICK C. KELIHER
COMMISSIONER

November 22, 2019

Dear Mrs. Howatt;

This letter is in response to your October 15th email request for information regarding the relicensing of the Shawmut Hydroelectric project and Lower Kennebec river, as it relates to the forthcoming Clean Water Act (CWA) Section 401 water quality certification. The Kennebec River is a high priority watershed for the Maine Department of Marine Resources (MDMR), with significant runs of sea-run fish resources and huge potential for further recovery. For more than 20 years, state and federal agencies, communities, fishing organizations, and environmental groups have been working to restore habitat and passage in the watershed for a wide variety of sea-run fish. The removal of the Edwards Dam in 1999 led to a resurgence of migratory fish numbers and is recognized as a nationally significant fisheries restoration success story. In 2018, over 6 million fish returned to the Kennebec and its tributaries to spawn. The State of Maine, federal agencies, NGO partners, and Licensee currently have an exciting opportunity to build on that success by addressing fish passage issues at several dams upstream, including making significant improvements at the Shawmut project. Unfortunately, the current proposed project by the Licensee in the draft Species Protection Plan (SPP) falls far short of the management objectives of MDMR for the Kennebec River.

MDMR appreciates the request for information and will continue to be a resource for the Department of Environmental Protection (DEP) during the water quality certification process. The authorities of the State of Maine for the purposes of ensuring healthy waterways, inclusive of the protection of fisheries resources, are broad through the 401 certification process and applicable state laws.

If you have any questions, please contact Sean Ledwin at 207-624-6348 or by email at sean.m.ledwin@maine.gov.

Sincerely,

Patrick C. Keliher, Commissioner

cc: Jerry Reid, Nick Livesay, Maine DEP
Scott Boak, Mark Randlett, Maine Office of the Attorney General

ATTACHMENTS

Summary

On the basis of our management goals and activities, analysis of river-specific data, and a federal recovery plan (USFWS and NMFS 2019), MDMR finds that the cumulative impacts of the four lowermost hydropower projects in the mainstem Kennebec River, including the Shawmut Project, and the Licensee's draft Species Protection Plan (SPP), 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. MDMR analysis using the best available scientific information indicates that the proposal by the Licensee would preclude the ability to recover Endangered Species Act (ESA) listed Atlantic salmon in the entire Distinct Population Segment (DPS), even under improved marine survival conditions. Without significant improvements to the proposed action, MDMR will be forced to consider discontinuing our stocking and trucking efforts of Atlantic salmon in the Kennebec River in consultation with the United States Fish and Wildlife Service (USFWS) and National Marine Fisheries Service (NMFS). Furthermore, MDMR would like the Licensee to conduct the Shawmut fish passage process under the ongoing licensing (rather than incorporated as an amendment to the existing license) to better incorporate agency and public concerns not considered during the original Interim SPP process. MDMR encourages DEP to bring forward these concerns to the Licensee under the CWA certification consultation process and consider further mandatory conditions in the Shawmut relicensing process beyond the proposed measures in the draft SPP provided by the Licensee.

Goals and Objectives

The 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. The Department's goal is to restore diadromous fish populations in Maine to their historic habitat and to their known or estimated historic abundance. MDMR has the sole authority to issue stocking permits for Atlantic salmon in Maine waters. MDMR has limited resources and must prioritize restoration efforts, including enhancement stocking of Atlantic salmon, in waters with the potential to meet MDMR and federal goals for recovery.

Geographic scope

The geographic scope of our analysis includes the mainstem Kennebec River from its mouth to the Williams Project and two major tributaries, the Sandy River and the Carrabassett River (Table 1). This area encompasses the historic range of 6 species of diadromous fish: the Atlantic salmon, American eel, sea lamprey, alewife, blueback herring, and American shad (Maine State Planning Office 1993).

Status of fish passage on the Kennebec River

The upstream fish passage facility at the **Lockwood Project**, which became operational in 2006, is an interim fish lift that terminates in a trap-and-truck facility. Fish and water are collected in the hopper, lifted, and discharged into a 12-foot diameter sorting tank. River herring (alewife and blueback herring) and American shad are dip-netted into two ten-foot diameter tanks, Atlantic salmon are moved into a 250-gallon isolation tank, and the other species are sluiced downstream. The river herring, shad, and salmon are trucked upstream to spawning habitat by MDMR. An upstream passage facility designed specifically for American eels (ramp) is installed in the bypass in the spring and removed in the fall. All fish can pass downstream via spill, a downstream bypass in the power canal that releases 350 cfs, or through the turbines. An angled boom in the power canal serves to guide fish to the bypass. Pursuant to the draft Species Protection Plan (draft SPP) for the Kennebec River, the Licensee in consultation with the resource agencies is developing drawings for a second technical fishway in the bypass reach. The permanent upstream fish passage facility at the **Hydro-Kennebec Project became operational** in the fall of 2017. The fishway is designed to collect fish and water in hopper, lift and then discharge fish and water into an exit flume that extends 470 feet into the headpond. An upstream passage facility designed specifically for American eels (ramp) is located on the west side of the spillway. The entrance and exit are installed in the spring and removed in the fall. All fish can pass downstream via spill (although spill is rare), through a gate located in the powerhouse forebay that discharges into a large plunge pool, or through the turbines. An angled boom in the forebay serves to guide fish to the bypass.

The **Shawmut Project** currently does not provide upstream fish passage. Prior to the installation in 2009 of a rubber dam on the spillway, permanent upstream eel passage (ramp) was located on the east side of the spillway. Since 2010, interim upstream eel passage (portable ramp) has been installed seasonally between the first section of the hinged flashboards and the Unit 1 tailrace; eels are captured in a bucket and released in the headpond. All fish can pass downstream via an existing sluice, a Tainter gate operated for additional passage flow, lowering of four hinged boards, spill, or through the turbines. Pursuant to the draft SPP, the Licensee in consultation with the resource agencies have developed 90% drawings for a permanent upstream passage facility (fishlift at the upper powerhouse and bypass to connect the lower powerhouse tailrace to the upper powerhouse tailrace), and an angled bar rack to guide downstream migrant to a new bypass.

The **Weston Project** currently does not provide upstream fish passage. An upstream passage facility designed specifically for American eels (ramp) is located on the west side of the south channel dam. All fish can pass downstream via a surface sluice gate and associated floating guidance boom unregulated spill, or through the turbines. Pursuant to the draft SPP, the Licensee in consultation with the resource agencies have developed conceptual drawings for a permanent upstream passage facility (fishlift at the powerhouse).

Concerns with fish passage

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 impede movements and migrations of species, creating potential hazards that impact individual fish and contribute to populations level responses. While these adverse impacts can often be mitigated by properly designed fishways, many fishways fail to perform as intended and result in long term impediments to the growth and survival of target species populations. When there are a series of fishways within a migration coordinator for a species, the risks are increased significantly that one or more underperforming fishways will result in significant cumulative impacts to diadromous fish populations. The cumulative risks of multiple fishways creates the need for highly effective fishways 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 dam removal is either infeasible or not agreed to by the licensee, agencies, or other stakeholders, 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. American shad migrations and associated production potential are significantly reduced or eliminated due to poor passage at hydroelectric dams on the Saco, Kennebec, Androscoggin, Penobscot, and the St. Croix rivers.

Status of Atlantic salmon

The original range of Atlantic salmon was probably about 12 miles above the confluence of the Dead River with the mainstem Kennebec; however, Caratunk Falls (current location of the Williams Project) likely was an impediment to a segment of the population, and the Sandy River and Carrabassett River likely were their principal spawning grounds (Atkins 1887). The construction of the dam at Augusta (Edwards Dam) in 1837-1838 resulted in the extirpation of all anadromous fishes including Atlantic salmon upstream of the dam. Access to the Sandy River is blocked by four hydroelectric projects and access to the Carrabassett River is blocked by six hydroelectric projects.

Endangered Species Act (ESA)

In December 2000, the Gulf of Maine (GOM) distinct population segment (DPS) of Atlantic salmon, originally defined as those naturally reproducing remnant populations from the Kennebec River downstream of the former Edwards Dam site northward to the mouth of the St. Croix River, was listed as endangered (65 FR 69459) by the National Marine Fisheries Service (NMFS) and the U.S. Fish and Wildlife Service (USFWS). In 2009, these federal agencies expanded the geographical area of the GOM DPS (74 FR 29344), and the NMFS delineated three recovery units for the expanded DPS (74 FR 29300). The three Salmon Habitat Recovery Units (SHRUs) were:

- Merrymeeting Bay, which includes the Androscoggin, Kennebec, Sheepscot, Pemaquid, Medomak, and St. George watersheds;
- Penobscot Bay, which includes the entire Penobscot basin and the Ducktrap watershed; and,

- Downeast, which includes all coastal watersheds from the Union River east to the Dennys River.

Interim Species Protection Plans

As a result of the expanded ESA listing, the licensees of the Lockwood, Shawmut, Weston, and Hydro-Kennebec projects initiated consultation with NMFS to obtain Incidental Take Permits under section 7 of the ESA. On January 5, 2011, the Federal Energy Regulatory Commission (FERC) received a request that the Licensee of the Hydro-Kennebec Project be designated as a non-federal representative for informal consultation under section 7 of the ESA; the request was granted on March 14, 2011. On January 31, 2012, the Licensee provided NMFS with a draft Biological Assessment (BA) and interim Species Protection Plan (ISPP), which was subsequently revised in March. On March 26, 2012, the Licensee held a meeting with state and federal resources agencies to present the BA and SPP. The Licensee filed the BA and ISPP with FERC on April 12, 2012, and NMFS issued a Biological Opinion (BO) on September 17, 2012. On January 31, 2013 FERC, received a request that the Licensee of the Lockwood, Shawmut, Weston projects be designated as a non-federal representative for informal consultation under section 7 of the ESA; FERC granted the request on February 7, 2013. Two weeks later, the Licensee submitted the ISSP and draft BA[1] to FERC, and NMFS issued its BO on July 29, 2013. Terms and conditions in the BOs were incorporated into the existing licenses of the four projects (Table 2). Thus, the requirement for operational upstream passage at Shawmut (originally by 2018, now 2021) was exempted from the relicensing process (initiated in 2016), which did not allow for sufficient public or interagency input in the view of MDMR.

The *Recovery Plan for the GOM DPS of Atlantic Salmon (Salmo salar)* identified dams, inadequacy of regulatory mechanisms related to dams, and low marine survival as major threats to the recovery of the species and a number of secondary stressors[2] that collectively constituted a fourth threat (USFWS and NMFS 2018). The Recovery Plan includes the following abundance criteria for down-listing of the GOM DPS from endangered to threatened and for threatened to de-listing the species[3]:

> ***Down-listing:*** 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 having a minimum annual escapement of 500 naturally reared adults.
>
> ***Delisting:*** 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.

The current numbers of wild origin Atlantic salmon that return to Maine rivers are orders of magnitude less than those required to meet ESA recovery standards. Data provided by MDMR and restoration partners, represented in the U.S. Atlantic Salmon Assessment Committee

[1] The ISPP and BA include the Brunswick Project and the Lewiston Falls Project in the Androscoggin River.
[2] Activities or actions that pertain to habitat quality and accessibility, commercial and recreational fisheries, disease and predation, inadequacy of regulatory mechanisms related to water withdrawal and water quality, aquaculture, artificial propagation, climate change, competition, and depleted diadromous fish communities.
[3] The criteria to accomplish recovery or delisting are much more rigorous and can be found in the Recovery Plan.

(USASAC 2019) reports, indicate severe limitations in freshwater production of "naturally reared" fish that would contribute to meeting recovery goals. Available assessments indicate that less than one smolt per unit is typical across Maine rivers and smolt to adult returns of "naturally reared" fish are generally lower than 1%. The recovery of the entire DPS is reliant on the Kennebec River because of the amount of high quality spawning/rearing habitat available in this system compared to other rivers in the SHRU and other rivers statewide. Safe, timely, and highly effective passage on the Kennebec River is essential to meeting recovery goals.

Atlantic Salmon Restoration in the Kennebec

In 2003, MDMR initiated a stocking program in the Sandy River using three life stages of GOM DPS Atlantic salmon. In addition to adult Atlantic salmon returns, which are transported from the Lockwood Project fish lift to the Sandy River and allowed to spawn naturally, MDMR has utilized Penobscot-origin, F2 generation[4] fry and eyed-eggs (Table 3). For five years, eyed-eggs were raised in streamside incubators and released as fry. Since 2004, eyed-eggs have been deposited in man-made redds in the winter, and allowed to develop and emerge naturally. MDMR has continued to stock F2 generation eggs; however, much of the habitat in the Kennebec remains underutilized due to poor adults returns and a limited supply of eggs. MDMR spends extensive state resources on stocking Atlantic salmon eggs and returning adults to the Sandy River (via trucking) and monitoring those populations, keeping the lifeline going for Atlantic salmon in the Kennebec River. Without better passage than is proposed, it would become nearly impossible to recover the species, which would require MDMR to reevaluate its investment in stocking efforts in the Kennebec River in consultation with the other resource agencies. Conversely, if significantly improved passage is secured, there would be a reasonable basis for MDMR to redouble its efforts to invest in Atlantic salmon recovery, including using new aquaculture partnerships and supporting investments in the USFWS hatchery capacity.

Salmon Model

MDMR developed a model for the Kennebec River to evaluate the impact of dams on smolt mortality and to estimate the number of returning adults. Major assumptions of the model were:

- 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 the Biological Valuation of Atlantic salmon habitat (NMFS 2009a).
- 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 head-of-tide in Augusta.

[4] The Kennebec River does not have a dedicated source of broodstock, and relies on Penobscot-origin F2 generation eggs (i.e. Penobscot sea-run fish are spawned in the USFWS hatchery, the offspring (F1 generation) are raised to adults, and the F1 adults are spawned to produce the F2 generation).

- Mortality was 4% at each dam encountered (Kleinschmidt 2019).
- 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 0.5%, 1.0%, and 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.
- Upstream passage efficiency of adults was 95% at each dam (Kleinschmidt 2019).
- The analysis did not included delays at dams during upstream or downstream passage.

Model Results

Estimates of smolt survival and adult returns were made with 6, 4, and 2 mainstem dams in place at low and high smolt production and low, medium, and high marine survival (Tables 4, Table 5, and Table 6). The removal of the lower 4 dams would result in 89% more adult returns compared to the current proposal (Figure 1). Under a high smolt high marine survival scenario, the loss of adult returns comparing the proposed action to the removal of four dams, would be over 1,500 naturally reared adults, more than the entire run for the State of Maine in most years (https://www.maine.gov/dmr/science-research/searun/programs/trapcounts.html). Under the current proposal, even with high freshwater survival and high marine survival, the number of adult returns would fall short of the 2,000 recovery target. The proposed action was the only alternative that did not reach even down-listing abundance targets under the current average marine survival for naturally reared fish. Given the assumptions that all available habitat would be stocked to capacity, the inability to meet recovery goals under the model's favorable conditions is very problematic. The excel based model results are provided as Attachment A and the excel model can be made available upon request.

Comparison of the Penobscot SPP and Kennebec draft SPP

Before implementation of the Lower Penobscot Settlement Accord (Accord), 74% of Atlantic salmon spawning and rearing habitat was above 4-7 dams[5]. After implementation of the Accord, which included removal of Veazie Dam and Great Works Dam, decommissioning of the Howland Dam, and construction of a natural-like bypass around the Howland Dam, 99% of the habitat was above 1-3 dams. The subsequent Penobscot SPP (2009) included the following performance standards:

- 95% of upstream migrating salmon have to pass the Milford and West Enfield project dams within 48 hours of approaching within 200 meters of the tailrace;
- 96% of out-migrating Atlantic salmon smolts and kelts, based on a 75% confidence interval, must safely pass the Stillwater, Orono, Milford and West Enfield project dams

[5] Habitat units from MDMR and MDIFW (2009), Appendix C.

within 24 hours of approaching within 200 meters of the project trashracks[6].

The Kennebec draft SPP proposes less stringent performance standards than the Penobscot SPP despite the fact that 76% of the spawning and rearing habitat in the Kennebec is above 4-6 dams. Rather than proposing that each project meet the downstream standard of 96% passage within 48 hours, the draft SPP proposes a cumulative "end-of-pipe" standard in which at least 84.9% ($=0.96^4$) of smolts must pass all four projects with a cumulative project residence time of no more than 96 hours. Similarly, rather than an upstream performance standard for each project, the draft SPP proposes a cumulative "top-of-pipe" standard in which at least 81.4% ($=0.95^4$) of adults must pass all four projects with a goal of having salmon that pass the Lockwood Project by September 30 pass the Weston Project no later than October 15. As written, an adult that passed Lockwood on June 3 could be delayed by as many as 134 days before passing Weston. These cumulative standards allow poorer performing projects to be subsidized by better performing ones (Table 7). The MDMR model indicates that the Kennebec River out-migrating salmon smolts would require higher standards than the Penobscot, not lower standards, based on the best available information.

Other species

Five other native species of diadromous fishes historically utilized habitat above Taconic Falls, the current location of the Lockwood Project. Alewife, blueback herring, and American shad ascended as far as Norridgewock Falls (Atkins 1887), current location of the Abenaki Project and Anson Project. The upstream limit of American eel and sea lamprey was not documented by Atkins (1887), but these species likely were able to ascend the river at least as far upstream as Atlantic salmon. Approximately 31% of historical spawning habitat that was accessible to alosines (American shad, blueback herring, and alewife) is upstream of the Lockwood Project. MDMR has estimated that this habitat could produce more than 2.6 million fish (Table 8).

Fish passage

The effectiveness of the existing upstream and downstream passage facilities at Lockwood has never been tested for the Alosines (alewife, blueback herring, and American shad) and sea lamprey. The effectiveness of interim downstream passages facilities at Hydro-Kennebec, Shawmut, and Weston projects has never been tested for Alosines and sea lamprey. The effectiveness of the existing upstream passage facilities at all four projects and the existing downstream passage facilities at Lockwood, Shawmut, and Weston has been tested for American eel.

MDMR has identified four problems with the existing upstream passage facility at Lockwood. First, the trap-and-truck part of the facility was not designed to accommodate the hundreds of thousands of fish that are now returning (Table 9), and it has become a bottleneck. The lifting cycle must stop when the three sorting tanks are full of fish (about 8,000 river herring at 18°C),and cannot resume until MDMR returns with an empty truck (round-trip travel for the Hydro-Kennebec and Shawmut headponds are 30 and 60 minutes, respectively). Thus, the number of fish, including endangered Atlantic salmon, that can be captured and transported in a day is limited. Second, few American shad have used the Lockwood fish lift in 19 years (Table 9), and the majority of those that did use the fish lift (98%) have done so when discharge was at

[6] Additional measures (usually increased spill) were recommended if this standard was not met.

or below the station hydraulic capacity. The safe, timely, and effective upstream and downstream passage of American shad remains problematic coastwide (Haro and Castro-Santos 2012). Third, the proposed fishway in the bypass will likely eliminate the existing upstream eel fishway and may not be passable for small yellow eels. Fourth, the fish lift, which only operates during the day, passes very few sea lamprey, which are mostly active at night.

Performance standards

In several recent relicensing proceedings (e.g. American Tissue, No. 2809), FERC has argued in its Environmental Assessment that there is no justification for the resource agencies (MDMR, USFWS, and NMFS) recommending studies to test the effectiveness of new fish passage facilities, because they did not include any specific performance standards that would need to be met. As a result, the resource agencies have been discussing the need for developing performance standards for a number of diadromous species. Stitch et al. (2019) developed a stochastic life-history based model for American shad to estimate the effects of dam passage and migratory delay on abundance, spatial distribution of spawning adults, and demographic structuring in space and time in the Penobscot River. A minimum downstream passage performance standard of about 0.90 was required for the simulated population to reach a mean abundance of 633,000 fish after 41–50 years for 24 h passage time, and a minimum downstream standard of 0.98 was needed under the 48 h upstream passage scenario. Because the number of American shad passing upstream at the Lockwood Project has remained low for more than a decade, MDMR is currently working with Dr. Stich to develop a shad passage model specifically for the Kennebec River.

Ongoing Collaboration

Since the fall of 2017, the Licensee has been consulting with the state and federal resource agencies to consider an alternative multi-dam approach to improve fish passage on the Kennebec River. The Licensee and the agencies agreed to develop and conduct an independent feasibility assessment to explore a range of fish passage options at Lockwood, Hydro-Kennebec, Shawmut, and Weston Projects that included but were not limited to the options currently proposed in the ISPP. The feasibility study was completed and released in October 2018. MDMR believes the most prudent course for the Licensee would be to propose significant improvements at each project and continue multi-party discussions to achieve the best desired outcome for all parties.

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Table 1. Location of hydropower projects and major tributaries relative to the mouth of the Kennebec River and available fish passage at each hydropower project.

Project or tributary	FERC Number	River mile	Anadromous passage	Catadromous passage
Wyman	2329	121.3		
Williams	2335	112.5		
Carrabassett River		103.3		
Anson	2365	97.5		Upstream, downstream
Abenaki	2364	96.8		Upstream, downstream
Sandy River		94.9		
Weston	2325	83.4	Downstream	Upstream, downstream
Shawmut	2322	69.7	Downstream	Upstream, downstream
Hydro-Kennebec	2611	64.2	Downstream	Upstream, downstream
Lockwood	2574	63.0	Downstream	Upstream, downstream

Table 2. Required activities pursuant to the License amendments pursuant to the ESA and relevant ISPPs. A star (*) indicates original dates were extended.

Year	Project	Activity
2012	Hydro-Kennebec	Develop ISPP and draft BA, BA issued, BO and ITP issued
2012-2014	Hydro-Kennebec	Downstream smolt studies, design new upstream passage
2014-2015	Hydro-Kennebec	Develop SPP, BO and ITP for period 2016-2036
2015	Hydro-Kennebec	Expect construction of upstream passage
2016	Hydro-Kennebec	Expect operational upstream passage
2013	Lockwood et al.	Develop ISPP and draft BA, BA issued, BO and ITP issued
2013-2015	Lockwood	Downstream smolt studies
2014	Lockwood	Design volitional upstream passage component
2015	Lockwood	Expect construction of volitional upstream passage component
2016	Lockwood	Expect operational upstream passage
2016-2017	Lockwood	Upstream salmon passage studies
2013-2015	Shawmut	Downstream smolt studies
2016	Shawmut	Design new upstream fish passage facility
2016	Shawmut	Start relicensing
2017	Shawmut	Expect construction of upstream fish passage
2018	Shawmut	Expect operational upstream passage
2013-2015	Weston	Downstream smolt studies
2018	Weston	Design new fish passage facility
2019	Weston	Expect construction of upstream fish passage
2020	Weston	Expect operational upstream passage
2019	Lockwood et al.	Develop SPP, BO, and ITP for period 2020-2036?
2021*	Shawmut	Expect operational upstream passage
2022*	Lockwood	Expect operational upstream passage
2022*	Weston	Expect operational upstream passage

Table 3. Summary of age classes stocked annually and annual adult returns and proportion that are naturally reared.

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 4. Results of model of Atlantic salmon smolt survival and adult returns with 6 mainstem dams in place at high and low smolt production in all spawning/rearing habitat and high, medium, and low marine survival.

	Dams on Kennebec River (Six Dams): Anson, Abenaki, Weston, Shawmut, Hydro-Kennebec, and Lockwood							
		Carra-bassett Low Smolt	Carra-bassett High Smolt	Williams Low Smolt	Williams High Smolt		Sandy Low Smolt (4 dams)	Sandy High Smolt (4 Dams)
Reach	Starting	26,977	80,931	11,957	35,871		43,137	129,411
Reach	Survive to Anson	23,069	69,207	11,040	33,119			
Reach	Survive Anson	22,146	66,438	10,598	31,794			
Reach	Survive Abenaki	21,260	63,781	10,174	30,522			
Reach	Survive to Weston	19,724	59,171	9,439	28,316		26,638	79,915
Reach	Survive Weston	18,935	56,804	9,061	27,184		25,573	76,719
Reach	Survive to Shawmut	17,623	52,868	8,433	25,300		23,801	71,402
Reach	Survive Shawmut	16,918	50,753	8,096	24,288		22,849	68,546
Reach	Survive to HK	16,393	49,179	7,845	23,535		22,140	66,420
Reach	Survive HK	15,737	47,212	7,531	22,593		21,254	63,763
Reach	Survive to Lockwood	15,623	46,869	7,476	22,429		21,100	63,300
Reach	Survive Lockwood	14,998	44,994	7,177	21,532		20,256	60,768
Reach	Survive to Augusta	13,647	40,941	6,531	19,592		18,431	55,293
Reach	Survive to MMB exit	4,980	14,939	2,383	7,149		9,147	27,442
	% survival to MMB exit	18%	18%	20%	20%		21%	21%
	Adult returns given marine survival scenarios (Low MS, medium MS, high MS)							
Low M	Adult returns to MMB	25	75	12	36		46	137
Low M	Adults returns to spawning habitat	18	55	9	26		37	112
Medi	Adult returns to MMB	50	149	24	71	0	91	274
Medi	Adults returns to spawning habitat	37	110	18	53	0	75	224
High	Adult returns to MMB	199	598	95	286	0	366	1,098
High	Adults returns to spawning habitat	146	439	70	210	0	298	894
	Total adult returns to spawning habitat							
		Low Smolt	High Smolt					
	Low Marine Survival (0.5%)	64	193					
	Medium Marine Survival (1.0%)	129	386					
	High Marine Survival (4.0%)	515	1,544					

Table 5. Results of model of Atlantic salmon smolt survival and adult returns with 4 mainstem dams in place at high and low smolt production in all spawning/rearing habitat and high, medium, and low marine survival.

	Dams on Kennebec River (Four Dams): Anson, Abenaki, Weston, and Hydro-Kennebec							
		Carra-bassett Low Smolt	Carra-bassett High Smolt	Williams Low Smolt	Williams High Smolt		Sandy Low Smolt (2 dams)	Sandy High Smolt (2 Dams)
Reach	Starting	26,977	80,931	11,957	35,871	0	43,137	129,411
	Survive to Anson	23,069	69,207	11,040	33,119	0		
	Survive Anson	22,146	66,438	10,598	31,794	0		
	Survive Abenaki	21,260	63,781	10,174	30,522	0		
	Survive to Weston	19,724	59,171	9,439	28,316	0	26,638	79,915
	Survive Weston	18,935	56,804	9,061	27,184	0	25,573	76,719
	Survive to Shawmut							
	Survive Shawmut							
	Survive to HK	17,035	51,106	8,152	24,457	0	23,007	69,022
	Survive HK	16,354	49,062	7,826	23,478	0	22,087	66,261
	Survive to Lockwood							
	Survive Lockwood							
	Survive to Augusta	14,762	44,285	7,064	21,193	0	19,937	59,811
	Survive to MMB exit	7,326	21,979	3,506	10,518	0	12,340	37,019
	% survival to MMB exit	27%	27%	29%	29%		29%	29%
MS	Adult returns given marine survival scenarios (Low MS, medium MS, high MS)							
Low	Adult returns to MMB	37	110	18	53	0	62	185
	Adults returns to spawning habitat	30	90	14	43	0	56	167
Medi	Adult returns to MMB	73	220	35	105	0	123	370
	Adults returns to spawning habitat	60	179	29	86	0	111	334
High	Adult returns to MMB	293	879	140	421	0	494	1,481
	Adults returns to spawning habitat	239	716	114	343	0	445	1,336
	Total adult returns to spawning habitat							
		Low Smolt	High Smolt					
	Low Marine Survival (0.5%)	100	299					
	Medium Marine Survival (1.0%)	200	599					
	High Marine Survival (4.0%)	798	2,395					

Table 6. Results of model of Atlantic salmon smolt survival and adult returns with 2 mainstem dams in place at high and low smolt production in all spawning/rearing habitat and high, medium, and low marine survival.

	Dams on Kennebec River (2 Dams): Anson and Abenaki							
		Carra-bassett Low Smolt	Carra-bassett High Smolt	Williams Low Smolt	Williams High Smolt		Sandy Low Smolt (no dams)	Sandy High Smolt (no Dams)
Re	Starting	26,977	80,931	11,957	35,871	0	43,137	129,411
	Survive to Anson	23,069	69,207	11,040	33,119	0		
	Survive Anson	22,146	66,438	10,598	31,794	0		
	Survive Abenaki	21,260	63,781	10,174	30,522	0		
	Survive to Weston							
	Survive to Augusta	15,521	46,564	7,428	22,283	0	18,112	54,335
	Survive to MMB exit	9,607	28,820	4,597	13,792	0	15,192	45,577
	% survival to MMB exit	36%	36%	38%	38%		35%	35%
	Adult returns given marine survival scenarios (Low MS, medium MS, high MS)							
Low N	Adult returns to MMB	48	144	23	69	0	76	228
	Adults returns to spawning habitat	43	130	21	62	0	72	216
Mediu	Adult returns to MMB	96	288	46	138	0	152	456
	Adults returns to spawning habitat	87	260	41	124	0	144	433
High I	Adult returns to MMB	384	1,153	184	552	0	608	1,823
	Adults returns to spawning habitat	347	1,040	166	498	0	577	1,732
	Total adult returns to spawning habitat							
		Low Smolt	High Smolt					
	Low Marine Survival (0.5%)	136	409					
	Medium Marine Survival (1.0%)	273	818					
	High Marine Survival (4.0%)	1,090	3,270					

Table 7. Results of the downstream smolt passage studies conducted between 2013 and 2016 at four hydropower facilities on the mainstem Kennebec River including project, annual, and 3-year end of pipe (EOP) averages.

	Downstream survival			
Project	Year 1	Year 2	Year 3	Project average
Weston	95.7	89.5	100.0	95.1
Shawmut	96.3	93.6	90.6	93.5
Hydro-Kennebec	94.7	94.1	90.0	92.9
Lockwood	100.0	97.7	98.0	98.6
Year average	96.7	93.7	94.7	
3-year EOP average				95.0

Table 8. Amount of spawning and rearing habitat and estimated adult production of Alosines above the Lockwood Project.

Habitat	Surface area (acres)	American shad	Blueback herring	Alewife
Lockwood to Hydro Kennebec				
Hydro Kennebec to Shawmut	523	29,111	253,135	
Shawmut to Weston	1,266	70,439	612,514	
Weston to Abenaki	1,025	57,058	496,156	
Sandy River to Rt 4 bridge	881	49,016	426,223	
Wesserunsett Lake	1,446			339,810
Norcross, Clearwater, North, Parker ponds	1,171			275,185
Total	6,311	205,624	1,788,029	614,995

Table 9. Annual number of river herring (alewife and blueback herring) and American shad passed at the Lockwood Project fish lift, 2007-2018.

Year	River herring	American shad
2006	3,152	
2007	4,537	66
2008	91,964	
2009	45,436	
2010	75,114	28
2011	31,094	
2012	156,449	
2013	95,326	
2014	108,282	1
2015	89,502	26
2016	206,971	830
2017	238,493	201
2018	238,953	275

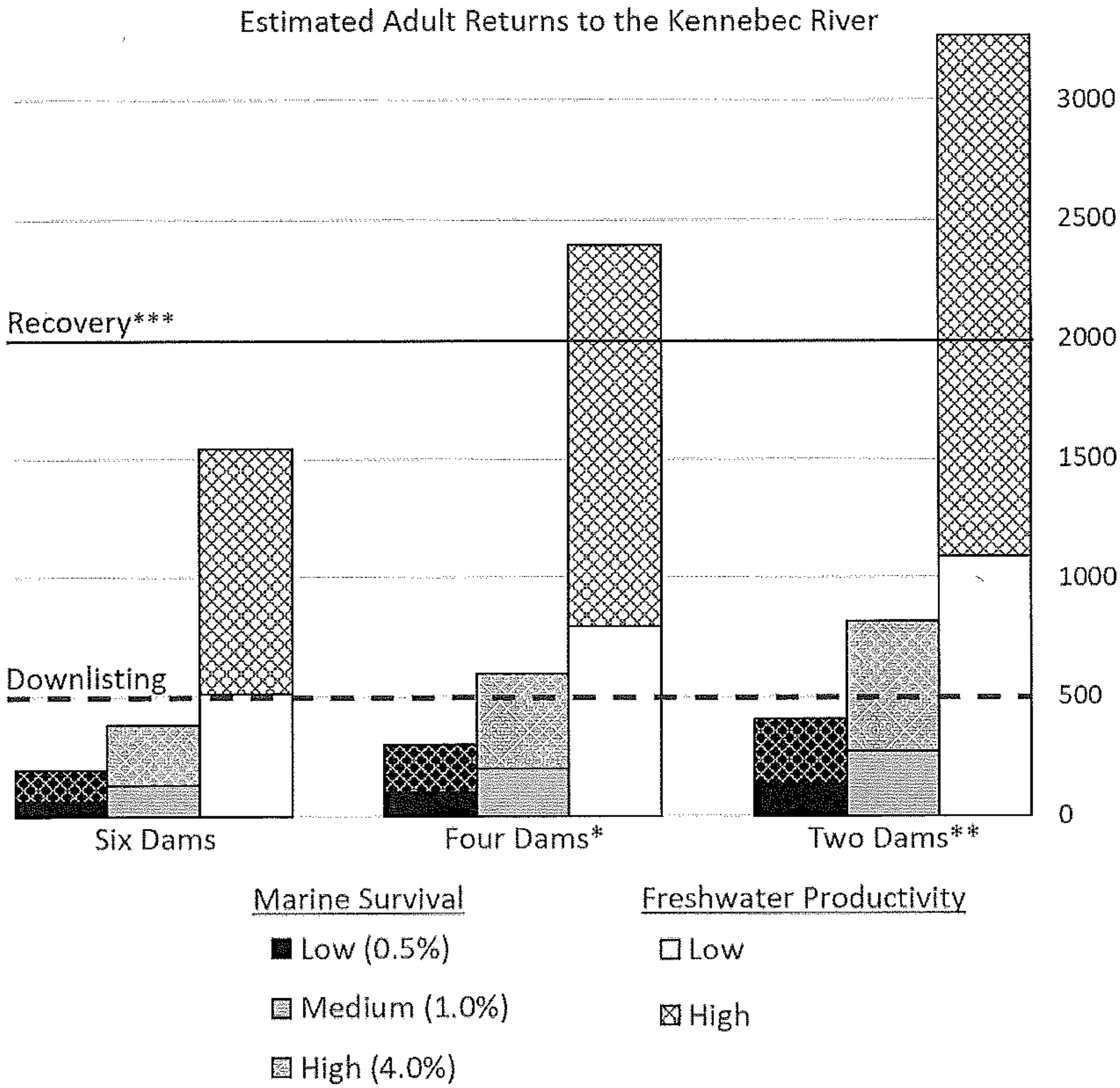

Figure 1: Estimated adult returns to the Kennebec River given realistic scenarios of marine survival and freshwater productivity as a function of number of mainstem dams on the river. *Four dam scenario assumes Shawmut and Lockwood have been removed. **Two dam scenario assumes Weston, Shawmut, Kennebec Hydro, and Lockwood have been removed. ***Recovery here is represented as the numerical target for abundance yet other criteria must also be met (USFWS and NMFS 2019).