Appendix 13

MDMR Kennebec Plan Amendment (December 2020)

Kennebec River Management Plan
Diadromous Resources Amendment

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* Photo Credit: Sandy River holding pool with Atlantic salmon trucked by MDMR above four hydroelectric dams.

Contents

1. Introduction
1.1 Purpose

This Amendment updates the 1993 Kennebec River Resource Management Plan (1993 Plan) that guided the restoration of anadromous fishes in the Kennebec River from 1993 to 1998. The goals of the 1993 Plan were to:

1. 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 Lockwood Project by removing Edwards Dam;
2. Restore and enhance American shad populations in the Kennebec River by achieving an annual production of 725,000 shad above Augusta; and
3. Restore and enhance alewife populations in the Kennebec River by achieving an annual production of 6.0 million alewives above Augusta.

Strategies to achieve the goals included:

1. Removing Edwards Dam;
2. Stocking alewife and American shad into selected habitat above the Edwards Dam; and
3. Requiring fish passage on a schedule beginning in 1999 at four mainstem dams in the Kennebec River (Lockwood, Hydro Kennebec, Shawmut, Weston), three in the Sebasticook River (Fort Halifax, Benton Falls, Burnham)[2], and one in the Sandy River (Madison Electric Works).

Significant progress in the restoration of diadromous fish to some parts of the Kennebec River has been made in the intervening 27 years (Table 1). 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, and American shad and blueback herring free access to about 21% of their historic spawning habitat. In addition, the reach between the old Edwards Dam site and Lockwood Dam now supports the greatest abundance and biomass of American eel above the head-of-tide (Yoder et al. 2006).

Restoration in the Sebasticook River has been spectacular. By 2003, the Maine Department of Marine Resources (MDMR) and its partners had provided upstream fish passage at four non-hydropower dams in the Sebasticook River (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 2), and this self-sustaining run of river herring (alewife and blueback herring) is the largest on the east coast (Wippelhauser in review). Upstream and downstream eel passage was also provided at the three projects in the Sebasticook River and to date nearly 900,000 yellow eels have been passed upstream.

Restoration of Atlantic salmon, American shad, blueback herring, alewife, and sea lamprey has lagged on the mainstem Kennebec River, primarily because of the lack of upstream fish passage. This situation is particular critical for the endangered Gulf of Maine (GOM) Distinct Population

[2] Licensees of the Lockwood, Hydro Kennebec, Shawmut, Weston, Fort Halifax, Benton Falls, and Burnham projects formed the Kennebec Hydro Developers Group (KHDG) in 1995 and were signatories to the 1998 Settlement Agreement.

Segment (DPS) of Atlantic salmon, one of the most iconic and imperiled species in the United States. All high-quality spawning habitat for Atlantic salmon lies above 4 dams (Sandy River) or 6 dams (Carrabassett River and mainstem Kennebec River) and restoring runs into the Kennebec River in sufficient numbers is essential to meet recovery goals for the entire species statewide (USFWS and NMFS 2019). About 60% of American shad and blueback herring historic spawning habitat is above the Lockwood and Hydro Kennebec projects, and 10% of alewife historical spawning habitat is above the Shawmut Project (Table 3; Table 4). Sea lamprey habitat above these projects exceeds 90% of presumed historic habitats. Significant underutilized habitat exists for American eel.

The MDMR will submit this document to the Federal Energy Regulatory Commission (FERC) as a Comprehensive Management Plan Amendment. Briefly this amendment expands the target species to include all of Maine's native diadromous fish; updates descriptions of the physical, biological, and ecological conditions in the watershed; revises goals, objectives, and actions for restoration in the Kennebec River; provides a rational for the decommissioning and removal of dams; and provides performance standards for target species when available. This Amendment will be updated or expanded upon in the future as appropriate.

1.2 Scope

This amendment focuses on the regions of the Kennebec River basin that were inhabited by diadromous fishes before the construction of dams, specifically the: Kennebec River from the outlet of Wyman Lake to the Gulf of Maine, Carrabassett River, Sandy River, Sebasticook River, Messalonskee Stream; Seven Mile Stream; and Cobbosseecontee Stream (Table 5; Figure 1).

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, that act as a barrier to fish movement in the river.

1.3 MDMR role

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.

1.4 Existing Comprehensive Plans

Our goals, objectives, and recommended actions are guided by our mission and the following comprehensive plans that have been approved by the FERC:

1.4.1 Pertinent goals of the Kennebec River Resource Management Plan (MSPO 1993) have already been described.

1.4.2 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[3] habitat that do not presently support natural spawning migrations, expand existing stock restoration programs, and initiate new programs to enhance depressed stocks.

1.4.3 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.

1.4.4 The Recovery Plan for the Gulf of Maine Distinct Population Segment of Atlantic Salmon (*Salmo salar*) (USFWS and NMFS 2019) includes the following goals, objectives and criteria for the reclassification and delisting of the GOM DPS of Atlantic salmon:

The overall goal of this recovery plan is to remove the GOM DPS of Atlantic salmon from the Federal List of Endangered and Threatened Wildlife. The interim goal is to reclassify the DPS from endangered to threatened status.

Reclassification Objectives – Maintain sustainable, naturally reared populations with access to sufficient suitable habitat in at least two of the three SHRUs, and ensure that management options for marine survival are better understood. In addition, reduce or eliminate those threats that, either individually or in combination, pose a risk of imminent extinction to the DPS.
Delisting Objectives – Maintain self-sustaining, wild populations with access to sufficient suitable habitat in each SHRU, and ensure that necessary management options for marine survival are in place. In addition, reduce or eliminate all threats that, either individually or in combination pose a risk of endangerment to the DPS.

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

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.

The 2009 listing rule called particular attention to three major threats to Atlantic salmon: dams, inadequacy of regulatory mechanisms related to dams, and low marine survival.

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

The four comprehensive plans consider the economic and social value of diadromous fish for the public, and they collectively recognize the reduced abundance and 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 1993 Plan (MSPO 1993) recommended the removal of Edwards Dam to restore and enhance populations of shortnose sturgeon, Atlantic sturgeon, striped bass,

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[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 The Merrymeeting Bay SHRU includes the Kennebec, Androscoggin, Sheepscot, Pemaquid, Medomak, and St. George watersheds.

and rainbow smelt to historical habitat in the Kennebec River. The Recovery Plan (USFWS 2019) states that dam removal might be necessary for the reclassification or delisting of the endangered Atlantic salmon.

1.5 Background of diadromous fish in the Kennebec River watershed

Foster and Atkins (1868) and Atkins (1887) reported that four species of anadromous fish (shortnose sturgeon, Atlantic sturgeon, striped bass, and rainbow smelt) historically did not migrate past Taconic Falls where the Lockwood Project is located (Table 5). Since the Edwards Dam was removed in 1999, these four species have been able to freely access all their historical habitat in the Kennebec River. Rainbow smelt have been captured in the Lockwood fish lift in spring, but the fish have not been sampled to determine whether they are an anadromous or landlocked population.

Six species (Atlantic salmon, American shad, blueback herring, alewife, American eel, and sea lamprey) historically migrated farther upstream, and this habitat is currently blocked by multiple hydropower dams (Table 5). Foster and Atkins (1868) and Atkins (1887) reported that Atlantic salmon ascended many miles in the Carrabassett River and the Sandy River, and these two rivers probably were there principal spawning grounds; however, the upstream limit of Atlantic salmon was probably about 12 miles above the Forks (confluence of the Kennebec River and Dead River) and at Grand Falls on the Dead River. Foster and Atkins (1868) and Akins (1887) also 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. It is likely their close relative, the blueback herring, had the same range. The historic upstream limit of American eel and sea lamprey is not known, but American eels currently are found in the Williams Project impoundment and sea lamprey generally occupy large river and tributary habitats with extents similar to Atlantic salmon.

2. Description of the watershed

The Kennebec River basin, located in west central Maine, has a total drainage area of 5,893 square miles, constituting almost one-fifth the total area of the State of Maine. The Androscoggin River basin lies to the west, the Penobscot River basin to the north and east, and a section of the Maine coastal area to the south. The northwesterly limit of the basin forms a part of the international boundary between the United States and Canada. The basin has a length in the north-south direction of 149 miles and a width of 72 miles. The upper two-thirds of the basin, generally above Waterville, is hilly and mountainous, being part of the Appalachian Mountain Range. The lower third of the basin, including the Sebasticook River and Cobbosseecontee Stream tributary areas, has a gentler topography representative of the coastal area. The Kennebec River Basin lies in a large section of Somerset County, the eastern part of Franklin County, most of Kennebec County, and smaller portions of Penobscot, Waldo, Sagadahoc, and Androscoggin Counties.

2.1 Land use and development

Acres of Land Cover Types from the National Land Cover Dataset 2011 were summarized for the HUC 8 and nested HUC 10 watersheds for the Kennebec River (J. Royte, The Nature Conservancy). The (A) Lower Kennebec HUC 8 summary encompassed 892,433 hectares in the Kennebec River from Merrymeeting Bay to the Wyman Dam, Cobbosseecontee Stream, Sebasticook River to Pittsfield, Messalonskee Stream, Austin Stream, Sandy River and Carrabassett River. The (B) Upper Kennebec River HUC 8 summary encompassed 410,833 hectares in the Kennebec River above the Forks, Brassua Lake, Moose River above Attean Pond, Moose River at Long Pond, South Branch Moose River, and Moosehead Lake. The (C) Dead River HUC 8 summary encompassed 227,766 hectares in the Dead River mainstem, Flagstaff Lake, North Branch Dead River, and South Branch Dead River. In addition to the summaries, cover types for the Sandy River and Carrabassett River were developed.

The five diadromous species that are the focus of this Amendment only inhabit the Lower Kennebec River, defined as the Kennebec River and its tributaries from Merrymeeting Bay to Wyman Dam. The three major areas (A, B, and C) are primarily forested with mixed forest, evergreen forest, and deciduous forest accounting for 65-71% of the land use type (Table 6). Forest cover is higher in the Sandy River and the Carrabassett River, both major spawning habitat for Atlantic salmon. Wetlands, Shrub/scrub, and grassland cover 22-33% of the three major areas, while developed land, farmland, and barren land accounts for 3-13% of the land use. The Lower Kennebec River encompassed the greatest amount of developed land.

2.2 Hydropower projects

Hydropower projects approved by the Federal Energy Regulatory Commission (FERC) operate under the terms of a license or an exemption (Maine DEP 2007). Licenses are issued under the Federal Power Act for the development or continued operation of non-federal waterpower projects. Licenses are valid for a maximum of 50 years. Under FERC's regulations, a licensee must file to relicense a project no later than 2 years prior to the license expiration date. When a license expires, FERC may deny license renewal, issue a new license to the original licensee or a new licensee, or recommend to Congress that the United States acquire the project. If action has not been taken by the license expiration date, the project will operate on an annual license until relicensing action is taken. Exemptions from the licensing provisions of the Federal Power Act are issued in perpetuity for the development of non-federal waterpower projects having a capacity of 5,000 KW or less and utilizing an existing dam or natural water feature. Exemptions are subject to conditions imposed by fish and wildlife agencies

Three hydropower projects have been decommissioned and removed since the 1993 Plan was issued. Edwards Dam, removed in 1999, was the lowermost dam on the Kennebec River. Madison Electric Works, which was the lowermost dam on the Sandy River, was removed in 2006. Fort Halifax, removed in 2008, was the lowermost dam on the Sebasticook River.

Currently there are 22 federally approved hydropower projects, representing 27 dams, on the Kennebec River and its tributaries. Of these, 16 federally approved projects (18 dams) lie within the historical range of Maine's native diadromous fishes (Table 4; Table 7). Twelve projects currently operate under a license terms and four under the terms of an exemption.

<u>2.3 Status of fish passage at hydropower projects</u>

Lockwood–The upstream fish passage facility at the Lockwood Project became operational in 2006 pursuant to the 1998 Settlement. It is an interim fishlift 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. Downstream passage is provided 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 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 upstream passage facility at Lockwood Project was never converted to a permanent 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 2). Ultimately, the listing of Atlantic salmon and the resulting ISPP became the trigger for providing permanent upstream passage at the four mainstem dams. The current license requires the Licensee to provide an upstream fish passage to be operational by May 1, 2022.

Hydro Kennebec–The permanent upstream fish passage facility at the Hydro Kennebec Project, a fish lift, became operational in the fall of 2017. Fish and water are collected in the hopper, lifted, and discharged 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. Downstream passage is provided 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.

Shawmut– Pursuant to the ISPP and the current license, the Licensee is required to provide an upstream fish passage to be operational by May 1, 2022. Permanent upstream eel passage (ramp) was operational on the east side of the spillway until the installation of a rubber dam on the spillway in 2009 that eliminated attraction to the area. Since 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. Water released at this location to provide additional downstream passage for Atlantic salmon smolts may interfere with upstream eel passage as evidenced by declines in upstream migrants from 2016 to 2018. In 2019, a second upstream eel passage, similar in design to the other ramp, was installed adjacent to the forebay plunge pool

Downstream passage is provided via a surface weir (sluice), a Tainter gate, hinged flashboards, the turbines or spillway. 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 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 (Next Era Energy 2009) on the downstream passage of American eel found that passage via the deep gate increased with higher flow through the gate when Units 7-8 were turned off (58.3% at 207 cfs and 83.5% at 425 cfs), immediate survival (not defined) increased with the higher flow, and immediate survival of eels passing through Units 1-6 was 90% (9 of 10). Survival of eels not entering the forebay was not described. In 2009, the Licensee 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.

Weston–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. Downstream passage is provided via a surface sluice gate and associated unregulated spill, or through the turbines. The current license requires the Licensee to provide an upstream fish passage to be operational by May 1, 2022.

Abenaki and Anson–These two projects, separated by 0.76 river miles, have the same owner and were licensed together. Both projects currently have upstream and downstream passage facilities for American eel, and both have the same license requirements for upstream and downstream passage for Atlantic salmon. Briefly,[5] interim downstream passage is to be to be operational at each project two years after the Licensee receives written notice from MDMR and the U.S. Fish and Wildlife Service (USFWS) that sustained annual stocking of Atlantic salmon above the projects has begun or will begin within two years. Permanent upstream passage is to be operational at each project within two years after the Licensee receives written certification from the MDMR and USFWS that 226 adult Atlantic salmon originating from the Kennebec River and obtained from the Lockwood fishlift or other lower Kennebec River trap and truck facility have been released into the Kennebec River watershed above the Weston dam in any single season. In no event, however, will permanent upstream and permanent downstream passage for Atlantic salmon be required to be operational prior to May 1, 2020.

[5] The licenses contain additional details regarding fish passage for Atlantic salmon.

Benton Falls–The Benton Falls Project currently has a permanent upstream fish passage facility for anadromous species (a fish lift), a permanent upstream passage facility for American eel (ramp), and a permanent downstream fish passage facility (bypass with two surface-openings; full-depth 1-inch clear screening deployed from September 1 – October 31 to exclude American eel). The fish lift was designed to pass 600,000 alewife (per MDMR), but has passed as many as 5.2 million river herring in one season.

Burnham–The Burnham Project currently has a permanent upstream fish passage facility for anadromous species (a fish lift), a zone-of-passage channel connecting the tailrace to the bypass reach (for upstream migrants attracted to turbine outflow), a permanent upstream passage facility for American eel (ramp), a permanent downstream fish passage facility for anadromous species (surface bypass and 1-inch clear screening on penstock intake), and permanent downstream fish passage for American eel downstream.

Pioneer and Waverly–These two exempt projects are owned by the town of Pittsfield. Both projects have license requirements to provide upstream and downstream fish passage when required by the MDMR or other resource agencies. Neither project currently has an upstream fish passage facility, but both provide a downstream passage that does not meet current USFWS standards.

Messalonskee Lake, Oakland, Rice Rips, Automatic, and Union Gas–These four projects (five dams) currently have upstream eel passage facilities that were installed and tested between 2011 and 2018 as a condition of their Low Impact Hydropower Institute (LIHI). From 2012 through 2019, the Licensee annually provided interim downstream passage (trap-and truck) that was intended to provide safe passage while obtaining information about the timing of the eel outmigration in the Messsalonskee drainage. However, only 6 eels were caught during the time period. The Licensee instituted nighttime shutdowns of all the projects in 2020 to provide downstream passage for American eel.

American Tissue–This project was relicensed in 2019. During the summer and fall of 2020 the Licensee installed a new upstream eel passage (ramp) and upgrading the downstream passage facility for American eel (bottom opening bypass) and the separate facility for anadromous fish.(surface sluice).

2.4 Fish passage testing and performance standards

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 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 diadromous 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 these fish populations. This potential for cumulative impacts creates the need for highly effective fish passage at each of the dams that meet agency design and performance standards.

To ensure that minimum restoration goals for the Kennebec River are met, the new fish passage facility at the Hydro Kennebec Project and the facilities that have been proposed for the Lockwood, Shawmut, and Weston projects (to be operational by May 1, 2022) will need to be improved and tested for their effectiveness in passing adult and juveniles stages of Atlantic salmon, American shad, blueback herring, alewife, sea lamprey, and American eel during their upstream and downstream migrations. In a report that analyzed mitigation (fish passage) at hydropower projects, FERC (2004) acknowledged the impacts of the projects on fish populations and the importance of testing the effectiveness of fish passage facilities and also recognized the use of modeling tools for assessing management actions and fish passage improvements at multiple projects.

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; Stich et al. 2019). 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.

In response to recent FERC filings, MDMR has developed performance standards in this Amendment for five species, Atlantic salmon, American shad, blueback herring, alewife, and sea lamprey, that are described and justified in sections 3.5-3.9. Highly effective fish passage for American eel should also be incorporated into fish passage infrastructure and management of hydropower project operations. In the Environmental Analysis of three recent relicensing proceedings (e.g. American Tissue FERC No. 2809-034; Barker Mills FERC No. 2808; Ellsworth FERC No. 2727-092), the FERC did not supported recommendations made by the resource agencies for effectiveness testing of all new fish passage facilities. One reason for the lack of support was the lack of specific performance standards by which the effectiveness testing will be evaluated.

In most cases, dam removal is the most effective fish passage strategy and reduces the cumulative impacts of multiple projects. When the need to meet 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. Diadromous species are often impacted significantly by a single improperly working fishway in a given watershed. For example, American shad distribution and abundance in a watershed is significantly reduced or eliminated due to poor passage at hydroelectric dams on the Kennebec, Androscoggin, Penobscot, Saco, and the St. Croix rivers in Maine. Poor passage at the Lockwood Project leaves an unknown number 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.

If dam removal is infeasible or undesirable at a dam with a potentially ineffective fishway, construction of a second fishway, either a nature-like fishway (NLF) or a technical fishway, may be required to reduce the impact on diadromous species. An NLF typically is a wide, low gradient channel, constructed of natural material and designed to create a variety of structures and hydraulic conditions that dissipate energy and provide efficient passage for both migratory and resident species (USFWS 2019). Two advantages of an NLF are: 1) it operates 24-hours a day, year-round, allowing volitional fish passage; 2) it has no moving parts (e.g. gates, hoists) that may deter fish from utilizing it. An NLF, such as the Howland bypass located on the Penobscot River, emulates the flow patterns and appearance typical of a naturalized stream channel and incorporates the landscape and naturalized materials. If designed correctly, an NLF can recreate conditions that fish may encounter elsewhere within the native channel network and the response of most native species to the nature-like conditions is more intuitive and volitional. Depending on the site, an NLF can also be scaled up to accommodate more flow than a technical fish passage, improving attraction to the fishway entrance and providing safe downstream passage. Initial studies focused on juvenile Atlantic salmon have shown that the Howland bypass is highly effective for downstream passage (Molina-Moctezuma 2020). Studies of adult salmon at the Howland bypass are ongoing, but preliminary results are promising. Given that the Howland bypass was designed to the above described standards, it is anticipated that it will be an effective passage structure for other species.

If an NLF is not feasible, a second fishway may be required if false attraction or other problems result in poor passage. Given the endangered status of Atlantic salmon, the recovery goals for other diadromous species, and the difficulty in requiring additional fishways after performance testing is complete, it may be necessary to err on the side of the species needs. As such, it may be prudent to implement appropriately sized and located NLF or multiple fishways during relicensing at dams on the lower Kennebec immediately, rather than allow for the construction of a single fishway that will likely not meet agency goals, including ESA requirements. Elimination or limiting generation during both upstream and downstream passage windows may also be necessary to meet agency goals.

2.5 Non-hydropower Dams

In addition to hydropower dams, there are at least 40 non-hydropower dams within historic diadromous fish habitat above the Lockwood Dam and the Benton Falls dam, primarily located at the outlet of the lakes and ponds. These dams block many species from historic habitat including alewife from spawning habitat and American eel from growth habitat (Table 4).

2.6 Water quality

The classification of the waters of the State's major river basins can be found in Maine statute MRSA38 §467 (http://legislature.maine.gov/statutes/38/title38sec467.html). The portion of the statue pertaining to the Kennebec River can be found in Appendix A). The highest water quality within the scope of this amendment occurs in the mainstem Kennebec River between the Anson Project and the Williams Project (Class A), in much of the Carrabassett River drainage (Class AA or Class A), and in the Sandy River (Class AA or Class A). Since the 1993 Plan was written, the mainstem Kennebec River from Waterville to Augusta was upgraded from Class C to Class B following the removal of Edwards Dam. In addition, free flowing segments between the Lockwood Dam and the Abenaki Dam have been classified as Class B waters while impoundments remain as Class C waters.

3.0 Status of diadromous fishes in the Kennebec River

3.1 Shortnose sturgeon (*Acipenser brevirostrum*)

The shortnose sturgeon is a long-lived, iteroparous, freshwater amphidromous[6] species (Collette and Klein-MacPhee 2002). The Shortnose Status Review Team (SRRT) documented its presence in 42 river systems on the East Coast of North American from the Saint John River, New Brunswick Canada to St. Johns River, Florida (SSRT 2010). The shortnose sturgeon originally was listed as an endangered species in 1967 under the Endangered Species Preservation Act (32 FR 4001) and subsequently was listed as endangered throughout its range under the 1973 Endangered Species Act (ESA) (39 FR 41370). Critical habitat was never designated for shortnose sturgeon, but a recovery plan was released approximately 30 years after the initial listing (NMFS 1998). Two pertinent recovery objectives were restoring access to habitat and restoring spawning habitat and conditions.

Based on life history information, migration data, and genetic analysis, the SRRT (2010) determined that there are 5 regional population clusters of shortnose sturgeon: 1) Gulf of Maine; 2) Connecticut and Housatonic Rivers; 3) Hudson River; 4) Delaware River/Chesapeake Bay; and 5) Southeast Rivers. Within the Gulf of Maine, shortnose sturgeon from the Saint John and Merrimack rivers were determined to be genetically differentiated from each other and from the Kennebec, Androscoggin, and Penobscot rivers, which clustered together (SRRT 2010).

Field studies have demonstrated the importance of the Kennebec River and the Androscoggin River below Brunswick Dam as spawning habitat for shortnose sturgeon in the Gulf of Maine. Spawning areas in the Kennebec River (rkm 48-74[7]) and Androscoggin River (rkm 7.7-8.4) were identified by the capture of adults, eggs, and larvae between 1977 and 1983 (Wippelhauser and Squiers 2015). Acoustic telemetry studies revealed that shortnose sturgeon, including egg-bearing females, that were tagged in the Kennebec, Penobscot, Saco, and Merrimack rivers migrated to spawning habitat in the Kennebec River made accessible by the removal of Edwards Dam (rkm 74-101) in addition to the previously identified spawning areas (Fernandes et al. 2010; Dionne et al. 2013; Wippelhauser et al. 2015). Shortnose sturgeon now have access to 100% of their historical spawning and nursery habitat in the State of Maine that was identified by Foster and Atkins (1868) and Atkins (1887).

The current abundance of the shortnose sturgeon population in the Kennebec River is unknown. However, on the basis of two mark–recapture studies, the adult shortnose sturgeon population in the Kennebec system was estimated to be 5,117 (95% confidence interval, 4,206–6,279) for the period 1977–1981 and 9,436 (7,542–11,888) for the period 1998–2000 (Wippelhauser and

[6] A freshwater amphidromous species spawns and remains in freshwater for most of its life but spends some time in saline water.
[7] "rkm" denotes river kilometer.

Squiers 2015). The population has likely expanded, and competition for food may be the reason shortnose sturgeon are now being seen in other river systems (Altenritter et al. 2018).

3.2 Atlantic sturgeon (*Acipenser oxyrhynchus oxyrhynchus*)

The Atlantic sturgeon is a large, long-lived, iteroparous, anadromous species that often co-occurs with the shortnose sturgeon in many river systems on the east coast of North America. The species has been documented 41 rivers from the Saint Lawrence River in Canada to the St. Marys River in Florida (FR 82 39160).

Protection of Atlantic sturgeon in Maine began in 1983 when MDMR promulgated a rule that made harvest of the species in the Kennebec River illegal, but coastwide protection of the species took much longer. In 1998, the Atlantic States Marine Fisheries Commission instituted a coastwide 40-year moratorium on the harvest of Atlantic Sturgeon (ASMFC 1998), and the Services[8] and determined that listing the species under the ESA was not warranted at the time. A subsequent status review found that the species could be divided into five distinct population segments distinguished by physical, genetic, and physiological factors; were located in a unique ecological setting; had unique genetic characteristics; and would represent a significant gap in the range of the taxon if one of them were to become extinct (ASSRT 2007). In 2012, the Gulf of Maine (GOM) DPS of Atlantic sturgeon was listed as threatened, while the other four[9] were listed as endangered (FR 77 5580; FR 77 5914).

Field studies have demonstrated the importance of the Kennebec River and the Androscoggin River below Brunswick Dam as spawning habitat for GOM DPS of Atlantic sturgeon. A spawning area in the Kennebec River (rkm 48-74) was identified by the capture of ripe males in multiple years between 1978 and 1997 (Wippelhauser and Squiers 2015). Acoustic telemetry studies revealed that Atlantic sturgeon tagged in the Kennebec, Penobscot, Saco, and Merrimack rivers utilized the same areas that are used by shortnose sturgeon, including the new spawning habitat made accessible by the removal of Edwards Dam (Wippelhauser et al. 2017). Atlantic sturgeon now have access to 100% of their historical spawning and nursery habitat in the State of Maine.

Critical habitat was designated in 2017 (FR 82 39160) and includes the Kennebec River main stem from the Lockwood Dam downstream to the Atlantic Ocean (rkm 0-101 and the Androscoggin River main stem from the Brunswick Dam downstream to Merrymeeting Bay.

3.3 Rainbow smelt (*Osmerus mordax*)

The rainbow smelt is a small, pelagic, anadromous fish that once ranged from the Hamilton Inlet-Lake Melville estuary in Labrador to the Chesapeake Bay, but now may extend only as far south as Buzzards Bay, Massachusetts (Scott and Crossman 1973; Enterline et al. 2012). Rainbow smelt once supported commercial fisheries in New England, but their numbers declined precipitously since the late 1800s to mid-1900s. Atkins (1887) identified the Kennebec River and Penobscot River as the two systems in Maine that had supported large bag-net fisheries for

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[8] The National Marine Fisheries Service (NMFS) and the United States Fish and Wildlife Service (USFWS).
[9] New York Bight, Chesapeake Bay, Carolina, and South Atlantic

rainbow smelt. Although recreational fisheries for rainbow smelt continue, declining catches have been occurring since the 1980s. On the basis of the range contraction and abundance declines, the National Oceanic and Atmospheric Administration (NOAA) listed rainbow smelt as a federal Species of Concern in 2004. The MDMR, in collaboration with the Massachusetts Division of Marine Fisheries and New Hampshire Fish and Game Department, received a grant from NOAA's Office of Protected Resources (NA06NMF4720249) to document the status of rainbow smelt and develop conservation strategies (Enterline et al. 2013).

The 1993 Plan identified rainbow smelt as one of the species that could benefit from access to additional spawning habitat by the removal of Edwards Dam. However, rainbow smelt are not strong swimmers, and a number of rapids reappeared when the Kennebec River was restored to its free-flowing state. These rapids had been identified in a survey conducted by the Army Corps of Engineers (Albert 1828) prior to the construction of the dam in 1837. MDMR has not conducted sampling to determine if rainbow smelt attempt to migrate past the head-of-tide where the Edwards Dam was located. Although a few rainbow smelt have entered the fish lift at the Lockwood Project, they have not been examined to determine whether they are anadromous fish that have migrated upstream or a landlocked population.

3.4 Striped bass (*Morone saxatilis*)

The striped bass is a large, long-lived, iteroparous, anadromous species with major spawning areas in the United States in Chesapeake Bay and its tributaries, the Hudson River, the Delaware River, and the Roanoke River and in Canada in the Saint John River (Collette and Klein-MacPhee 2002). Little (1997) reported that striped bass spawned in almost every river along the coast of New England in the seventeenth and eighteenth centuries until they were extirpated. The Kennebec River once supported a large spawning population as evidence by the presence of ripe males in June and early July and the capture of great numbers of 2-3-inch long young-of-year (YOY) in the winter bag net fishery for rainbow smelt and Atlantic tomcod (Atkins 1887). Striped bass historically migrated up the Kennebec River to Habitat loss due to the construction of Edwards Dam in 1837 and habitat degradation due to increased water pollution led to the decline or possible extirpation of striped bass in the Kennebec River by the late 1930s. A directed survey conducted by MDMR in the 1960s failed to capture any striped bass eggs, larvae, juveniles or adults.

Passage of the Clean Water Act in 1977 led to improved water quality, which encouraged MDMR to initiate a restoration program for striped bass. Between 1982 and 1989, MDMR stocked 187,560 striped bass fingerlings of Hudson River origin into the Kennebec River system. In 1987, just five years after stocking was initiated, 26 wild young-of-year (YOY) striped bass were collected at three different sampling locations during MDMR's beach seine survey. This represented the first documented spawning of wild striped bass in the Kennebec River system in over 50 years. Striped bass YOY have continued to be collected in the beach seine survey in most years since 1987, but CPUE (catch-per-unit-effort) has been highly variable.

Striped bass now have access to 100% of their historically accessible habitat in the Kennebec River Maine that was identified by Foster and Atkins (1868) and Atkins (1887).

3.5 Atlantic Salmon (*Salmo salar*)

The goal for Atlantic salmon is to restore a minimum population of 2,000 adults annually to historic high-quality habitats (identified in Table 12) in the Kennebec River above the Weston dam. Because restoration of this species was not considered in the 1993 Plan, a more complete description of the species biology, ecology, and fish passage requirements are included in the Kennebec River Amendment.

The Atlantic salmon is a medium-sized, highly migratory, anadromous, iteroparous fish that historically ranged from northeastern Labrador to the Housatonic River in Connecticut (Collette and Klein-MacPhee 2002). Hundreds of thousands of adult Atlantic salmon returned annually to spawn in the rivers of New York and New England and represented a culturally significant species for Maine's tribes and later became an important economic resource both recreationally and commercially. Habitat loss and degradation due to dams and industry, overharvest, and other human impacts brought the Atlantic salmon to the brink of extinction within its U.S. range (Fay et al. 2006, NAS 2004). Today, the only remaining population of Atlantic salmon in the United States, the Gulf of Maine Distinct Population Segment (GOM DPS), exists in several watersheds in Maine.

Atlantic salmon are part of a co-evolved diadromous fish community that together shaped Maine's riverine and lacustrine habitats through connectivity with the ocean (Fay et al. 2006, Saunders et al. 2006). As the returns of Atlantic salmon to Maine's rivers declined, it is likely that some of these ecosystem functions also declined or were lost, including reductions to the primary productivity due to the loss of marine derived nutrients from metabolic waste products, eggs, and carcasses that are incorporated into the local food web in the areas where spawning occurs (Moore et al. 2011, Guyette et al. 2014).

Restoration of the species began in 2003 when 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 fishlift to the Sandy River in trucks and allowed to spawn naturally, MDMR has utilized Penobscot-origin, F2 generation fry and eyed-eggs. 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 (Table 8). Despite these efforts, much of the spawning habitat in the Kennebec River remains underutilized due to poor adults returns and a limited supply of eggs. The USFWS has also transported Penobscot-origin F1 generation parr to the Nashua National Fish Hatchery to stock as smolts into the Kennebec river. The first stocking of 100,000 smolts occurred in the spring of 2020, with planned stocking to continue into the foreseeable future if funding is available.

In 2009, the 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 SHRU is in the Kennebec River, specifically in the Sandy River (above 4 hydropower dams), the Carrabassett River, and upper Kennebec River above 6 hydropower dams). Access to this critically important, climate resilient habitat is blocked by all of these mainstem dams.

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 schedules for constructing upstream fish passage and testing the effectiveness of existing downstream fish passage at the four projects; the ISPPs were incorporated into the project licenses by FERC. 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) tocan 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 standards, and no reasonable and prudent measures to avoid, minimize, and mitigate project impacts on Atlantic salmon.

In 2019, the Recovery Plan for the Gulf of Maine Distinct Population Segment of Atlantic Salmon (*Salmo salar*) Plan (Recovery Plan) was issued (USFWS and NMFS 2019). The 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 includes the following abundance criteria for downlisting of the GOM DPS from endangered to threatened and for delisting the species[10]:

> ***Downlisting:*** 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 (Table 8). Data provided by MDMR and restoration partners, represented in the U.S. Atlantic Salmon Assessment Committee (USASAC 2019) reports, indicate severe limitations in freshwater production of “naturally reared” fish that would contribute to meeting recovery goals. The recovery of the entire DPS is reliant on the Kennebec River based on the available habitat in this system compared to other rivers statewide. Restoration of Atlantic salmon populations and connectivity to critical habitat in the Kennebec River drainage, therefore, is of utmost importance to the State of Maine. Providing safe, timely, and highly effective passage on the Kennebec River is essential to meeting recovery goals.

To assess the cumulative impacts of multiple dams on Atlantic salmon recovery, the MDMR developed a deterministic model utilizing the best available data, current research, and knowledge of the watershed. The model was used to develop survival goals for upstream and

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[10] The complete list of criteria to accomplish recovery or delisting can be found in Section 1.4 or the Recovery Plan.

downstream passage at each hydropower facility. Major assumption of the model were generally consistent with NOAA Fisheries Dam Impact Models (Nieland et al. 2013; Nieland and Sheehan 2020), utilized in the Penobscot River, and included:

- 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 23900.
- 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 no dams; 0.0087/km for fish that passed 2 dams; .0.115/km for fish that passed 4 dams; 0.013 for fish that passed five 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 ranged from 4% to 1% at each dam.
- Upstream passage efficiency of adults ranged from 95% to 99% at each dam.
- The analysis did not included delays at dams during upstream or downstream passage.

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 federal and 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" freshwater survival (Table 9; Fig. 2). Under "high" marine survival and "low" freshwater 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. As dams were removed, the upstream and downstream passage efficiency to reach 500 or 2,000 adult returns approached efficiencies that have been documented by field studies. The scenarios of high marine and freshwater survival represent ideal conditions. Therefore, standards may need to be even higher to avoid jeopardy, meaning multiple dam removals would be imperative to recover the species.

While this analysis indicates that it may be possible to achieve recovery goals, 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.

Adults salmon return to Maine's rivers during summer and can be exposed to high temperature events. High temperature both slows and 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 2009; Elliott and Elliott 2010; Martin et al. 2012). Migratory delays caused 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.

Effectiveness studies demonstrate the difficulty of meeting high performance standards for fish passage, although increased flow may improve survival of downstream migrants. Radio telemetry studies conducted at the Weston, Shawmut, Hydro-Kennebec, and Lockwood projects resulted in baseline survival[11] of downstream migrating Atlantic salmon smolts ranging from 89.5–100%, but only 66-94.5% of smolts successfully passed the projects within 24 hours (Table10). Because the 93.5% baseline survival at the Shawmut Project was less than the 96% proposed in the ISPP, downstream passage flow was increased from 420 to 650 cfs although no additional testing occurred. Radio telemetry studies conducted at four projects in the Penobscot River resulted in adjusted survivals of 84.0-98.0% after spill had been increased between 20% and 50% of river flow at each station from 8 p.m. to 4 a.m. during the peak two weeks of the outmigration period. In the Kennebec River, upstream passage effectiveness has only been tested 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. As part of a study of energy consumption, adult Atlantic salmon were captured at the Lockwood fish lift, tagged with thermal radio tags and released downstream of the Project. In 2018, 66.7% of the tagged adults (4 of 6) were recaptured, and the time to recapture was 16-33 days (mean=21.8). The following year, 45.0% of tagged adults (9 of 20) were recaptured, and the time to recapture was 9-30 days (mean=18.7).

The NMFS (2013) clearly foresaw the need for high performance standards. The Biological Opinion issued for the ISPPs states on page 17: "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

[11] The baseline rate does not consider amount of time to pass the project. The adjusted survival is calculated from fish that passed a project within 24 hours.

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."

Climate Change and Atlantic Salmon
The Atlantic salmon is a cold-water anadromous species that has a narrow temperature tolerance range. As such, this species is susceptible to the effects of climate change during both the freshwater and marine phases of its life cycle (Brett 1956; Pörtner and Farrell 2008; Jonsson and Jonsson 2009; Hare et al. 2016). The negative effects of climate change on salmonids, however, are expected to be worse in systems with habitat that is degraded or is fragmented by dams (Rieman and Isaak, 2010; Williams et al. 2015).

In the northeastern United States, the streams and rivers where Atlantic salmon occur are predicted to experience warmer summer water temperature combined with overall drier summers, with rainfall predominantly occurring as localized but intense events (Magnuson et al., 1997; Spierre and Wake, 2010; Todd et al. 2011). Winters are predicted to be wetter, with more rain than snow, which have the potential to alter winter baseflow, ice cover, and the timing, frequency, and severity of ice breakup events (Magnuson et al., 1997; Beltaos and Burrell 2003; Spierre and Wake, 2010). Mid-winter ice break-up events can be particularly detrimental to the over-winter survival of Atlantic salmon and other aquatic life (Cunjak et al. 1998; Turcotte and Morse 2017). Reduced ice cover also has been linked to reduced overwinter survival of juvenile Atlantic salmon (Hedger et al. 2012).

Salmon metabolism increases with increasing temperature, thus river temperature drives processes like timing of spawning, hatching of eggs and emergence timing, growth rates, size and age at smolt transition, migration patterns, gonad development, and fecundity (Jonsson and Jonsson 2009). At a certain temperature, termed the upper incipient lethal temperature, salmon begin to experience thermal stress; if salmon are unable to find cooler water, then they will die (Jonsson and Jonsson 2009; Elliott and Elliott 2010). For salmonids, the upper incipient lethal temperature is generally between 20 and 28 °C (Jonsson and Jonsson 2009; Elliott and Elliott 2010). Below the upper incipient lethal temperature, but outside the range of optimal temperatures, growth of juvenile salmon and energy stores of over-summering of adult salmon are reduced (Berman and Quinn 1991; Hasler et al. 2012).

Maximizing growth of juvenile salmon, energy stores available for adults, and overall survival, requires that Atlantic salmon have access to suitable cold-water refuge habitat during summer heat events (Torgersen et al. 1999; 2012). Low flow conditions, road-stream crossings, and dams all can impede access to cooler headwater tributaries and cool refuges (Torgerson et al. 1999; Hasler et al. 2012; Brewitt et al. 2014). The warmer, drier summers expected to occur in Maine under future climate change scenarios make maintaining access to headwater tributaries and thermal refuges even more important (Magnuson et al. 1997; Spierre and Wake 2010; Todd et al. 2011; Dugdale et al. 2016; Frechette et al. 2018).

Headwater habitats have been identified as critically important for salmonid species, including Atlantic salmon (Colvin et al. 2018). In addition to serving as cool refuges, productivity (in terms of parr density) has been positively associated with cumulative drainage area: i.e., parr density was lower in mainstem reaches (Sweka and Mackey 2010), possibly because of higher temperatures in the larger mainstem habitat. Colder headwater stream could also serve as an invasion shield, protecting native species like salmon from negative interactions with non-native species with higher temperature tolerances (Isaak et al. 2015). Erkinero et al. (2019) found greater life history diversity for Atlantic salmon in tributaries than in river mainstems. Life history diversity can buffer effects of population fluctuations and help ensure population persistence; a concept referred to as the “portfolio effect” (Schindler et al. 2010). This evidence of the portfolio effect in Atlantic salmon further supports the need to ensure that salmon have access to a variety of habitat types, particularly headwater tributaries, to maximize life history diversity and population persistence in the face of a changing climate.

In addition to impeding access to critical headwater habitat, dams and associated impoundments also impose other thermal challenges for salmon that can compound the effects of climate change. Impoundments created by dams alter the river temperature regime, both in the impoundment itself and in downstream habitat. Removal of the mainstem dams in the Klamath River (California) is expected to result in a decrease in mainstem river temperature by 2 to 4˚C, which would help buffer the effects of climate change induced temperature increase on salmon and steelhead (Goodman et al. 2011; Perry et al. 2011; Brewitt et al. 2014). On the Snake River, most of the acute thermal stress on radio-tagged salmon and steelhead occurred at dams, with the warmest temperatures experienced in reservoirs or even in the fishways (Caudill et al. 2013; Keefer and Caudill 2016). In fact, when fishway temperatures were warmer, individuals made repeated passage attempts resulting in energetically costly passage delays (Caudill et al. 2013).

The large area of impounded water and significant numbers of dams between the only climate resilient habitat in the Kennebec river, the Sandy River, upper Kennebec, and Carrabassett River, creates an increasing urgency to remove dams in the Kennebec drainage to ensure safe, timely, and effective passage.

3.6 American Shad (*Alosa sapidissima*)

The American shad is a highly migratory, pelagic, schooling species that ranges along the east coast of North American from Newfoundland to Florida (Colette and Klein-MacPhee 2002; Scott and Crossman 1973). Populations of American shad that spawn north of Cape Hatteras are iteroparous (repeat spawners). American shad return to their natal rivers to spawn, predominately at 5 and 6 years of age New England, and spawning begins at water temperatures ranging from 18 to 25°C. Spawning sites are associated with hydrographic parameters (high current velocity, high dissolved oxygen, and shallow depth), physical habitat features (increasing sediment size and woody debris), and the presence of a forested shoreline (Bilkovec et al. 2004). In the Connecticut, which supports the largest American shad run on the east coast of the United States, year-class strength is determined during the larval emergence stage and is significantly correlated with mean river discharge, water temperature, and total monthly precipitation (Crecco et al 1983; Crecco and Savoy 1984; Crecco and Savoy 1985).

The goal of the 1993 Plan was to restore American shad to their historical range in the Kennebec River and achieve an annual production of 725,000 American shad above Augusta (i.e. above Edwards Dam). American shad historically ascended the Kennebec River to rkm 157, the Sandy River to rkm 75, and the Sebasticook River to rkm 51 (Table 5). Restoration of American shad began in 1987 with the signing of the first KHDG settlement agreement (Table 1), which provided funds for restoration in exchange for delays in upstream fish passage. Between 1987 and 1997, MDMR stocked millions of American shad fry and thousands of fingerlings and adults above the Edwards Dam (Table11).

This Amendment provides reach by reach (dam to dam) minimum production targets for adult American shad, which were not included in the 1993 Plan. Minimum production targets are based on accessible and potentially accessible spawning/nursery habitat area and the adult production/unit of habitat area, a method commonly used in other American shad plans and studies in the Connecticut River (CRASC 2017), Susquehanna River (SRAFRC 2010), Merrimack River (USFWS 2010), and Penobscot River (MDMR 2008). Because of insufficient data for Maine's rivers, we used the most recent determination of minimum adult production/unit habitat developed for the Connecticut River (203 adults/hectare; CRASC 2017). This value likely underestimates the true production/unit habitat due to upstream and downstream passage inefficiencies that were known to exist when it was calculated (CRASC 2017). MDMR may increase the minimum adult production target values as improvements to habitat quantity and quality and fish passage occur in the future.

The Kennebec River watershed contains approximately 2,508 hectares of American shad riverine spawning/nursery habitat that was historically accessible (Table3; Table 5). The majority of the habitat (59.6%) is above the Lockwood Dam, while 20.9% lies between the head-of-tide (site of former Edwards Dam) and the Lockwood Dam, and 19.5% is in the Sebasticook River (Table 3). Removal of Edwards Dam was an important step in enhancing the American shad population, but access to habitat above the Lockwood dam is clearly necessary to reach production and distribution goals. Restoration of American shad above the Lockwood Project has not been successful. As described in section 2.3, the trigger for converting the interim upstream passage facility at the Lockwood Project to a permanent one – the capture of 8,000 American shad in any single season – was never met. Since the interim fish lift became operational in 2006, only 1,413 adult American shad have used it (Table 2). Attempts to determine why so few American shad use the Lockwood fish lift have failed. In 2015, the Licensee in consultation with the agencies, conducted a sound study, a 2D hydraulic modeling study, and a radio telemetry study. Interestingly, adult American shad used in the telemetry study were angled by recreational fishermen in the tailrace (Figure 3, Event 1, and Event 2&3), but none of the tagged American shad were detected near the fishway entrance.

There are multiple examples of hydropower projects equipped with upstream and downstream fish passage that are not effective for passing American shad. Restoration has stalled due to the small numbers of American shad that annually pass upstream at the lowermost barrier on the Kennebec River (0-830; mean=108) and the Androscoggin River (0-1,096; mean=23). The number of American shad passing the east and west channel dams on the Saco River in 27 years has been marginally better (399-16,435; mean = 2,836), but most are trucked past the next pair of dams (Springs and Bradbury) because the two passage facilities collectively pass < 5% of the arriving American shad. On the Merrimack River, an average of 17% of the American shad that passed the first barrier successfully also passed the second barrier (Sprankle 2004). The mean passage efficiencies for American shad migrating upstream through fishways from the first dam to the spawning grounds were less than 3% on the Susquehanna River, Connecticut River, and Merrimack River (Brown et al 2013). Survival of adult American shad migrating downstream at four hydropower dams in the Penobscot River ranged from 76.6-94.7% (75% CI of 71.1-97.9%) with 27-80% of migrants passing within 48 hour (BREG 2018; BREG 2019). Migration delays caused by fishways or trapping facilities need to be considered because they can limit spawning success and the number of repeat spawning adults (Castro-Santos & Letcher, 2010).

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. Exelon (2012) developed an American shad passage model for the Susquehanna River, but it did not include a time-to-pass metric. Stich et al. (2018) developed a stochastic, life-history based, simulation model for the Penobscot River and found that the probability of achieving management goals (total spawner abundance, distribution to upstream habitat, and percentage of repeat spawners) was greatest with high downstream passage efficiency, minimal migration delays at dams, and high upstream passage efficiency. The Stich et al. (2018) model was modified to develop performance standards for the Connecticut River projects (CRASC 2020) and for the Kennebec River (Stich 2020). Dr. Stich ran 48 scenarios to explore the effects of downstream passage survival (1.00, 0.95, and 0.90) in combination with varying upstream passage efficiency (0.70-1.00) and time-to-pass (1, 3, 7, and 20 days per dams) on American shad distribution and abundance in the Kennebec River.

3.7 Blueback herring (*Alosa aestivalis*)

The blueback herring is an anadromous, highly migratory, pelagic, schooling fish found along the east coast of North America from Cape Breton, Nova Scotia and the Bay of Fundy watershed, New Brunswick, to Florida in the United States (Scott and Crossman 1973; Colette and Klein-MacPhee 2002). Blueback herring are iteroparous, returning to their natal rivers to spawn predominantly between the ages of 4 and 5. Spawning occurs in flowing water over hard substrates and is initiated at water temperatures between 10-15°C.

The 1993 Plan did not include specific goals for blueback herring, because little was known about its distribution and abundance in the Kennebec River at the time. This Amendment provides reach by reach (dam to dam) production targets for adult blueback herring. Production targets are based on accessible and potentially accessible spawning/nursery habitat area and the most recent determination of adult production per unit of habitat area, a method commonly used for American shad and alewife. The unit production was estimated from the number of blueback herring passed at Benton Falls and the amount of available upstream habitat. The targets were calculated as target number of adult blueback herring = (habitat surface hectares) × (1,196 adults/hectare).

The Kennebec River watershed contains approximately 2,508 hectares of blueback herring riverine spawning/nursery habitat that was historically accessible (Table 3; Table 5). The majority of the habitat (59.6%) is above the Lockwood Dam, while 20.9% lies between the head-of-tide (site of former Edwards Dam) and the Lockwood Dam, and 19.5% is in the Sebasticook River (Table 3). Removal of Edwards Dam was an important step in enhancing the blueback herring population, which naturally recolonized the reach between Augusta, the Lockwood Dam, and the Fort Halifax Dam. The population rapidly expanded in the Sebasticook River after the removal of Fort Halifax with over one million adults being passed annually at Benton Falls in the past 4 years (Table 2). Blueback herring began using the fish lift at the Lockwood Project soon after it became operational in 2006 (Table 10). However, free access to habitat above the Lockwood dam is clearly necessary to reach production and distribution goals. MDMR estimates that the habitat above the Lockwood Project could produce a minimum of 2 million blueback herring.

Dr Stich has recently developed a stochastic, life-history based, simulation model for blueback herring for the Mohawk River and the Kennebec River; these models are conceptually similar to the American shad model. Dr. Stich ran 48 scenarios to explore the effects of downstream passage survival (1.00, 0.95, and 0.90) in combination with varying upstream passage efficiency (0.70-1.00) and time-to-pass (1, 3, 7, and 20 days per dams) on blueback herring distribution and abundance. The upstream and downstream passage facilities should be operated daily (24 hours/day) to accommodate the migratory movements of river herring (Grote et al. 2013).

3.8 Alewife (Alosa pseudoharengus)

The alewife is an anadromous, highly migratory, pelagic, schooling fish found along the east coast of North America from Newfoundland to North Carolina (Scott and Crossman 1973; Colette and Klein-MacPhee 2002). Alewife are iteroparous, returning to their natal waters to spawn, predominantly between the ages of 4 and 5. Alewife typically spawn in lakes and ponds, and spawning is initiated at water temperatures between 10-22° C.

One goal of the 1993 Plan was to achieve an annual production of 6.0 million alewives above Augusta. The 1993 Plan identified 20 lakes and ponds above Augusta (totaling 24,606 acres); 15 lakes and ponds below Augusta primarily in the Cobbosseecontee Stream drainage (totaling 13,077 acres), and 8,154 acres of tidal freshwater as historical alewife spawning habitat. The 1993 Plan provided reach by reach (dam to dam) production targets for adult alewife that were based on historically accessible spawning/nursery habitat area and an adult production per unit of habitat area. At the time, MDMR used 235 adults/acre as the unit production, which was the average minimum production of 6 harvested populations for the period 1971-1983 when the fishery was closed one day per week. Recent analysis of data for 7 harvested runs for the period 2005-2017 (with three closed days per week) and reanalysis of the 1971-1983 data resulted in updating the average unit production to 400 adults/acre. This updated unit production estimate is an average but, similar to the previous estimate, the data only includes harvested populations. Because all the populations included in the updated unit production are subjected to harvest, the updated unit production estimate (400/acre) should be considered an average of harvested populations. The unit production of non-harvested populations would be a more accurate assessment of habitat carrying capacity, which has been estimated for Maine and New

Brunswick alewife populations, and this metric is used for management of alewife populations in Canada (Gilbert & Myers 2003; Gilbert et al. 2017). The average production in this amendment were calculated by the equation: number of adult alewife = (habitat surface acres) × (400 adults/acre) or in metric units number of adult alewife = (habitat surface hectares) × *(988.4 adults/hectare).

Restoration of alewife to the Kennebec River began in 1987 with the signing of the first KHDG settlement agreement. With funds from the settlement, MDMR stocked approximately 1.3 million adult alewife into 9 inaccessible lakes and ponds from 1987 through 2006 (Table 4). In 2006, six ponds in the Sebasticook River drainage became accessible due to the removal of Edwards Dam, the installation of upstream fish passage at the Benton Falls, the Burnham project, and three non-hydropower dams, and the removal of one non-hydropower dam (Table 1). After the Fort Halifax Dam was removed, the alewife population migrating up the Sebasticook River expanded significantly (Table 2). Upstream passage into Webber Pond on Seven-Mile Stream has produced an alewife population. Alewives returning to the mainstem of the Kennebec River have increased in number, but the population is maintained by stocking.

The new fish passage facility at the Hydro Kennebec Project and the facilities proposed for the Lockwood, Shawmut, and Weston projects will need to be tested for their effectiveness in passing multiple species and life stages, including adult and juvenile alewife. In the Kennebec River Amendment we propose performance standards by which to evaluate the results of the testing. The standards were developed using a newly available alewife population model[12] that was developed to compare theoretical spawner abundance between scenarios with different dam passage rates. This type of model defines inputs using averages applied to groups and is used to explore general trends and compare the results of scenarios when different average values are used as inputs. The basic structure and inputs of the original model have been described in Barber et al. (2018); the same information and the R code is annotated at the web site.

In order to achieve a minimum number of spawners (608,200 adult alewife) to historic habitat in the Kennebec River, upstream passage of adults would need to be at least 90% effective at each of the four dams and downstream passage of adults and juveniles at each of the four dams would need to be at least 95% effective (Figure 4). If dams were removed, , required upstream and downstream passage effectiveness of adults and juveniles at remaining projects would decrease. Because adult alewife have limited energy stores, time to pass as each dam should be minimized. The upstream and downstream passage facilities should be operated daily (24 hours/day) to accommodate the migratory movements of river herring (Grote et al. 2013).

3.9 Sea lamprey (*Petromyzon marinus*)

The goal for sea lamprey is to restore access for the species to historic spawning and nursery habitat. Because restoration of this species was not considered in the 1993 Plan, a more complete description of the species biology, ecology, and fish passage requirements are included in this Kennebec River Amendment.

[12] The model is available at https://umainezlab.shinyapps.io/alewifepopmodel/

The sea lamprey is an anadromous, semelparous, species that ranges in the wester Atlantic Ocean from the St. Lawrence River in Canada to the State of Florida in the United States (Scott and Crossman; Colette and Klein-MacPhee 2002). Unlike the other diadromous species native to Maine, there is no evidence that sea lamprey home to their natal river system (Kircheis 2004?). The species is an important component of the riverine ecosystem in Maine that, like other sea run fish species, has been prevented from reaching much of its historic range by barriers to upstream passage. Restoring sea lamprey to their historic range within the state is considered to be beneficial in and of itself and for the restoration and recovery of other sea run fish, particularly endangered salmon (Kircheis 2004). MDMR's goal is to restore sea lamprey to historic habitat above the Lockwood Dam.

In watershed unrestricted by dams, 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 important (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 two dam removals, installation of a fish lift that is operated day and night, and installation of a nature-like fishway at a decommissioned hydropower project 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 filter-feeding ammocetes, (the juvenile life stage that spends up to eight years in stream sediments), break down terrestrially derived nutrients in streams, and eventually export 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).

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 May 7; lamprey have been recorded at Milford as late as July 6 (MDMR unpublished data). Lamprey on the Westfield River have been observed as early as April 14 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 May 1 and extend to July 30. As more information becomes available, this season can be adjusted.

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.

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).

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.

3.10 American Eel (*Anguilla rostrata*)

The American eel was not included in the 1993 Plan. Therefore, a more complete description of the species biology, ecology, and fish passage requirements are included in this amendment.

The American eel is a highly migratory, semelparous, facultative catadromous species that spends most of its life in freshwater or estuarine environments then migrates to the Sargasso Sea as an adult to reproduce and die (Collette and Klein-MacPhee 2000; Shepard 2015). Because all adult eels from the entire range of the species come together in one place and reproduce, the American eel population is considered a panmictic (single) spawning population. The larval eels (leptocephali) are transported by ocean current to the west and to the north by the Gulf Stream. The leptocephali metamorphose into glass eels as they migrate toward land. Glass eels become pigmented stage as they move into brackish or freshwater and are called elvers (<6 inches) or yellow eels (>6 inches). Yellow eels inhabit fresh, brackish, and saltwater habitats where they feed primarily on invertebrates and smaller fishes. When they become sexually mature (<8 to 27 years old in Maine), they migrate to the Sargasso Sea to spawn.

The timing of the American eel migrations in Maine' waters is well-known from commercial harvests and MDMR monitoring. Upstream migrations generally begin earlier in the western part of the state and downstream migrations generally begin earlier in the upper reaches of a watershed. The upstream migration of glass eels is considered to occur from March 15- June 15. The upstream migration season for elvers and yellow eels is June 1-September 30. The downstream migration of silver eels occurs from August 15- October 31. Migration mostly occurs at night although glass eels may occasionally move during the day.

Like anadromous species, the abundance of American eel has declined, and the decline has been attributed in part to dams, overfishing, and poor water quality. The species has been considered for listing under the ESA twice, but the USFWS determined in both cases that listing was not warranted at the time. The Atlantic States Marine Fisheries Commission (ASMFC) recently completed a stock assessment for American eel (ASMFC 2012), which used trend analyses and Depletion-Based Stock Reduction Analysis and concluded the stock status is depleted. Two years later Addendum IV reduced the commercial harvest of all life stages of American eel (ASMFC 2014).

Pursuant to the 1998 Settlement Agreement, upstream and downstream passage (either permanent or interim) for American eel has been provided at all of the mainstem dams in the Kennebec River and the Sebasticook River. However, our understanding of the best means of providing downstream passage and the timing of the outmigration of silver eels have evolved in the last 25 years and testing of the existing interim facilities has not been rigorous. Analysis of Maine's silver eel harvest data indicates that the downstream migration of silver eels in the Kennebec River primarily occurs from August 15-October 31.

4.0 Energy Potential

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, sources of renewable energy, including hydropower, can still have impacts on the resources in the State of Maine. Due to large impacts on State resources and relatively small generation, the State believes 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. These four projects impact 5 species of diadromous fish species and prevent ESA listed species from reaching all of their available high-quality habitat. Any potential lost generation at the lower Kennebec projects through a decommissioning and removal could 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).

Electricity is generated from a variety of sources in Maine including coal, petroleum, natural gas, nuclear, hydroelectric, and renewable sources. According to data collected by the U.S. Energy Information Administration, the average electricity generated annually from all these sources from 2001 to 2019 was approximately 4.04 billion megawatt hours (U.S. Energy Information Administration, 2020). Most of the power generated annually during this period was from three sources: coal (41%), natural gas (25%), and nuclear (20%). By comparison, the average annual amount produced by hydroelectric facilities during this period accounted for 6.68% of total generation[13]. The average annual amount produced by renewable sources, defined in the report as non-hydropower sources of renewable power, accounted for 5.04% of total generation. In addition, the annual generation by renewable sources increased by 288% from 2001 to 2019, surpassing annual generation by hydroelectric facilities in 2014. In 2019, 0.27 billion megawatt hours were generated by hydroelectric facilities, whereas 0.45 billion megawatt hours were produced by renewable resources. This same trend has continued in 2020 with a record numbers of applications received for development solar sites in the state.

In Maine there are 132 hydropower dams administered through 97 federal licenses or exemptions authorized by the Federal Energy Regulatory Commission (Maine DEP, 2020). The total authorized capacity of all hydropower dams in Maine is 735,331 KW. Of the 132 in Maine, just 12 hydropower dams account for 65% of authorized capacity in the state (FERC, 2020). The largest generating dam, Wyman Dam (FERC No. 2329), has an authorized capacity of 83,000 KW or 11.4% of authorized hydroelectric capacity. The sum of authorized capacity of all four dams in the lower Kennebec River is 6.4% of the total hydropower and accounts for 0.43% of annual electricity generation in Maine.

The four dams in the lower Kennebec River are Lockwood, Hydro-Kennebec, Shawmut, and Weston and account for 0.94%, 2.10%, 1.19%, and 2.17% respectively of the total authorized capacity for hydropower in Maine. In contrast, the dams reduce or impede access to roughly 88.5% of the historic Atlantic salmon habitat in the Kennebec river and approximately 30% of the historic habitat of Atlantic salmon within the state of Maine. In addition, the dams are located low enough in the watershed to impact spawning migrations of alewives, blue back herring, American shad, American eel, and sea lamprey. Several of the dam sites are complex and present significant uncertainty regarding the ability to effectively pass fish at required standards. In addition, the cumulative impacts of four dams and associated fishways will require

[13] The U.S. EIA has separated the statistics for hydropower from other renewable generation types due to the impact of hydropower generation. All mentions of ‘renewable resource’ energy generation in this document also exclude hydropower.

reliance on unproven high passage performance at each project to ensure Atlantic salmon recovery and other species goals are achieved. Finally, removal of these dams 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).

5.0 Economic value of the resource

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.

Value of salmon habitat

The Kennebec River once supported a robust Atlantic salmon population, and habitat in the Kennebec River is critical to the recovery of the species today. In particular, the Sandy River has the greatest biological value for spawning and rearing habitat in the watershed, but it is currently only accessible to adult salmon through a trap and truck program around the four mainstem dams (NMFS 2009). Dams are also the most significant contributing factor to the loss of salmon habitat connectivity within the range of the DPS (Fay et al. 2006) and have been identified as the greatest impediment to self-sustaining Atlantic salmon populations in Maine (NRC 2004). In the Kennebec River, there are approximately 251,083 units of historically accessible spawning and rearing habitat for Atlantic salmon, however hydropower dams reduce or impede access to roughly 222,105 units (88.5%) of that habitat (NMFS 2009). Put into perspective, this is a loss of 30% of the historic habitat of Atlantic salmon within the state of Maine; the only remaining intact population of Atlantic salmon in the United States.

The Atlantic Salmon Restoration and Conservation Program (ASRCP) was established in 2018. The program is an In-Lieu Fee Program for compensating adverse impacts to Atlantic salmon within the State of Maine. The ASRCP allows a consistent and defensible mechanism for calculating program credits and debits (fees) based on project impacts to Atlantic salmon habitat. The scope of impacts includes any adjacent or blocked, spawning or rearing Atlantic salmon critical habitat. The fee schedule defines a cost per habitat unit for each of the three bioregions and it was developed by incorporating a series of cost models and quantitative habitat measures. For the Merrymeeting Bay Salmon Habitat Recovery Unit (MMB SHRU), the bioregion that includes the Kennebec River, the cost per habitat unit is $4,850.

The four mainstem dams on the Lower Kennebec constitute the single largest impact on historical habitat in the Kennebec River. Lockwood, Hydro-Kennebec, Shawmut, and Weston and their associated impoundments impact both principle constituent elements defined in the Endangered Species Act listing of the species: migratory corridors and spawning and rearing habitat. In addition, the Anson and Abenaki project also impact historical salmon habitat but are not within the current critical habitat listing for Atlantic salmon. These two projects also are located much further upstream and have a lesser impact on other anadromous species.

For simplicity, the calculations of habitat value (Table 12) are based on blocked habitat and do not include adjacent habitat impacts. The sum of rearing habitat impacted by the six dams is roughly 93,369 units. The quantity of rearing habitat used for this calculation is based on a modeling approach developed by Wright et al. (2008). The sum of measured spawning habitat impacted by the four dams is roughly 2,145 units. Spawning habitat has been identified by habitat surveys, but the majority of habitat in the watershed has not been surveyed and thus the quantity of spawning habitat used in this calculation represents only a portion of actual spawning habitat in the Kennebec watershed. If the fee schedule developed for the Kennebec River is applied to the total habitat impacted by the six dams, the cost to restore, enhance, create, or preserve in order to mitigate for the lost habitat would be approximately $463.8 million for projects below Williams and over $1 billion for all historic salmon habitat. While this approach is appropriate for estimating the monetary value of the impact to habitat in the Kennebec River, the quantity of habitat that is impacted is so great that it is impossible to replace in-kind.

6.0 Restoration goals and objectives

6.1 Goals and objectives

The State's overarching goal for the Kennebec River is to restore and guide the management of diadromous fish populations, aquatic resources and the ecosystems on which they depend, for their intrinsic, ecological, economic, recreational, scientific, and educational values for use by the public. Specific goals are to 1) restore Maine's native diadromous fishes to their historic habitat and in sufficient abundance, 2) provide safe, timely, and effective upstream and downstream passage for diadromous fishes, 3) maintain or improving abiotic (physical) and biotic habitat for diadromous fishes using ecosystem-based management, and 4) increase opportunity for recreational and commercial fisheries within the next 30 years.

1.The goal for **shortnose sturgeon, Atlantic sturgeon, striped bass, and rainbow smelt** is to maintain or improve existing habitat access, habitat quantity and habitat quality in the Kennebec River.

2. The goal for **Atlantic salmon** is to restore a minimum population of 2,000 adults annually to historic habitats (identified in Table 12) in the Kennebec River and to provide safe, timely, and effective passage.

3.The goal for **American Shad** is to

- Achieve and sustain a minimum population of 1,018,000 adults entering the mouth of the Kennebec River annually based on 5,015 hectares of spawning and nursery habitat in the mainstem and identified tributaries;
- Achieve and maintain an adult return of a minimum of 203 adults/hectare;
- Achieve and sustain a minimum population of 509,000 adult American shad above Augusta;
- Pass at least 303,500 adult American shad at the Lockwood and Hydro Kennebec Project dams;
- Pass at least 260,500 adult American shad at the Shawmut Project dam;
- Pass at least 156,600 adult American shad at the Weston Project dam; and
- Pass at least 99,200 adult American shad at the Benton Falls Project dam.

4.The goal for **blueback herring,** is to

- Achieve and sustain a minimum population of 6,000,000 adults entering the mouth of the Kennebec River annually based on 5,015 hectares of spawning and nursery habitat in the main stem and identified tributaries;
- Achieve and maintain an adult return of a minimum of 1,196 adults/hectare (484/acre);
- Achieve and sustain a minimum population of 3,000,000 adults above Augusta;
- Pass at least 1,788,000 adults at the Lockwood and Hydro Kennebec Project dams;
- Pass at least 1,535,000 adults at the Shawmut Project dam;
- Pass at least 922,400 adults at the Weston Project dam; and
- Pass at least 585,000 adults at the Benton Falls Project dam.

5.The goal for **alewife** is to

- Achieve and maintain an adult return that exceeds a minimum of 581.5 adults/hectare (235/acre) and is consistent with the Maine State average of 988.4/ha (400/acre);
- Achieve and sustain a minimum population of 5,785,000 adults above Augusta;
- Pass at least 608,200, adults at the Lockwood, Hydro Kennebec, and Shawmut project dams;
- Pass at least 473,500 adults at the Weston Project dam; and
- Pass at least 4,540,200 adults at the Benton Falls Project dam.

6.The goal for **sea lamprey** is to provide safe, timely, and effective upstream and downstream passage throughout its historically accessible habitat.

7. The goal is to provide safe, timely, and effective upstream and downstream passage for **American eel** throughout its historically accessible habitat.

6.2 Actions, standards, justifications to meet goals

1. The Licensee shall be responsible for providing, operating, maintaining, and evaluating **volitional upstream fish passage** facilities at the Lockwood, Hydro Kennebec, Shawmut, and Weston projects that shall be capable of passing the minimum populations annually in a

safe, timely, and effective manner. MDMR recommends that each project facility shall be considered to be performing in a safe, timely, and effective manner if:

1.1. At least 99% of the adult Atlantic salmon that pass upstream at the next downstream dam (or approach within 200 m of the project powerhouse) pass upstream at the project within 48 hours;

1.2. At least 70% of the adult American shad that pass upstream at the next downstream dam (or approach within 200 m of the project powerhouse) pass upstream at the project within 72 hours;

1.3. At least 90% of the adult blueback herring that pass upstream at the next downstream dam (or approach within 200 m of the project powerhouse) pass upstream at the project within 72 hours;

1.4. At least 90% of the adult alewife that that pass upstream at the next downstream dam (or approach within 200 m of the project powerhouse) pass upstream at the project within 72 hours; and

1.5. At least 80% of the adult sea lamprey that pass upstream at the next downstream dam (or approach within 200 m of the project powerhouse) pass upstream at the project within 48 hours.

2. The Licensee shall operate the upstream passage daily (24 hours/day) from May 1 through July 30 and daily (daylight hours) from August 1 through November 10 in order to pass all species (Table 10).
3. The upstream passage facility shall adhere to the USFWS design criteria (USFWS 2019).
4. On May 1, the year following construction of the facility, the Licensee shall initiate three consecutive years of upstream passage 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 MDMR and the other regulators and resource agencies. Annual reports that describe the study, its results, and conclusions shall be submitted to the resource agencies by December 1 of each year the study is conducted. Based on the results of the annual reports, the regulators may require adjustments to the study methodology for the next year's evaluation.
5. If MDMR and other resource agencies or regulatory bodies determine the results **in any year** of the 3-year study show that the fish passage facility is not performing effectively, regulators shall require the construction of a new upstream fishway, to be operated concurrently with the existing fishway. This new fishway may replace an existing ineffective fishway or be a second or third fishway depending on the existing fishway(s). The new upstream fishway shall be designed using USFWS passage criteria within 2 years of the determination by MDMR and other resource agencies that the upstream fish passage is not performing effectively. The new facility shall meet all of the criteria in paragraph B.
6. After the new fishway becomes operational, the Licensee shall immediately 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) as described in paragraph D.

7. The Licensee shall be responsible for providing, operating, maintaining, and evaluating a **volitional downstream fish passage facilities** at the Lockwood, Hydro Kennebec, Shawmut, and Weston projects 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 manner. MDMR recommends that each project facility shall be considered to be performing in a safe, timely, and effective manner if:
   - 7.1. At least 99% of the Atlantic salmon smolts and kelts that pass downstream at the next upstream hydropower dam (or approach within 200 m of the project spillway) pass the project within 24 hours;
   - 7.2. 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 project spillway) pass the project within 24 hours.
   - 7.3. At least 95% of the adult and juvenile alewife that pass downstream at the next upstream hydropower dam (or within 200 m of the project spillway) pass the project within 24 hours.
8. The downstream passage facility shall adhere to the USFWS design criteria (USFWS 2019).
9. The Licensee shall operate the downstream passage daily (24 hours/day) from April 1 through August 14, daily (24 hours/day) from August 15 through October 31, and daily (daylight hours) from November 21 through December 31 (or until winter shutdown) in order to pass all species and life stages (Table 10).
10. Non-emergency maintenance at projects shall be conducted during the first two weeks in August whenever possible.
11. On May 1, 2023, the Licensee shall initiate three consecutive years of downstream passage 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 alewife, adult American eel, and microphthalmia sea lamprey. The study plans shall be developed in consultation with, and require approval by, the MDMR and other regulators and resource agencies. Annual reports that describe the study, its results, and conclusions shall be submitted to the resource agencies by December 1 of each year the study is conducted. Based on the results of the annual reports, the regulators may require adjustments to the study methodology for the next year's evaluation.
12. If MDMR and other resource agencies and regulators determine the results **in any year** of the 3-year study show that the fish passage facility is not performing effectively, regulator shall require additional measures including, but not limited to: 1) increased downstream passage flow during the passage season, 2) reduced generation and spill during the passage season, 3) screening of turbine intakes, or 4) construction of a new bypass channel. Measures 1 or 2 would be instituted immediately. Measures 3 or 4 would be instituted within 2 years of the determination by MDMR and other resource agencies that the downstream fish passage is not performing effectively. The additional measures shall be designed using USFWS passage criteria and shall meet all of the criteria in paragraph H.

13. After the new measures become operational, the Licensee shall immediately conduct three consecutive years of effectiveness testing using radio telemetry or an equivalent technique for each of the species and life stages as described in paragraph K.
14. If one or more of the projects (Lockwood, Hydro Kennebec, Shawmut, or Weston) is decommissioned and the project dam removed, the MDMR may amend the criteria for safe, timely and effective volitional upstream fish passage defined in 6.2 for one or more species, based on the fish passage performance at the remaining projects.

Supporting Narrative

As a state agency responsible for managing diadromous fish and their habitat, MDMR recommends that the Shawmut Project and the Lockwood Project be decommissioned, and the dams removed. MDMR also recommends that the Hydro-Kennebec and Weston projects be considered for decommissioning and removal pending further investigation of fish passage performance at Hydro-Kennebec and further technical assessments and community outreach at the Weston project. 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, 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.

Our section 10(a) recommendation for decommissioning and removal is consistent with the following FERC approved comprehensive plans for Maine:

- Maine State Planning Office. 1993. Kennebec River Resource Management Plan.
- Atlantic States Marine Fisheries Commission. 1999. Amendment 1 to the Interstate Fishery Management Plan for shad and river herring.
- Atlantic States Marine Fisheries Commission. 2009. Amendment 2 to the Interstate Fishery Management Plan for shad and river herring.
- Atlantic States Marine Fisheries Commission. 2010. Amendment 3 to the Interstate Fishery Management Plan for shad and river herring.
- Atlantic States Marine Fisheries Commission. 2000. Interstate Fishery Management Plan for American eel (*Anguilla rostrata*).
- Atlantic States Marine Fisheries Commission. 2008. Amendment 2 to the Interstate Fishery Management Plan for American eel.
- Atlantic States Marine Fisheries Commission. 2013. Amendment 3 to the Interstate Fishery Management Plan for American eel.
- Atlantic States Marine Fisheries Commission. 2014. Amendment 4 to the Interstate Fishery Management Plan for American eel.
- U.S. Fish and Wildlife Service and NMFS. 2019. Recovery plan for the Gulf of Maine Distinct Population Segment of Atlantic salmon (*Salmo salar*).

These 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 and NMFS 2019) states that dam removal might be necessary for the reclassification or delisting of the endangered Atlantic salmon. The 1993 Plan (MSPO 1993) recommended the removal of Edwards Dam to restore and enhance populations of shortnose sturgeon, Atlantic sturgeon, striped bass, and rainbow smelt to historical habitat in the Kennebec River, and those species responded quickly and positively to the removal by recolonizing habitat previously blocked by the former dam.

Removal of dams on the Kennebec would eliminate direct project impacts and reduce cumulative impacts on indigenous diadromous species in the Kennebec River. These impacts include mortality and injury of adults and juveniles, migratory delays, reduced river productivity, thermal alteration, water quality impairment, predation due to impoundments, reductions in nutrient and energy exchange between freshwater and marine ecosystems, alteration of the natural hydrologic regime, and restriction to sediment and organic material transfer. MDMR is not aware of any examples on the east coast of self-sustaining populations of Atlantic salmon, American shad, blueback herring, alewife, sea lamprey, and American eel above four hydropower dams. MDMR's analysis has shown that self-sustaining populations of diadromous fish, especially the endangered Atlantic salmon, are possible in the Kennebec River, now or in the future, only if very high-performance standards for fish passage are consistently achieved at each of the mainstem project dams. MDMR's review of effectiveness studies conducted in Maine demonstrates that our recommended performance standards are not achievable based on current proposed fishways by the Licensee.

The Licensee commissioned a study, *Energy Enhancements and Lower Kennebec Fish Passage Improvements Study* (Feasibility Study), for stakeholder review and comment on May 20, 2019 FERC Accession #s 20190701-5155 and 20190701-5154). The Feasibility Study considered several fish passage options, one being dam removal, for the Shawmut, Lockwood, and Weston projects. Removal of those projects was determined to be feasible and reasonably practical. Therefore, this recommendation should be given full consideration.

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Appendix A. Tables and Figures

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
1987-2006	MDMR stocks 1.3 million river herring into historic habitat above Edwards Dam
1987-1997	MDMR stocks American shad adults (1,849), fry (44.6 million) and fingerlings (197,176) into historic spawning habitat above Edwards Dam
1988-2006	Interim, downstream passage operational at Benton Falls, Fort Halifax, Burnham, Lockwood, Shawmut, and Hydro Kennebec projects
1992	Interim upstream passage (fish pump) installed at Edward Dam
1993	Kennebec River Resource Management Plan
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 (Sebasticook River)
2003	MDMR completes upstream passage at Sebasticook Lake (Sebasticook River)
2003	MDMR initiates salmon stocking (eggs, fry, returning adults) in Sandy River
2003	Relicensing of Abenaki and Anson project
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)
2009	Expanded listing of the GOM DPS of Atlantic salmon including Kennebec River
2012-2013	Interim Species Protection Plans (ISPP) for Atlantic salmon for Kennebec River and Androscoggin River
2012-2014	Downstream passage effectiveness studies for Atlantic salmon smolts at Lockwood, Hydro Kennebec, Shaw, and Weston
2016	Fish lift operational at Hydro Kennebec Project
2016-2017	Upstream passage studies of adult Atlantic salmon at the Lockwood Project
2017	Relicensing of the Williams 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 Pond
2020	MDMR develops Amendment to the 1993 Plan

Table 2. Total number of river herring, number of river herring that were estimated to be 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 3. 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	568				561,309
Sandy (4 lakes)	479				473,510
Totals			509,035	2,999,004	1,034,819

Table 4. Location and amount of alewife spawning habitat in the Kennebec River drainage and number of downstream barriers. Accessible lakes and ponds are shown in bold. The number of hydropower dams are shown first, followed by the number of non-hydropower dams in parentheses.

Subwatershed	Water body	Surface hectares	Number of dams
Sandy River	Clearwater Pond	322	6 (1)
Sandy River	Norcross Pond	46	6 (1)
Sandy River	Parker Pond	42	6 (1)
Sandy River	North Pond	70	6 (1)
Wesserunsett Stream	Wesserunsett Lake	568	3(2)
Sebasticook River	**Pattee Pond**	288	0 (0)
Sebasticook River	China Lake	1,587	0 (4)
Sebasticook River	Lovejoy Pond	131	1 (1)
Sebasticook River	**Unity Pond**	1,023	1 (0)
Sebasticook River	**Pleasant Pond**	311	2 (2)
Sebasticook River	**Plymouth Pond**	194	2 (1)
Sebasticook River	**Sebasticook Lake**	1,735	2 (1)
Sebasticook River	Wassokeag Lake	430	4 (4)
Sebasticook River	Big Indian Pond	401	4 (3)
Sebasticook River	Douglas Pond	212	4 (0)
Sebasticook River	Great Moose Lake	1,450	4 (2)
Sebasticook River	Little Indian Pond	58	4 (3)
Seven-Mile Stream	**Webber Pond**	507	0 (1)
Seven-Mile Stream	**Three-Mile Pond**	436	0 (1)
Seven-Mile Stream	**Spectacle Pond**	56	0 (1)
Seven-Mile Stream	Three Cornered Pond	79	
Cobbosseecontee Stream	Pleasant Pond	302	1 (2)
Cobbosseecontee Stream	Cobbosseecontee Lake	2,243	1 (4)
Cobbosseecontee Stream	Woodbury Pond	176	1 (4)
Cobbosseecontee Stream	Annabessacook Lake	575	1 (5)
Cobbosseecontee Stream	Narrows Pond	217	1 (5)
Cobbosseecontee Stream	Cochnewagan Lake	156	1 (6)
Cobbosseecontee Stream	Wilson Pond	232	1 (7)
Cobbosseecontee Stream	Maranacook Lake	677	1 (6)
Cobbosseecontee Stream	Torsey Pond	312	1 (8)
Total		14,779	

Table 5. Historic and currently accessible anadromous spawning habitat and catadromous growth habitat in the Kennebec River watershed. Before the construction of dams, natural barriers such as Taconic Falls (current location of the Lockwood Project) and Norridgewock Falls (current location of the Abenaki and Anson proejcts) prevented the upstream migration of diadromous fishes. Species are listed from those with the shortest upstream range to the longest.

Species	Historic range	Current accessible range
Atlantic tomcod	Mainstem to head-of tide	Mainstem to head-of tide
Rainbow smelt	Mainstem to Lockwood Dam	Mainstem to Lockwood Dam
Shortnose sturgeon	Mainstem to Lockwood Dam	Mainstem to Lockwood Dam
Atlantic sturgeon	Mainstem to Lockwood Dam	Mainstem to Lockwood Dam
Striped bass	Mainstem to Lockwood Dam; Sebasticook to Benton Falls Dam	Mainstem to Lockwood Dam; Sebasticook to Benton Falls Dam
American shad	Mainstem to Abenaki Dams; Sandy River to Rt 4	Mainstem to Lockwood Dam (truck stocking upstream)
Blueback herring	Mainstem to Lockwood Dam; Sandy River to Rt 4	Mainstem to Lockwood Dam (truck stocking upstream)
Alewife	Mainstem to Abenaki Dam; 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-above Williams Dam	Above Williams Dam

Table 6. Percent of land cover types summarized for three major areas in the Kennebec River watershed: (A) Lower Kennebec (below Wyman Dam), (B) Upper Kennebec (above Wyman Dam excluding the Dead River), and (C) the Dead River. Percent land cover for the Carrabassett River and the Sandy River, historic spawning habitat for Atlantic salmon, has been separated from Lower Kennebec summary.

Land use type	(A) Lower Kennebec	Carrabassett	Sandy	(B) Upper Kennebec	(C) Dead
Mixed Forest	29.8	25.3	30.2	24.5	24.5
Evergreen Forest	14.9	22.6	15.3	22.9	30.2
Deciduous Forest	20.9	30.2	31.6	17.2	15.9
Woody Wetlands	10.7	7.7	6.6	8.4	7.5
Water	4.6	1.8	1.3	11.5	4.5
Shrub/Scrub	3.7	5.4	4.5	7.6	10.9
Grassland/Herbaceaous	1.9	1.9	1.5	4.1	3.0
Emergent Wetlands	1.0	0.4	0.4	1.0	0.7
Pasture/Hay	6.0	1.2	3.9	0.0	0.0
Developed - Open	3.2	2.4	2.9	1.9	1.8
Developed -Low Intensity	1.7	0.6	1.0	0.4	0.3
Developed - Medium Intensity	0.6	0.2	0.3	0.1	0.1
Cultivated Crops	0.6	0.1	0.3	0.0	0.0
Barren Lands	0.2	0.1	0.1	0.3	0.5
Developed, High Intensity	0.2	0.0	0.1	0.0	0.0

Table 7. Federally licensed hydropower facilities that lie within the historic range of six diadromous fish species native to the State of Maine.

FERC Status	FERC number	Project name	Total capacity (KW)	River/stream	Expiration date
License	2574	Lockwood	6550	Kennebec	10/31/2036
License	2611	Hydro-Kennebec	15433	Kennebec	9/30/2036
License	2322	Shawmut	8650	Kennebec	1/31/2021
License	2325	Weston	14750	Kennebec	10/31/2036
License	2364	Abenaki	19917	Kennebec	4/30/2054
License	2365	Anson	9000	Kennebec	4/30/2054
License	2335	Williams	14500	Kennebec	12/31/2017
License	5073	Benton Falls	4468	Sebasticook	2/28/2034
License	11472	Burnham	1000	Sebasticook	10/31/2036
Exempt	8736	Pioneer	300	Sebasticook	
Exempt	4293	Waverly Avenue	700	Sebasticook	
License	2556	Messalonskee	6200	Messalonskee	6/30/2036
		Union Gas (M5)	1800	Messalonskee	
		Rice Rips (M3)	1600	Messalonskee	
		Oakland (M2)	2800	Messalonskee	
License	2555	Automatic (M4)	800	Messalonskee	6/30/2036
License	2809	American Tissue	1000	Cobbosseecontee	4/30/2019
Exempt	7473	Gilman Stream	120	Sandy	
Exempt	8791	Starks	35	Sandy	

Table 8. 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	60	58	0.97
Total	145,900	8,187,501	306	223	

Table 9. 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. The four-dam scenario assumes Shawmut and Lockwood have been removed. The dam scenario assumes Weston, Shawmut, Kennebec Hydro, and Lockwood have been removed.

Number of dams	Downstream mortality/dam	Upstream mortality/dam	Low M low F survival	Low M high F survival	High M low F survival	High M high F survival
6	0.01	0.01	91	274	730	2,190
6	0.04	0.05	64	193	514	1,541
5	0.01	0.01	107	321	856	2,568
5	0.02	0.02	99	296	790	2,371
5	0.03	0.03	91	274	730	2,189
5	0.04	0.04	84	252	673	2,019
4	0.01	0.01	123	369	984	2,951
4	0.02	0.02	116	347	927	2,780
4	0.03	0.03	109	327	873	2,618
4	0.04	0.04	103	308	822	2,465
4	0.04	0.05	100	299	797	2,392
2	0.01	0.01	150	451	1,203	3,609
2	0.02	0.02	147	440	1,173	3,520
2	0.03	0.03	143	429	1,144	3,433
2	0.04	0.04	140	419	1,116	3,348
2	0.04	0.05	137	412	1,099	3,297

Table 10. Baseline and adjusted downstream passage efficiencies for Atlantic salmon smolts at four Kennebec River dams, 2013-2015. Baseline values, calculated for all fish, were adjusted to include only fish that passed a dam within 24 hours.

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

Table 11. 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 12. Estimates of cost to mitigate for lost value of Atlantic salmon spawning and rearing habitat blocked by dams in the Kennebec River. *Spawning habitat has been identified by habitat surveys, but the majority of habitat in the watershed has not been surveyed and thus the quantity of spawning habitat in this table represents only a portion of actual spawning habitat in the Kennebec watershed.

	Y (Occupied) N (Unoccupied) I (Inaccessible)*	Critical Habitat	Blocked Rearing Habitat Units	Blocked Spawning Habitat Units*
Lockwood	Y	Y	93,369	Not surveyed
Hydro-Kennebec	Y	Y	91,284	Not surveyed
Shawmut	Y	Y	87,800	Not surveyed
Weston	Y	Y	74,617	2,145
Anson	N	N	38,954	Not surveyed
Abenaki	N	N	38,954	Not surveyed
Cost to Mitigate Lost Habitat				$ 463,816,081

Figure 1. Map showing historical range of diadromous species in the Kennebec River watershed, location of dams that have been removed (open circles), hydropower dams with upstream passage (green circles), hydropower dams without upstream passage (red circles), non-hydropower dams (black circles), and accessible (green) and inaccessible lakes and ponds. Hydropower dams are Edwards (ED), Hydro-Kennebec (HK), Shawmut (SH), Weston (WE), Madison Electric Works (MEW), Fort Halifax (FH), Benton Falls (BF), and Burnham (BU).

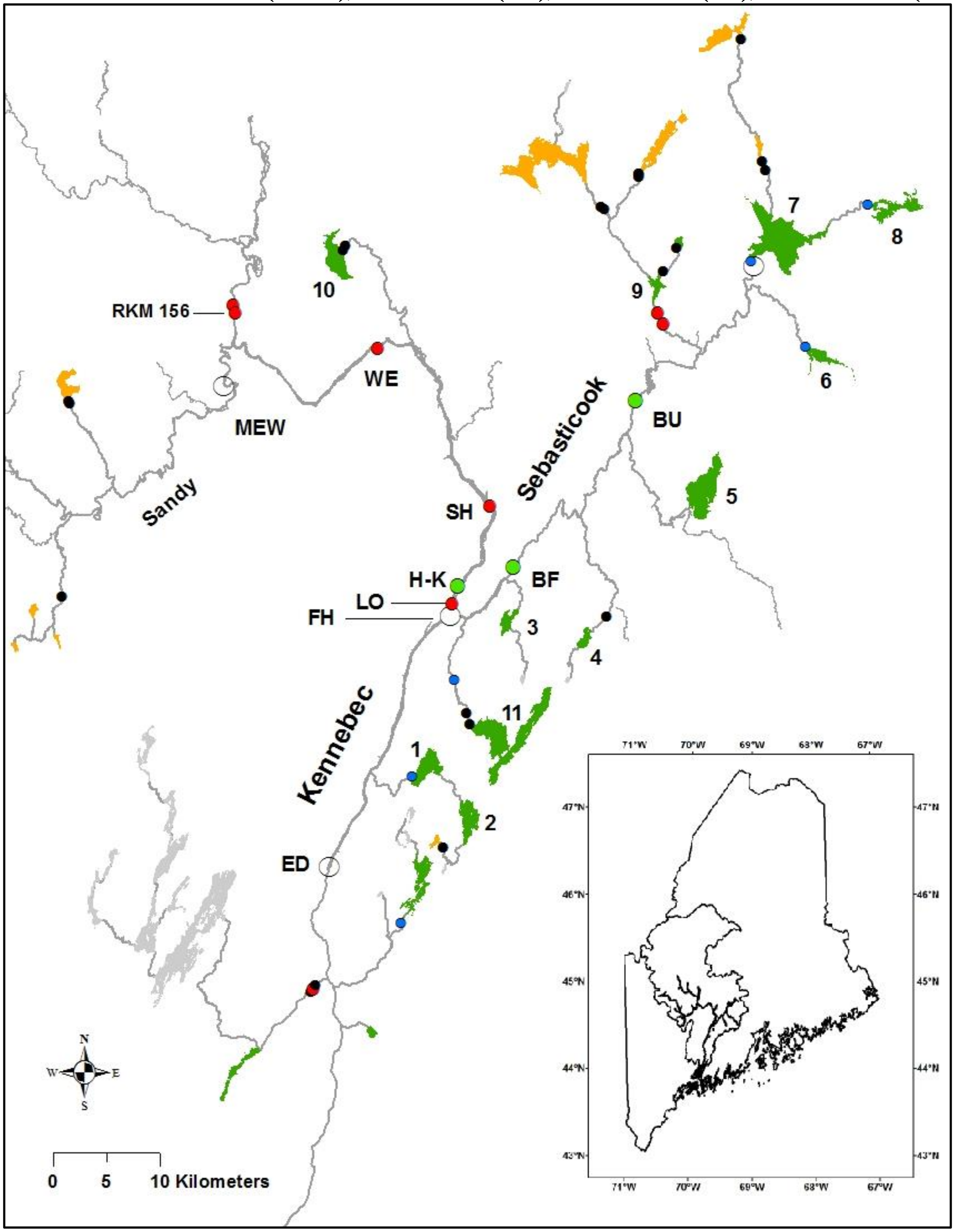


Figure 2. Estimated returns of adult Atlantic salmon to the Kennebec River as a function of the number of mainstem dams on the river, marine survival, and freshwater productivity. The mainstem dams in ascending order are: 1) Lockwood, 2) Hydro Kennebec, 3) Shawmut, 4) Weston, 5) Abenaki, and 6) Anson. The five-dam scenario removes 1); the four-dam scenario removes 1) and 3); and the two-dam scenario removes 1), 2), 3) and 4). Low marine survival and low freshwater production (light blue bars); Low marine survival and high production (dark blue bars); high marine survival and low freshwater production (light gray bars), and high marine survival and high freshwater production (dark gray bars). Thin red line is number of fish needed for downlisting, and thick red line is minimum number of fish needed for delisting.

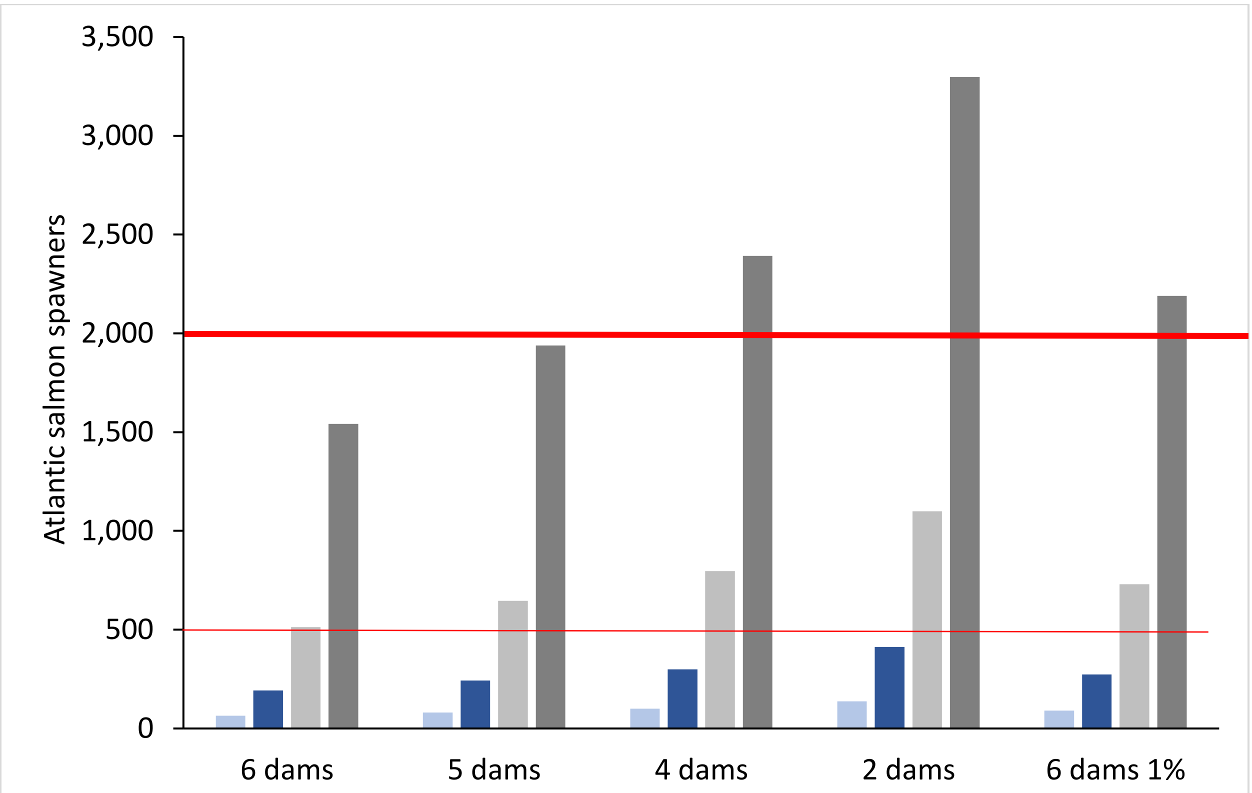


Figure 3. Modeled downstream (DS) passage efficiency (Panel A 95%; B 90%; and C 95%) and upstream passage efficiency needed to produce the minimum number of adult alewife returns meet Atlantic State Marine Fisheries Commission's threshold (235/acre) and to be consistent with the Maine mean escapement (400/acre).

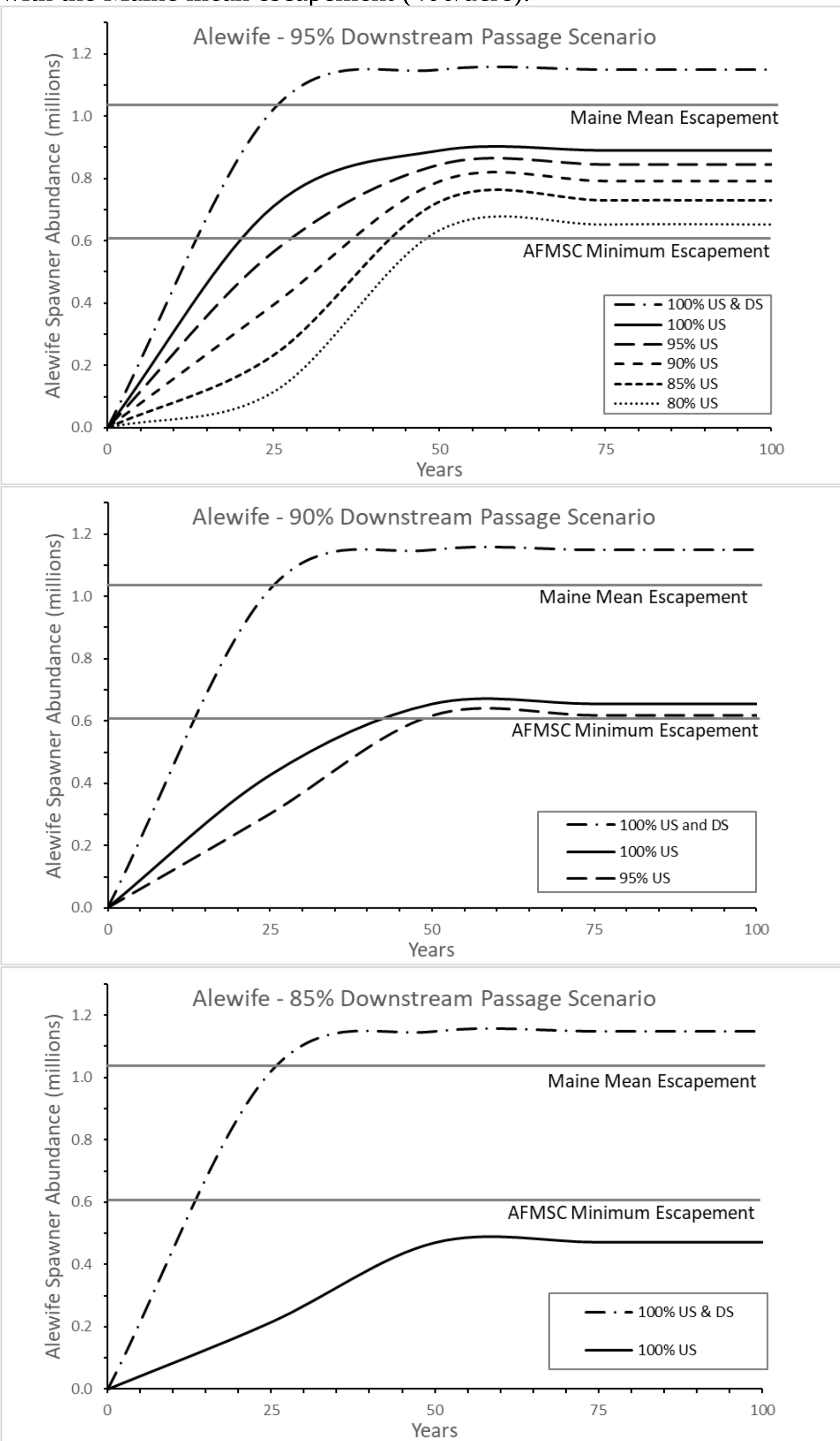
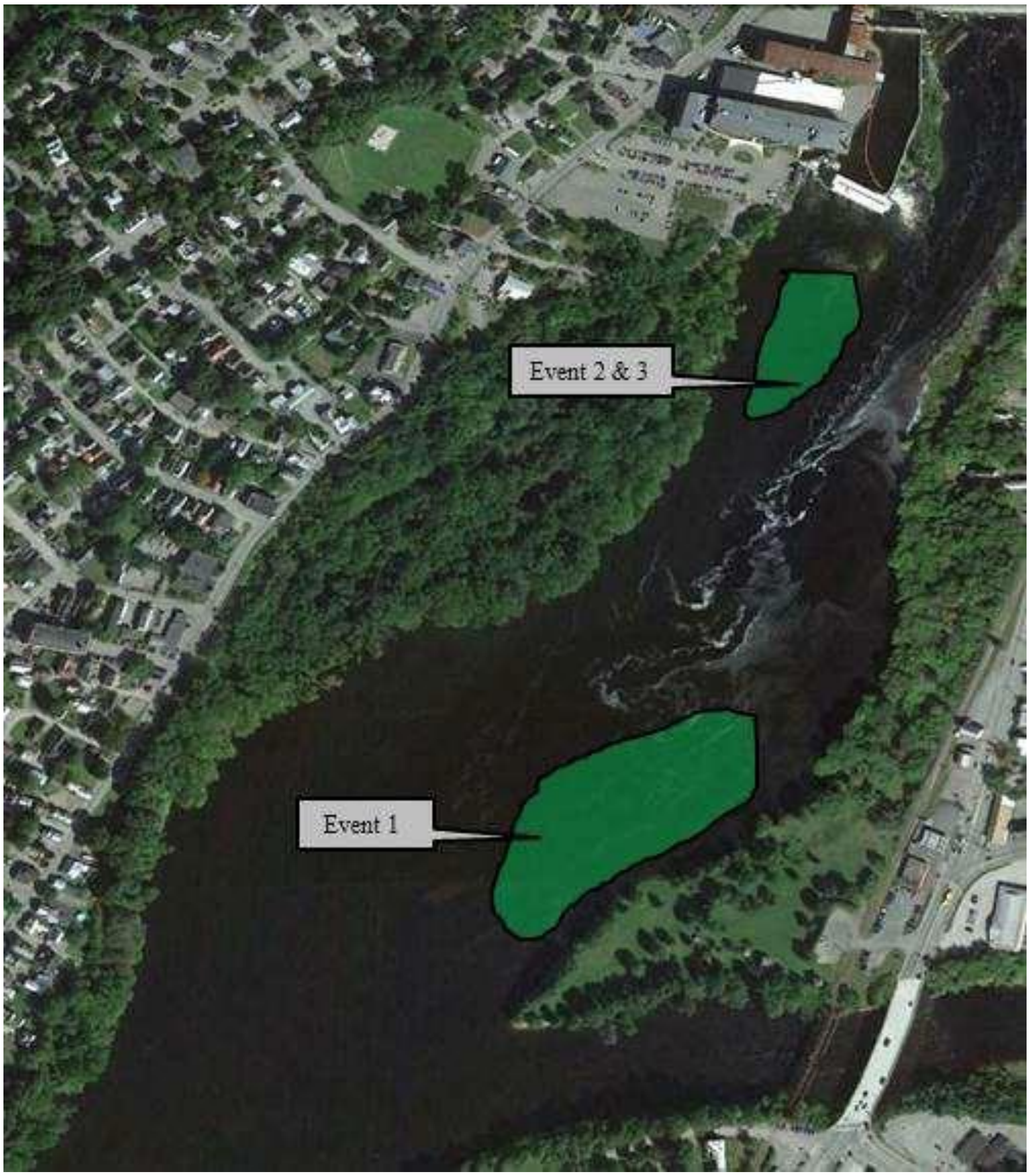


Figure 4. Aerial view of the Lockwood Project tailrace showing locations (green polygons) where American shad were captured for a radio telemetry study in 2015.



Appendix B. Water Quality

A. Kennebec River, main stem.
(1) From the east outlet of Moosehead Lake to a point 1,000 feet below the lake - Class A.
(2) From the west outlet of Moosehead Lake to a point 1,000 feet below the lake - Class A.
(3) From a point 1,000 feet below Moosehead Lake to its confluence with Indian Pond - Class AA.
(4) From Harris Dam to a point located 1,000 feet downstream from Harris Dam - Class A.
(5) From a point located 1,000 feet downstream from Harris Dam to its confluence with the Dead River - Class AA.
(6) From its confluence with the Dead River to the confluence with Wyman Lake, including all impoundments - Class A.
(7) From the Wyman Dam to its confluence with the impoundment formed by the Williams Dam - Class A.
(8) From the confluence with the Williams impoundment to the Route 201A bridge in Anson-Madison, including all impoundments - Class A.
(9) From the Route 201A bridge in Anson-Madison to the Fairfield-Skowhegan boundary, including all impoundments - Class B.
(10) From the Fairfield-Skowhegan boundary to the Shawmut Dam - Class C.
(10-A) From the Shawmut Dam to its confluence with Messalonskee Stream, excluding all impoundments - Class B.
(a) Waters impounded by the Hydro-Kennebec Dam and the Lockwood Dam in Waterville-Winslow - Class C.
(11) From its confluence with Messalonskee Stream to the Sidney-Augusta boundary, including all impoundments - Class B.
(12) From the Sidney-Augusta boundary to the Calumet Bridge at Old Fort Western in Augusta, including all impoundments - Class B.
(13) From the Calumet Bridge at Old Fort Western in Augusta to a line drawn across the tidal estuary of the Kennebec River due east of Abagadasset Point - Class B. Further, the Legislature finds that the free-flowing habitat of this river segment provides irreplaceable social and economic benefits and that this use must be maintained. Further, the license limits for total residual chlorine and bacteria for existing direct discharges of wastewater to this segment as of January 1, 2003 must remain the same as the limits in effect on that date and must remain in effect until June 30, 2009 or upon renewal of the license, whichever comes later. Thereafter, license limits for total residual chlorine and bacteria must be those established by the department in the license and may include a compliance schedule pursuant to section 414-A, subsection 2.
(14) From a line drawn across the tidal estuary of the Kennebec River due east of Abagadasset Point, to a line across the southwesterly area of Merrymeeting Bay formed by an extension of the Brunswick-Bath boundary across the bay in a northwesterly direction to the westerly shore of Merrymeeting Bay and to a line drawn from Chop Point in Woolwich to West Chop Point in Bath - Class B. Further, the Legislature finds that the free-flowing habitat of this river segment provides irreplaceable social and economic benefits and that this use must be maintained. [RR 2009, c. 1, §30 (COR).]
B. Carrabassett River Drainage.
(1) Carrabassett River, main stem.
(a) Above a point located 1.0 mile above the dam in Kingfield - Class AA.

(b) From a point located 1.0 mile above the dam in Kingfield to a point located 1.0 mile above the railroad bridge in North Anson - Class A.
(c) From a point located 1.0 mile above the railroad bridge in North Anson to its confluence with the Kennebec River - Class B.
(2) Carrabassett River, tributaries - Class A unless otherwise specified.
(a) South Branch Carrabassett River - Class AA. The Legislature finds, however, that permitted water withdrawal from this river segment provides significant social and economic benefits and that this existing use may be maintained.
(b) All tributaries entering the Carrabassett River below the Wire Bridge in New Portland - Class B.
(c) West Branch Carrabassett River above its confluence with Alder Stream - Class AA. [PL 1999, c. 277, §5 (RPR).]

C. Cobbosseecontee Stream Drainage.

(1) Cobbosseecontee Stream, main stem - Class B.
(2) Cobbosseecontee Stream, tributaries - Class B. [PL 1989, c. 228, §2 (RPR).]

E. Messalonskee Stream Drainage.

(1) Messalonskee Stream, main stem.
(a) From the outlet of Messalonskee Lake to its confluence with the Kennebec River, including all impoundments except Rice Rips Lake - Class C.
(2) Messalonskee Stream, tributaries - Class B unless otherwise specified.
(a) Rome Trout Brook in Rome - Class A.

G. Sandy River Drainage.

(1) Sandy River, main stem.
(a) From the outlet of Sandy River Ponds to the Route 142 bridge in Phillips - Class AA.
(b) From the Route 142 bridge in Phillips to its confluence with the Kennebec River - Class B.
(2) Sandy River, tributaries - Class B unless otherwise specified.
(a) All tributaries entering above the Route 142 bridge in Phillips - Class A.
(b) Wilson Stream, main stem, below the outlet of Wilson Pond - Class C.

H. Sebasticook River Drainage.

(1) Sebasticook River, main stem, including all impoundments.
(a) From the confluence of the East Branch and the West Branch to its confluence with the Kennebec River - Class C.
(2) Sebasticook River, tributaries - Class B unless otherwise specified.
(a) Sebasticook River, East Branch from the outlet of Corundel Lake to its confluence with the West Branch - Class C.
(b) Sebasticook River, West Branch main stem, from the outlet of Great Moose Lake to its confluence with the East Branch, including all impoundments - Class C.
(c) Johnson Brook and tributaries in Burnham - Class A.
(d) Martin Stream and tributaries upstream of the Ridge Road in Plymouth - Class A.
(e) Halfmoon Stream upstream of Route 220 in Thorndike and Knox - Class A.
(f) Crosby Brook in Unity and Thorndike - Class A.
(g) Hall Brook in Thorndike - Class A. [PL 2003, c. 317, §9 (RPR).]

I. Kennebec River, minor tributaries - Class B unless otherwise specified.

(1) All minor tributaries entering above Wyman Dam that are not otherwise classified - Class A.
(2) All tidal portions of tributaries entering between the Sidney-Vassalboro-Augusta town line and a line drawn across the tidal estuary of the Kennebec River due east of Abagadasset Point - Class B, unless otherwise specified.

(a) Eastern River from head of tide to its confluence with the Kennebec River - Class C.
(3) Cold Stream, West Forks Plantation - Class AA.
(4) Moxie Stream, Moxie Gore, below a point located 1,000 feet downstream of the Moxie Pond dam - Class AA.
(5) Austin Stream and its tributaries above the highway bridge of Route 201 in the Town of Bingham - Class A.
(6) East Branch Wesserunsett Stream above the downstream Route 150, Harmony Road, crossing in Athens - Class A.
(7) Tributaries to East Branch Wesserunsett Stream - Class A. [PL 2019, c. 333, §2 (AMD).]
[PL 2019, c. 333, §2 (AMD).]