Opinion of Randy Bailey

1.0 Introduction

For this report, I was asked to evaluate the impacts of four dams on the Kennebec River (Lockwood, Hydro Kennebec, Shawmut, and Weston) and three dams on the Androscoggin River (Brunswick, Pejepscot, and Worumbo) on the behavior, habitat, and mortality to adult and juvenile Atlantic salmon which are listed as Endangered under the auspices of the Endangered Species Act (ESA). I was also asked to assess the impacts that these dams have on the recovery potential of the Gulf of Maine Distinct Population Segment (GOM DPS) of Atlantic salmon in general; suggest a list of interim measures that could be implemented immediately or in the very near future to mitigate the dams' impacts on salmon; and generally evaluate why it is important to the conservation of the species to begin implementation of concrete measures to avoid or reduce the mortality levels associated with the projects' infrastructure and operations. For the Kennebec River dams, I was asked to evaluate whether adult Atlantic salmon and American shad are present above the dams and whether any scientifically defensible, quantitative, site-specific studies have been conducted to assess the impacts of these dams on Atlantic salmon and American shad adults passing through turbines.

This report is divided into sections. **Section 1** is the introduction which outlines the issues addressed in this report and explains its format. **Section 2** contains a brief summary of my education, experience, and qualifications. **Section 3** contains a brief summary of my assessment of the status of the Atlantic salmon populations in the Kennebec and Androscoggin rivers. **Section 4** contains a brief background history on why the Atlantic salmon in these two rivers were listed, as well as some information on the Principal Component Elements (PCE's) of spawning and rearing habitats and migration corridors that will form the basis for developing a recovery plan for the conservation of the species. Section 4 also contains the list of factors I used to assess the impacts of each individual dam. These factors are directly related to my assessment of whether death, injury, or adverse change in habitat or fish behavior has been occurring at each dam. **Section 5** contains a brief summary of my conclusions regarding the dams' impacts on downstream migration of Atlantic salmon smolts and kelts (post spawning adults returning to the ocean), impacts on upstream migration including blockage and/or delay in passage, a brief summary of changes in habitats resulting from the project being in place, and a brief evaluation of the cumulative impacts of the two series of dams on the Atlantic salmon populations in the rivers. **Section 6** contains a review of the pertinent literature regarding mortality of fish passing through hydropower turbines and a description of the methods and flow data used to assess what percentage of time, based on historical flow records, all of the river flows could potentially pass through a project's turbines during the critical migration time periods (April – June and October – November) for Atlantic salmon. **Section 7** contains the assessment of each individual dam on the Kennebec River using the seven factors identified in Section 4. **Section 8** contains the same analysis for the three Androscoggin River dams. **Section**

9 is a brief assessment of the consequences to the Atlantic salmon populations of further delaying implementation of improvements in project operations and both upstream and downstream fish passage. **Section 10** is my evaluation comparing my experiences working with ESA listed fish species, the associated scientific studies, and restoration efforts in California and Oregon, with my impressions of what has been occurring in the Kennebec and Androscoggin watersheds. A list of references cited in the report is included at the end.

2.0 Qualifications and Experience

2.1 I am the owner and principal senior fishery scientist of my own aquatic resource consulting firm, Bailey Environmental. My office is located at 18294 S. Scotts Lane, Oregon City, OR.

2.2 I have 20 years of experience as a fishery biologist in various positions with the Federal government, including 9 years as the Chief of the Fisheries Division in the Alaska Regional Office of the U.S. Fish and Wildlife Service. In addition, I have 16 years of fishery biology consulting experience specializing in Endangered Species Act (ESA) issues, where my work has involved the evaluation of the impacts of human development on aquatic ecosystems, and the evaluation of scientific studies, reports, and environmental documents related to ESA compliance.

2.3 During my years of federal service, I was involved in numerous projects regarding ESA-listed fish species. My work with these projects included evaluating the impacts of resource development on listed species, planning and implementing habitat restoration projects for anadromous salmonids in the western United States, and designing and managing field studies on the life histories of Pacific salmon and other cold water fish species common to the west and Alaska. In my last federal position, I served as the Fish and Wildlife Program Manager for the Portland, Oregon, District of the U.S. Army Corps of Engineers. In this capacity, I was responsible for providing funding and program oversight for fish passage operations, involving numerous ESA-listed fish species, at 11 hydroelectric dams: three main-stem Columbia River dams and eight dams on four tributaries to the Willamette River in Oregon. In this position, I was responsible for the updating and modernization of four fish-trapping facilities on the four Willamette River tributaries and their associated “trap and truck” programs for ESA-listed winter steelhead and spring Chinook salmon. I also was responsible for interagency coordination regarding the development and implementation of an ESA Section 7 consultation for the operation of 8 dams in the Willamette River watershed, including provision for fish passage over the eight dams, and management of six associated genetics conservation hatchery programs.

2.4 In my consulting business, I have specialized in dealing with issues related to ESA-listed fish species for various clients. I have helped clients with a Section 7 consultation on Southern

California steelhead trout; provided technical review of various ESA documents, including biological opinions, recovery plans, and ecosystem restoration programs; provided policy recommendations on ESA issues; assisted in the development of the biological assessment for a consultation on operations of the California State Water Project (SWP) and the federal Central Valley Project (CVP); developed a portion of new water quality standards for the Sacramento/San Joaquin Delta; and provided technical review of over $500 million of habitat restoration projects for ESA-listed salmon and steelhead in Central California. I have developed or co-developed two ecosystem restoration plans aimed at protecting or improving conditions for listed species: one for two tributary watersheds to the Sacramento River, and one for the impacts of SWP and CVP operations with an estimated cost of approximately $5 billion. I believe that my experience with Pacific salmon and steelhead are directly applicable to Atlantic salmon, since these species have very similar life histories and habitat requirements.

2.5 I have a B.S. in Natural Resources Management, with an emphasis in Fish and Wildlife Management, from California Polytechnic State University, and an M.S. in Wildlife Management, with an emphasis in Fisheries Science, from Virginia Polytechnic Institute and State University. I am a Fellow Emeritus of the American Institute of Fishery Research Biologists, and am a Life Member of the American Fisheries Society, where I have held various offices and committee memberships over the past 40 years. A list of my publications is in the attached resume.

2.6 In preparing this report, I have personally reviewed the documents listed in the references section of this report, and other reports associated with the dams and individual studies and a number of the annual fish passage reports on both the Kennebec and Androscoggin rivers. Also, I was able to tour each of the dams and have my questions answered by representatives of the various owners/operators of the projects. In addition, I have had discussions with numerous representatives of federal and State of Maine resource agencies involved with Atlantic salmon and hydroelectric dams.

2.7 I have not testified as an expert witness within the last four years in any other case. I am being compensated by the plaintiffs at the rate $120.00 per hour.

3.0 Status of Gulf of Maine Atlantic Salmon Distinct Population Segment (GOM DPS)

The GOM DPS was listed in 2000 and further expanded and listed as Endangered under the authority of the ESA in 2009 (National Marine Fisheries Service and U.S. Fish and Wildlife Service 2009). Several reasons were cited for the decision to list, including:

- The small wild population levels in all rivers containing Atlantic ,
- The dependence on a conservation hatchery program to sustain the largest individual population in the Penobscot until restoration actions can be implemented,
- The potential to create a genetic bottleneck and reduce the level of genetic diversity in the populations as a whole,
- The lack of sufficient geographic distribution and habitat diversity to create conditions that would stabilize the population's viability and allow genetic selection to continue to operate on the population.

The National Research Council, the 2006 GOM DPS Status Review Team assembled by the National Marine Fisheries Service, and the final rule on the listing decision all cite the presence of dams as the single most important factor in depressing the Atlantic salmon populations in the GOM DPS (National Research Council 2004, Fay et al. 2006, National Marine Fisheries Service and U.S. Fish and Wildlife Service 2009). All of these sources note that historically the combination of the Androscoggin, Kennebec, and Penobscot rivers support an adult run size estimated at between 300,000 and 500,000 fish annually. These sources also state that the future of the Atlantic salmon populations in Maine depends on providing access to high quality habitats and reducing or minimizing the mortality associated with passage through dams or dam complexes.

From an ecological standpoint, these same authors concluded that having only a single, currently hatchery-dependent majority population in a single river (Penobscot) was untenable. They concluded that the key to conserving the species in Maine depended on restoring robust Atlantic salmon populations to the Androscoggin and Kennebec rivers. They noted that each watershed has an abundance of high quality habitats in the upper portion of each watershed, albeit there are a number of dams currently blocking volitional access by adult Atlantic salmon. They also concluded that providing or improving adult passage at these dams was within easy reach with current technology, and that reducing mortality of downstream migrants could be accomplished by the installation of available, effective downstream bypass systems and by taking available, effective measures to keep smolts and kelts from entering project turbines.

Small, remnant populations of Atlantic salmon have persisted in the lower Androscoggin and Kennebec rivers despite all of the pollution and obstacles that existed historically. In 2010 only

14 adults were counted in both rivers combined. However, 2011's combined count was 110 adult fish. These populations have the potential to expand if access is provided to upstream areas where suitable spawning and rearing habitats exist, and if safe downstream passage for smolts and kelts is ensured.

4.0 Background Information on Development of Recovery Criteria for Habitat Requirements and Spawning Population Levels and Factors Used to Assess Dam Impacts on Atlantic Salmon Habitat and Population Levels

4.1. Listing and Recovery Criteria – In 2009, the U.S. Fish and Wildlife Service (USFWS) and National Marine Fisheries Service (NMFS) (collectively the Services) listed the Atlantic salmon populations in the Androscoggin and Kennebec rivers as "Endangered" under the auspices of the Endangered Species Act (ESA) (74 FR 29344-29387). This listing includes the Atlantic salmon populations occurring in these river systems and the associated conservation hatchery populations being used to support recovery efforts in the Gulf of Maine Distinct Population Segment (GOM DPS). The ESA requires that critical habitat be designated concurrently with the listing determination. Critical habitat designations provide additional protections beyond the listing decision by avoiding the destruction or adverse modifications of the physical and biological features essential for the conservation of the species. The ESA requires that any proposed Federal actions not adversely modify or destroy designated critical habitat (NMFS 2009a). Critical habitat is generally defined as those specific areas within a broader geographic area in which are found the physical or biological features essential to the conservation of the species (NMFS 2009a).

In order to accommodate the variability in Atlantic salmon life history parameters and the diversity in aquatic habitats and watershed characteristics within the GOM DPS, three Salmon Habitat Recovery Units (SHRUs) were established for various geographic areas in the State of Maine (NMFS 2009a, NMFS 2009b): The Merrymeeting Bay SHRU; the Penobscot Bay SHRU; and the Downeast Coastal SHRU. The Androscoggin and Kennebec river watersheds contain most of the area within the Merrymeeting Bay SHRU. In addition to the designation of the SHRUs, an adult spawner population level was established for each SHRU. The level is based on the need to maintain genetic diversity within a SHRU and ensure sufficient juvenile production to maintain the population's viability within the SHRU over a substantial time period. The minimum levels to begin discussions regarding delisting are: an effective census population (assuming a 1:1 sex ratio) of 500 adult spawners; and an adult population level of 2,000 spawning adults in each SHRU to account for the complex age of spawning life history patterns in Atlantic salmon and the overall lower ocean productivity currently being experienced by pre-spawning juveniles in the open sea (NMFS 2009a, NMFS 2009b, NMFS et al. 2010).

Next, the Services completed an evaluation of the quantity and quality of habitats available within the SHRU to support 2,000 spawning adults. This evaluation considered the geographic location of habitats suitable for spawning, egg incubation, fry emergence, parr rearing, smolt migration to the ocean and abiotic factors such as water quality and water temperature. Once the 2,000 adult spawner level was determined, an evaluation was completed that determined a minimum of 30,000 units of spawning and rearing habitat (a unit of habitat is defined as 100 m^2) was necessary to support 2,000 spawning adults in each SHRU (NMFS 2009a, NMFS 2009b, NMFS et al. 2010). As part of this evaluation, a calculation of the amount of "functional equivalent" habitat was completed for the Merrymeeting Bay SHRU. The functional equivalent determination is based on the gross quantity of habitat in the geographic area adjusted downward based on the quality of the habitats to support the various life history stages of Atlantic salmon. For example, the Merrymeeting Bay SHRU was estimated to contain 372,639 habitat units based on a Geographic Information System (GIS) habitat prediction model. After the adjustment for habitat quality, the functional equivalent habitat for the SHRU was reduced to 40,001 units, which is sufficient to meet the recovery criteria for this SHRU (NMFS 2009b). The life history requirements for Atlantic salmon that were used to drive the functional equivalents determination are based on Kircheis and Liebich (2007).

4.2. Development of Primary Constituent Elements Necessary for the Conservation of the Species – The National Marine Fisheries Service (2009a) states: "Section 3(5)(A)(i) of the ESA defines critical habitat as "the specific areas within the geographical area occupied by the species at the time it is listed…on which are found those physical and biological features essential to the conservations of the species." The Departments of the Interior and of Commerce provide further regulatory guidance under 50 C.F.R. 424.12(b), stating that the Secretary shall "focus on the principal biological or physical constituent elements within the defined area that are essential to the conservation of the species … Primary Constituent Elements (PCE's) may include, but are not limited to, the following: roost site, nesting grounds, spawning sites, feeding sites, seasonal wetland or dryland, water quality or quantity, host species or plant pollinators, geological formation, vegetation types, tide, and specific soil types."

The net result of this regulatory guidance is that the Services are required to focus their recovery efforts on ensuring that a sufficient quantity and quality of habitats are available for the listed species to support all life history requirements for the population levels determined to be necessary to keep the species from becoming endangered in the future.

For the GOM DPS of Atlantic salmon, three PCE's have been established (NMFS 2009a). Listed below are the three PCE's with their subcomponents:

A. Physical and Biological Features of the *Spawning and Rearing PCE*

1. Deep, oxygenated pools and cover (e.g., boulders, woody debris, vegetation, etc.), near freshwater spawning sites, necessary to support adult migrants during the summer while they wait to spawn in the fall.

2. Freshwater spawning sites that contain clean, permeable gravel and cobble substrate with oxygenated water and cool water temperatures to support spawning activity, egg incubation, and larval development.

3. Freshwater spawning and rearing sites with clean, permeable gravel and cobble substrate with oxygenated water and cool water temperatures to support emergence, territorial development and feeding activities of Atlantic salmon fry.

4. Freshwater rearing sites with space to accommodate growth and survival of Atlantic salmon parr.

5. Freshwater rearing sites with a combination river, stream, and lake habitats that accommodate parr's ability to occupy many niches and maximize parr production.

6. Freshwater rearing sites with cool, oxygenated water to support growth and survival of Atlantic salmon parr.

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

B. Physical and Biological Features of the *Migration PCE*

1. Freshwater and estuary migratory sites free from physical and biological barriers that delay or prevent access of adult salmon seeking spawning ground needed to support recovered populations.

2. Freshwater and estuary migration sites with pool, lake, and instream habitat that provide cool, oxygenated water and cover items (e.g., boulders, woody debris, and vegetation) to serve as temporary holding and resting areas during upstream migration of adult salmon.

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

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

5. Freshwater and estuary migration sites with sufficiently cool water temperatures and water flows that coincide with diurnal clues to stimulate migration.

6. Freshwater migration sites with water chemistry needed to support sea water adaption of smolts.

C. Physical and biological feature of marine sites and "Specific Areas" within the geographical range occupied by the species

Specific subcomponents for this PCE had not been identified at the time the NMFS (2009a) document was written.

4.3. Factors Used to Assess Impacts of the Various Dams on Atlantic Salmon Habitats and Populations – In this report, I used the physical and biological features outlined under the PCE's above to inform my evaluation of the various sources of information regarding dam-specific impacts and reach my conclusions regarding whether the Defendants' dam(s) and operations thereof are: killing, wounding or otherwise injuring Atlantic salmon directly; killing or injuring Atlantic salmon through significant habitat modification or degradation by significantly impairing normal and essential behavioral patterns (such as breeding, spawning, rearing, migrating, feeding or sheltering); or creating the likelihood of injury to Atlantic salmon by otherwise significantly disrupting these normal and essential behavioral patterns.

During my evaluation, I reviewed, for each dam:

1. The physical structure of the dam,

2. The downstream fish bypass system (if one was installed),

3. The types of turbines used to generate power,

4. The upstream fishway for adult passage (if one was installed),

5. The size and configuration of the headpond upstream of the dam,

6. The physical character of the river immediately downstream of the dam and tailrace areas as potential habitat for predators, and

7. The river flow regime during time periods critical for Atlantic salmon (April – June and October – November) in relation to the hydraulic capacity of the turbines at each project.

Each of these seven factors were reviewed to determine whether, in my opinion, direct harm results from any of these factors, or the dam or its operations significantly interferes with a fish's ability to access the type of habitats described under the PCE's, or the dam or its operations potentially alters the behavior of Atlantic salmon in biologically significant ways.

In performing this analysis, I also reviewed the results of any individual studies and all annual reports on fish passage and restoration efforts under the KHDG Settlement Agreement of 1998 for the period 2000-2010.

5.0 General Conclusions on Impacts of Hydroelectric Dams on Atlantic Salmon in the Kennebec and Androscoggin Rivers

5.1 Background Information

While there have been a number of "effectiveness" studies over the past 13 years that have assessed routes of passage through a particular dam and provided some qualitative estimates of survival for some species, the fact is that no scientifically rigorous, quantitative studies have been conducted at any of the projects to address the critical factors associated with the mortality of fish passing through dams. A quantitative study requires test fish to be released and then recaptured, to verify the fate of the fish as a result of the "treatment" imposed by, say, passing through a dam's turbines. In the absence of a downstream recapture procedure, any result can at best be labeled qualitative.

The qualitative information has been used where I believe there was sufficient data to support the conclusions stated in the various reports and if these data were consistent with other published study results that I deemed comparable.

My general conclusions regarding several aspects of fish passage through or over dams, and the cumulative effects, are provided below.

5.2 Impacts on Downstream Migrating Fish

5.2.1 Mortality Associated with Passing through Project Turbines

While a number of studies have looked at the effectiveness of various structural components of some of the dams at issue, and at routes of passage through or over some of the dams, none has addressed the fundamental question: "If fish pass through a project turbine, what percentage will be killed?" However, some of the qualitative results, from Lockwood studies in particular, fall within the range of published values in the scientific literature. Based on the review of the turbine mortality literature in Section 6.1 of this report, I conclude that the probability of an Atlantic salmon smolt passing through a project turbine has about a 15% chance of being killed within death occurring within 48 hours. For Atlantic salmon kelts, the values range from about 25-60% depending on the type of turbine, but there is essentially no literature that assesses salmon or rainbow trout of the same length as Atlantic salmon kelts in the Kennebec or Androscoggin rivers. The maximum length of comparable fish tested (from the literature) is at least about 200 mm shorter than the typical length of kelts found in the two rivers. These data suggest that the mortality rates for kelts in the Androscoggin and Kennebec rivers would be greater than the rates shown in Section 6.1 of this report.

To put this in perspective, if one assumes a "non-spill" condition (i.e., no water passing over the spillway of the dam) in the spring during the migration period for salmon smolts at the four Kennebec River dams, and if turbine mortality is 15% at each dam, then the net smolt survival rate after four dams is $(0.85)^4$, which is 52.2%. This means that 48% of the smolts migrating downstream would die from passing through four dams. This mortality rate does not include any delayed or latent mortality that would occur after injury and after 48 hours of passing through the turbine. The rate also does not include predation mortality for fish that become disoriented after passing through a turbine. With respect to kelts, if their turbine mortality is estimated at 43% at each dam (a mid-range figure based on the available literature), the net kelt survival rate after four dams is $(0.57)^4$, which is only 10.5%. Again, this rate does not include delayed or latent mortality.

A second factor to consider regarding turbine mortality is with what frequency a smolt or kelt is confronted with no choice but to pass either through a turbine or the ineffective downstream fish bypass systems currently installed at these dams (discussed in detail below). In other words, what is the probability that a fish will be forced to pass through a project's turbines because the total river flow during a critical migration period is at or below the hydraulic capacity of the project's turbines. I completed such a flow analysis for each project, which is found in Section 7 or 8 depending on the particular dam. The results of these analyses show that river flow levels are often sufficiently low to allow all river flow to pass through a project, with a probability ranging from 5-10% of the time in April to 90% of the time in October. If one's goal is to conserve these salmon populations, this situation is unacceptable and critical on both rivers. The Androscoggin is of particular concern, because all three dams have some form of adult passage which allows adults to pass upstream of the dams and spawn and a much lower overall flow regime during critical downstream migration periods. The problem is also critical on the Kennebec River, because of a combination of low flows and the fact that the State of Maine is transporting adult spawners to, and planting nearly 1,000,000 Atlantic salmon eggs per year in, the Sandy River to jump-start the restoration of Atlantic salmon. The primary problem is that even one year of low flows, forcing the salmon to run a gauntlet of multiple project turbines, can negate years of restoration efforts and adversely affect adult returns for decades into the future.

5.2.2 Passage through the Downstream Fish Bypass

Numerous studies have evaluated fish mortality associated with fish passage through bypass systems and via project spill (e.g., Stone and Webster Environmental Services 1992). Fish can be injured or killed in bypass systems due to the way the water entering the bypass system strikes hard objects in the bypass such as the walls or any associated infrastructure. Flow hydraulics in a bypass can also cause fish to be essentially trapped in the bypass or to become disoriented because of turbulent flow; such disorientation changes their behavior, and can attract predators that would not normally be attracted, resulting in death by predation.

I am unaware of any completed quantitative studies documenting the impacts of passing through the bypass facilities of the dams here. Based on my personal observations, some of the downstream bypass facilities appear to be relatively benign, while others appear as though they could be a considerable source of mortality. However, with no data, it is impossible to assess the impacts.

I conclude that one of the most important factors relating to mortality of downstream migrating Atlantic salmon is the physical location of the bypass facilities in relation to a project's turbine intakes. This situation is exacerbated because of the relatively minor flow volume passing into the bypass system at these dams when compared to the flow volume entering the turbines. Also, a number of the downstream bypass discharges drop the water and fish directly into areas that appear to be great habitat for predators. The advantages of having a bypass system may be negated simply because of the bypass's discharge location. Again, no rigorous studies have been conducted to quantitatively assess this mortality factor.

5.2.3. Downstream Passage via Spill

Fish passing via spill, either through the spillway gates or over the crest of the dam (with or without flashboards installed), can be killed, injured, or disoriented by striking project infrastructure (particularly glancing blows), striking the sill at the bottom of the dam on the downstream side, or by turbulence created by the amount of flow and the configuration of the downstream spillway (Robson et al. 2011). Several dams also have extensive bedrock outcrops on the downstream side of the dam. Fish can be killed, injured, or become disoriented by being propelled against these rocks. Fish that are disoriented can become easy prey for a variety of predators.

No project-specific, quantitative data have been collected to assess this factor in relation to fish mortality. Based on my personal observations, some projects appear to have a very low potential to kill or injure fish that pass via spill, while others appear to have a much higher potential to cause harm. I conclude that there must be some mortality or injury of fish passing via spill, but the rate will be project-specific and is not quantified at this time.

5.2.4. Disrupting Normal Behavior Patterns through Changes to Habitat

Each of the dams has an upstream impoundment that alters the behavior of juvenile fish moving downstream when they encounter the low velocity water associated with the impoundment upstream of the dam. The impacts of these impoundments are different because each impoundment is different. For example, the Worumbo Project on the Androscoggin has a relatively small impoundment because of the low height of the dam. The same situation occurs at the Lockwood Project on the Kennebec. However, the impoundment upstream of the Weston Project on the Kennebec is over 12 miles long.

Atlantic salmon smolts are adapted to moving downstream to the sea via a flowing river channel. Smolts encountering a “reservoir” can exhibit behavioral changes, such as slowing their rate of downstream movement. This is significant, as spending more time en route usually subjects them to greater predation rates (Holbrook et al. 2011). In addition, reservoirs change the location and amount of “hiding cover” in the water column, which can lead smolts to move their migratory path closer to the shore, where more hiding and escape cover is present. As a result, these smolts are at a greater risk of predation because predators such as smallmouth bass are also more likely to frequent the shoreline. Further, the interaction between the slow-moving reservoir and the dam itself provides a well-known opportunity for predators, to wait for the salmon near the dam’s spillway or fish bypass. One study conducted at the Hydro Kennebec Project videotaped large predators waiting near the entrance to the downstream bypass for juvenile fish to approach (Madison Paper Industries 2010). Some of the salmon lose their lives in this manner. Also, some smolts will feel compelled to actively swim downstream through the slow-moving reservoir water (rather than moving at their own pace), in order to meet their need to reach the estuary when growth and survival conditions are optimal. This additional physical demand can reduce their energy reserves below what would normally be expected, meaning that they reach the estuary in a less fit condition to begin the transition to salt water (Fay et al. 2006).

Again, I am aware of no quantitative studies that have been conducted to assess the mortality and behavioral changes associated with the impoundments upstream of the dams at issue here. It is reasonable to assume that fish behavior does change and that the mortality rate of passing through an impoundment is higher than it would be passing through a natural flowing water channel.

5.3 Impacts on Upstream Migrating Fish

The biggest impact of the four dams on the Kennebec River is the blockage and/or delay caused by the absence of volitional, state of the art upstream adult passage facilities. Not allowing adult Atlantic salmon to freely swim past these dams disrupts their normal migratory behavior by causing artificial delays in upstream migration, blocking passage directly during periods when the fish trap is not operational and flows are insufficient to allow passage upstream of Lockwood, or short-circuiting the normal migratory behavior and timing by trapping and trucking fish to a location not necessarily of the fish's choosing in the Sandy River. Disruption of normal migratory behavior timing can occur during the spring and/or fall migration period.

The four projects on the Kennebec River currently claim that adult fish passage is accomplished through the trap and truck program at Lockwood. However, my analysis of the physical configuration of the Lockwood Project in Section 7.1 of this report demonstrates that the program does not guarantee adult upstream passage for adult Atlantic salmon. I have managed four trap and truck programs during my time with the Army Corps of Engineers in the Willamette Valley of Oregon for listed spring Chinook salmon and winter steelhead. In my experience, relying on a trap and truck program for these low head dams in Maine is a mistake. There are a myriad of potential problems associated with a trap and truck program. For example, unless you have the entire river blocked at your trapping facility, then it is impossible to determine what fraction of the adult run that you are actually trapping. Hauling fish can be problematic because of various simple issues, such as water temperatures in the release stream being incompatible with truck water temperature, stress-related delayed mortality associated with transport, and the potential for vehicle accidents during transport. All of these issues can have major impacts on the viability of using a trap and truck system. In my opinion, the best option is to let the fish move upstream volitionally, at their own pace, over these low head dams.

On the Androscoggin, the major impact is not having enough adult passage locations available at any one dam, and the use of fish traps and lifts at the Pejepscot and Worumbo projects. While these systems technically provide upstream passage opportunities for Atlantic salmon adults, I am not aware of any evaluations as to the effectiveness of these facilities to attract and move adult fish upstream. Also, the sufficiency of attraction flows to attract salmon to the trap is a concern.

5.4 Cumulative Impacts

A successful biological ecosystem functions as a continuum. The Androscoggin and Kennebec River watersheds are part of the ecological continuum necessary to support Atlantic salmon populations required to ensure conservation of the species. These two watersheds are the second and third largest in Maine that support Atlantic salmon. Each of these watersheds can support much larger populations of Atlantic salmon than they currently do. Overall, the major impediment to increasing Atlantic salmon populations is the combination of the direct and indirect impacts that the dams in the watersheds have on the ability of the species to migrate, spawn, rear, and emigrate to the ocean.

The majority of suitable habitats necessary for salmon to complete the freshwater phases of their life history are upstream of the various dams. However, it is imperative that the sources of mortality, blockage, or delay are minimized at each individual project. If several dams upgrade by installing effective upstream and downstream fish passage facilities, much of the species gain can still be offset or negated by a single facility that does nothing to reduce its impacts on the species. Based on my experience in the Pacific Northwest, the optimum approach to restoring salmon populations is for each negative influence to be overcome in order of priority. This must be accomplished through the range of the species in each watershed in order to provide the PCE’s necessary to ensure species conservation and eventual delisting.

6.0 Review of Turbine Mortality Rates and Methodology Used to Develop the River Flows Analysis

6.1 Review of Mortality and Injury Rates to Fish Passing Through Project Turbines

Each type of turbine has different characteristics (e.g., number of blades, spacing between the blades, rotation speed, etc.); these differences in characteristics result in generally different levels of mortality for fish passing through each type of turbine. Francis turbines generally have more blades (vanes), less distance between blades, and spin at higher rotations per minute (rpm), as compared with most Kaplan turbines (which include "propeller type" turbines), which have few blades, more space between blades, and spin at lower rpm. Fish passing through turbines are generally killed or injured because of three factors: 1) being struck by a spinning blade, 2) being impinged between the outside edge of the blade and the wall surrounding the turbine, and 3) experiencing rapid changes in barometric pressure that occur as water passes through the turbines. Change in barometric pressure is likely not a significant factor at these projects because the operations have a low hydraulic head. The primary direct cause of fish death or injury at the Kennebec and Androscoggin dams is blade strike. The probability that a fish will be struck by a blade is related to fish length (Robson et al. 2011). In short, the longer the fish, the shorter the distance between the blades, and the faster the turbine is spinning, the higher the probability of a fish being struck by a blade and killed or injured.

A variety of researchers have completed studies or compiled compendiums of study results for fish mortality through Kaplan and Francis type turbines. Representative results from these studies (including those for the Kennebec River) show, for Kaplan type turbines, mortality rates of:

- 5-20% -- juvenile salmonids (Robson et al. 2011).
- 24-25% -- adult eels: incomplete cites in: Normandeau Associates, Inc. and NextEra™ Energy Maine Operating Services, LLC. (2009b).
- 33% -- Immediate mortality; Atlantic salmon kelts (post-spawning adults): Lockwood Dam, ME (Normandeau Associates, Inc. and FPL Energy Maine Hydro, LLC. 2008b).
- 16% -- Atlantic salmon smolts: Lockwood Dam, ME (Normandeau Associates, Inc. and FPL Energy Maine Hydro, LLC. 2008d).
- 30% -- Immediate mortality; American shad: Lockwood Dam, ME (Normandeau Associates, Inc. and FPL Energy Maine Hydro, LLC. 2008c).
- 16.7-21.5% -- Adult American shad (Stone and Webster Environmental Services 1992).
- Generally <10% for American shad and river herring juveniles (Stone and Webster Environmental Services 1992).
- Range of 9-16% for juvenile salmonids (Stone and Webster Environmental Services 1992).

- 11-14% -- Atlantic salmon smolts (Stone and Webster Environmental Services 1992).
- 5.7-30.5 % -- Atlantic salmon smolts (range of values from two studies of Kaplan turbines cited in the database from Winchell and Amaral 1997).

For Francis turbines, the data specific to Atlantic salmon smolt-sized fish are more limited, but it is generally agreed among fish biologists and fishery engineers that Francis turbines have higher mortality rates than Kaplan turbines for the same species and size of fish (see Stone and Webster Environmental (1992) and Robson et al. (2011) for reviews). The following references provide some indication of the mortality rates for Atlantic salmon smolts (and similar-sized fish) passing through Francis turbines:

- 0-16% -- Atlantic salmon smolts (Winchell and Amaral 1997).
- 11.8-13.7% -- Atlantic salmon smolts (Stone and Webster Environmental Services 1992).
- 28.6% -- Adult American shad (Stone and Webster Environmental Services 1992).
- 10-40% -- Juvenile American shad (Stone and Webster Environmental Services 1992).
- 22.2% -- Rainbow trout (275-360 mm) (Stone and Webster Environmental Services 1992).
- 31.4% -- Rainbow trout (280-410 mm) (Stone and Webster Environmental Services 1992).
- 38.8% -- Rainbow trout (228-401 mm) (Stone and Webster Environmental Services 1992).
- 40-60% -- Probability of blade strike for fish 500-700 mm (Robson et al. 2011).

For Francis turbines, mortality rates are directly related to the diameter of the turbine, the rotational speed, and the size of fish passing through the turbine.

6.2 Analysis of the Probability of River Flows Being Less Than or Equal to a Project's Hydraulic Capacity During Critical Migration Periods.

The objective of evaluating river flows in relation to a project's hydraulic capacity (the maximum amount of water that could flow through the project's turbines) is to obtain an understanding of how often, during critical migration periods, all of the river flow is, or could potentially be, routed thorough the turbines. *This is highly significant because at such times salmon cannot pass over the dam's spillway: they can only pass the dam by swimming through the turbines or through whatever downstream fish bypass may be available*.

I used the following project hydraulic capacities (which are drawn from the sources listed in the later sections of this report addressing these dams individually) in this evaluation:

Kennebec River Projects:

- Lockwood Project: 5,660 cfs
- Hydro Kennebec Project: 7,800 cfs
- Shawmut Project: 6,700 cfs
- Weston Project: 6,000 cfs

Androscoggin River Projects:

- Brunswick: 7,191 cfs
- Pejepscot: 8,100 cfs
- Worumbo: 9,600 cfs

I chose to evaluate mean daily flows for the time periods April through June and October through November. These time periods are generally considered to be the downstream migration periods for Atlantic salmon: smolts and kelts in the spring, and kelts in the fall (Fay et al. 2006). Although no smolt trapping occurs in the Androscoggin or Kennebec rivers, emigrating smolts are trapped in the adjacent Sheepscot River watershed. These data show that Sheepscot origin smolts began their downstream migration about the 12th of April in 2010 and median dates of capture for all smolts in 2002, 2006, and 2010 occurring near the 1st of May in those years (See Figures 5.4.5 and 5.4.6 in U.S. Atlantic Salmon Assessment Committee 2011). Atlantic salmon kelts are known to move downstream in the fall and early spring. Results from a 2008-2009 radio telemetry movement study on adult Atlantic salmon released in the Sandy River (a tributary to the Kennebec River upstream of the Weston Project) showed that fish moved downstream as expected during the fall and winter months, with several fish moving downstream to about the Lockwood Project in April of 2009 (McCaw et al. 2009).

Kennebec River flows used in this assessment are based on 25 years (1978-2011, less 1993-2000 when no flows were recorded at this site) of mean daily flow records from the USGS North Sidney, Maine, gaging station (with flows from the Sebasticook River recorded at Pittsfield, Maine subtracted). I did not adjust the flow values obtained for watershed area differences at different points along the Kennebec because of the numerous assumptions that would be required. I reasoned that adjusting flows upward, based on an additional watershed area of 374 mi.^{2} in the Sebasticook watershed that are not measured by the Pittsfield gage, were essentially offset by flow reductions achieved by reducing the watershed area upstream of the Lockwood, Hydro Kennebec, Shawmut, and Weston projects by a maximum of 283 mi.^{2}. The net effect of not adjusting for watershed area means that the flow at each of the four projects is *overestimated* by about 15-20 percent. That means the information presented in the flow analysis figures under each Kennebec River specific project assessment (Sections 7.1-7.4) will tend to *underestimate* the percentage of time when the entire flow of the river can pass through the project turbines (i.e., river flow is $\leq$ project hydraulic capacity). I used the 5th, 10th, 25th, and 50th low flow percentiles of the mean daily flows, which equate to daily probabilities of a 1 year in 20 (5%), 10 (10%), 4 (25%), or 2 (50%), respectively, chance that mean river flow on that day has historically been ≤ project hydraulic capacity. I did not use the flow records from a temporary USGS gage near Waterville because there was only a 7-year record, from 1993 to 2000.

Androscoggin River flows used in this assessment are based on 83 years (1929-2011) of mean daily flow records from the USGS Auburn, Maine, gaging station. I adjusted the flow values obtained from the gaging station upwards by a factor of 1.0806, which is the difference in watershed area at the gaging station divided by the watershed area for the Androscoggin watershed (National Marine Fisheries Service 2009b). The net effect of adjusting for watershed area means that the flow at each of the three projects may be slightly *overestimated*. This means the information presented in the flow analysis figures under each Androscoggin River specific project assessment (Sections 8.1-8.3) may tend to *underestimate* the percentage of time when the entire flow of the river can pass through the project turbines (i.e., river flow is ≤ project hydraulic capacity). I was unable to find any published estimates of the watershed area upstream of each project. I used the 5th, 10th, 25th, 50th, 75th, and 90th low flow percentiles of the mean daily flows, which equate to daily probabilities of 5%, 10%, 25%, 50%75%, or 90% chance that mean river flow on that day has historically been ≤ project hydraulic capacity.

7. 0 ANALYSIS OF KENNEBEC RIVER DAMS

7.1 Lockwood Project (NextEra)

7.1.1 Brief Project Description

The project has an 875-foot-long spillway section with 15-inch flashboards. The spillway discharges to a large exposed series of bedrock terraces, known as Ticonic Falls. The height of the top of the spillway varies from about 6-10 feet above the terraces downstream of the dam. Under high flows, the falls become submerged. A power canal is located on the west bank of the Kennebec River which leads to three surface sluices (which are considered the Project's downstream fish bypass infrastructure) and the powerhouse.

The first sluice is located just upstream of the power canal headworks structure and has a manually adjustable fixed gate with stop logs and is 7.5 feet wide by 16 inches deep. Flows through this sluice fluctuate with headpond elevation and range from 35 to 40 cfs which discharge over the face of the dam into a shallow bedrock pool connected to the river. The second sluice, located between turbine units 6 and 7 (closest to the west bank of the river), is a manually adjustable fixed gate containing five stop logs. The gate is 6 feet wide by 30 inches deep. With all stop logs removed; this gate passes flows in the range of 60 to 70 cfs. Flows from this sluice discharge directly into the tailrace of the Project, which is approximately 15 feet deep. The third sluice, installed in 2009, is located on the river side of the power canal just upstream of Unit 1 trash rack and discharges directly into the river. This facility consists of a new 10-foot-deep floating boom leading to a new 7-foot-wide by 7-foot-deep sluice and associated mechanical overflow gate. Maximum flow through the gate is 6% of station capacity or 340 cfs. The boom is 300-feet-long and is secured on the land side of the canal and angles downstream to the new sluice gate.

The powerhouse contains six vertical Francis units (#'s 1-6) and one horizontal Kaplan unit (#7) producing a total of approximately 7.5 megawatts of electricity. Total unit flow is approximately 5,660 cfs. Trash rack spacing is 2 inches for Units 1-6 and 3.5 inches for Unit 7. The project contains a fish trapping facility for upstream migrating fish located on the west bank of the river adjacent to turbine unit 7. Flow in the approximately 1,300 ft long bypassed reach (approximate distance between the spillway section of the dam and a point downstream of the powerhouse tailrace) is currently limited to leakage around and through the flashboards, including through 3 engineered slots in the boards (estimated at a total of 50 cfs) (Normandeau Associates, Inc. and FPL Energy Maine Hydro, LLC, 2008d; NextEra™ Energy Maine Operating Services, LLC, 2010; Normandeau Associates, Inc., 2011b). While the published flow capacity of the turbines at the Lockwood Project is 5,660 cfs, National Marine Fisheries Service staff commented that downstream juvenile passage via spill would probably not occur if depth of flow over the spillway/flashboards was <6 inches (Normandeau Associates, Inc., 2011b). Assuming this statement is correct, that would in effect direct juvenile fish towards the power canal at flows < ~6,000 cfs, increasing the probability of fish interacting with the downstream fish bypass system or the turbines.

7.1.2 Impact of Lockwood Project on Atlantic Salmon

7.1.2.1 Impact on Individual Fish

I have analyzed seven factors (See section 4.3 for a detailed listing) related to the physical structure of the dam and adjacent river channel and operational parameters and characteristics in evaluating impacts of the project on Atlantic salmon. Below is my evaluation of these seven factors:

1. **Physical Structure of the Dam**

    A. **Evaluation –** The physical configuration and height of the dam create a barrier to upstream migrating Atlantic salmon under lower flows, but the flow volumes at which passage over the existing structure is possible are not known.

At flow levels that occur with some frequency in the Kennebec River, upstream migrating adult Atlantic salmon can in fact pass over the Lockwood Project spillway. There are places in the stream channel where water depth and flow turbulence would allow such passage. The two locations that appear to provide upstream passage opportunities are in the center of the channel adjacent to the old mid-stream fish ladder and on the east bank near and around the railroad trestle pier. In these areas the geomorphology of the channel combined with concrete structures create sufficient turbulence that could allow fish to pass upstream of the dam. Under higher flows, adults could swim right over the dam, unimpeded by the structure. (During my site visit on December 8, 2011, staff at the Lockwood Project indicated that during the 1987 flood, there was approximately 20 feet of water over the top of the dam.) If these higher flows occur during the upstream migration period, then passage is possible.

The shape and location of the spillway in relation to the powerhouse create a problem for upstream "passage" via the trap and truck program because there is about 1,300 feet of river channel to the northeast and east of the powerhouse that adult fish will occupy while migrating upstream. These fish may or may not eventually find the entrance to the fish trapping facility, which is downstream about a quarter-mile and on the extreme west bank of the river. Under flow levels that are insufficient to provide upstream passage opportunities, it is unknown what percentage of adult fish actually finds the entrance to the fish trapping facility. At lower flow levels, where the majority or all of the river flow is passing through the turbines, it is much more likely that adult fish will be attracted to that area of the river channel and eventually find the fish trapping facility. However, no studies have been completed to date which demonstrates the effectiveness of project operations to attract adult fish to the vicinity of the fish trapping facility and, if attracted, what percentage of adult fish actually enter the trap. It is possible, even under low flow conditions, that adult fish remain in the river channel near the spillway and do not find the fish trap entrance.

Atlantic salmon smolts migrating *downstream* to the ocean tend to move under low light or dark conditions (Fay et al. 2006). Given the physical shape of the spillway, it is likely that downstream migrating fish moving along the west bank of the river would move directly into the power canal towards the Project turbines. While the published flow capacity of the turbines at the Lockwood Project is 5,660 cfs, National Marine Fisheries Service staff commented that downstream juvenile passage via spill would probably not occur if depth of flow over the spillway/flashboards was <6 inches (Normandeau Associates, Inc. 2011b). Assuming this statement is correct, that would in effect direct juvenile fish towards the power canal at flows < ~6,000 cfs, increasing the probability of fish interacting with the downstream fish bypass system or the turbines.

B. Conclusions Regarding Impacts on Fish – Given the physical configuration of the spillway, its height, and the location of the power canal along the west bank of the river, I believe that the Lockwood Project is causing the following impacts to Atlantic salmon:

I. Under low flow conditions, adult Atlantic salmon are blocked from moving upstream towards spawning habitat areas that contain the characteristics outlined in the subcomponents of the "primary constituent elements" (PCE's) detailed earlier in this report.

II. Under certain flow conditions, adult Atlantic salmon are delayed from migrating upstream due to the lack of adequate fish passage facilities at the Project. This delay in their normal migration timing results from an inability to locate the entrance to the fish trapping facility in a timely fashion. Overall population productivity is likely lower because of the effect of passage blockage and/or delay on the salmon's ability to spawn at more favorable upstream locations and times.

III. The physical shape of the Project makes it much more likely that Atlantic salmon smolts and kelts migrating downstream to the ocean will enter the power canal and thus interact with one of the Project's turbines or downstream fish bypass facilities, especially when river flows are near or below the Project's turbine flow capacity. Interaction with the Project's turbines and/or downstream bypass systems causes smolt and kelt mortality and injury.

2. Downstream Fish Bypass System

A. Evaluation – The Project currently has four locations that effectively serve as a downstream fish bypass system. There are engineered slots in the flashboards on top of the spillway and the three sluices associated with the power canal. Details of each location are presented in the Brief Project Description above.

A 2007 downstream Atlantic salmon smolt passage study at the Project, conducted before the completion of the third sluiceway in the power canal in 2009, found: "For all radio-tagged Atlantic salmon smolts released into or entering the powerhouse canal, approximately 18% (8 of 45) passed via the surface sluice and the other 82% (37 of 45) passed via the turbine units."(Normandeau Associates, Inc. and FPL Energy Maine Hydro, LLC, 2008d). A companion study of Atlantic salmon kelts found: "For all radio tagged

Atlantic salmon kelts released into or entering the powerhouse canal, approximately 50% (3 of 6) passed via the surface sluice and the other 50% (3 of 6) passed via Unit 7." (Normandeau Associates, Inc. and FPL Energy Maine Hydro, LLC, 2008b). These two studies clearly demonstrate that fish entering the power canal with only two sluices operating were as likely as or more likely to exit through the turbines than through the sluices (the bypass facilities). The results for the kelt study are particularly disturbing since Unit 7 has a trash rack with 3.5 inch clear spacing – which is wide enough for kelts to swim through.

In a 2011 study of Atlantic salmon smolts at the Project, downstream passage routes were determined for smolts released into the power canal (forebay canal) and upstream of the Project. This study was performed after the 2009 installation of the third fish bypass sluiceway and a fish guidance boom. For the 38 fish released directly into the forebay canal with definitive passage routes determined, only four (10.5%) were confirmed passing via the bypass sluiceways, with the remainder passing through the turbines (Table 5, Normandeau Associates, Inc. 2011c. Note, this document is under a court protective order). For the groups released upstream of the Project, 45 of 62 fish passed via spill and 17 entered the forebay canal. Of the 17 that entered the forebay canal, only five (29.4%) were confirmed using the bypasses for passage. Considering all the fish that were released into or entered the forebay canal, only 9 of 55 (16.4%) passed through the Project via the fish bypasses (Tables 5-11, Normandeau Associates, Inc. 2011c. Note, this document is under a court protective order).

In conjunction with the Lockwood Project radio telemetry smolt passage study summarized immediately above, the antennas at the Project were able to detect radio tagged Atlantic salmon smolts released upstream of the Hydro Kennebec Project, approximately 1 mile upstream of the Lockwood Project. Antennas at Lockwood detected 93 radio signals from the Hydro Kennebec releases. Of those 93, 89 signals were determined to have entered the Project area. According to Table 5 of Normandeau Associates (2011c Note, this document is under a court protective order), 74 signals passed via spill. Definitive passage routes were determined for 11 of the 15 fish detected in the forebay canal. Of these 11, only 3 (27.3%) were confirmed to have passed via the downstream fish bypass system.

These studies demonstrate clearly that Atlantic salmon smolts and/or kelts (albeit a small sample size for the kelt study) have a very high potential to not pass via the installed fish bypass system and that the guidance boom in the power canal is ineffective at guiding fish away from the turbine intakes. Atlantic salmon smolts are much more likely to pass the Project via the turbines than the fish bypass system. Under high flow conditions, some fish will pass via spill, but the critical condition occurs when river flows are just above or below the Project's turbine flow capacity of 5,660 cfs. The frequency of these lower flow conditions will be discussed in detail below. Also, I am aware of no quantitative mortality studies of fish passing via the various fish bypass routes or via spill that have been completed.

B. Conclusions Regarding Impacts on Fish – Given the 2011 combined results from studies of the smolts released at Lockwood and Hydro Kennebec, which reflect the current infrastructure configuration at the Lockwood Project, the vast majority of salmon that enter the forebay canal – more than 70%, and as many as to 85% – pass the Project via the turbines, and not via the bypass system. The initial boom installation did not function as planned, and despite modifications it is unknown if the boom will function as planned in the future. I conclude that the current downstream bypass system at the Project is ineffective, resulting in a large percentage of smolts passing through the turbines with resulting direct and indirect mortality occurring.

Further, under lower flow (non-spill) conditions, all Atlantic salmon, both smolts and kelts, are forced to pass the Project via the forebay canal and, ultimately, the ineffective fish bypass system or the Project turbines. In my opinion, the bypass system is inadequate to provide the level of protection to Atlantic salmon needed to prevent unacceptable (in terms of population recovery) levels of direct and/or indirect mortality.

3. Types of turbines used to generate power

A. Evaluation – For an overview of turbine mortality rates see Section 6.1 of this report. The Project currently contains six vertical Francis turbines (Units 1-6) and one Kaplan turbine (Unit 7).

In a 2011 draft white paper presented to the resource agencies, the NextEra Defendants reject, with no explanation, the results of their own studies, saying they are inadequate to establish passage mortality at Lockwood. The draft white paper states: "Due to the 1ack of site-specific information, estimates for passage survival of Atlantic salmon smolts through the Lockwood spillway and downstream bypass were developed based on existing empirical studies conducted at other hydroelectric projects." This report also states: "Due to the lack of site-specific information, estimates of turbine passage survival of Atlantic salmon smolts at Lockwood were developed using a combination of existing empirical studies and modeled calculations." (Normandeau Associates, Inc. 2011e. Note: this document is under a court protective order).

I agree that site-specific empirical studies have not been conducted at the Project to assess the following causes of hydroelectric dam-related mortality: predation in the headpond area as a result of changing the type of habitat upstream of the dam; spill-related mortality; mortality associated with fish using the downstream bypass system; delayed or latent mortality associated with fish passing through the turbines and not immediately killed; and mortality due to predation at locations immediately downstream of the Project infrastructure due to fish being injured or disoriented during passage through the Project.

I also agree that rigorous, scientifically reliable, quantitative studies of immediate turbine mortality have not been conducted at the Project. However, I disagree with the conclusion that *no* site-specific mortality information associated with passage through the turbines is available. Various studies conducted under the auspices of the 1998 Kennebec Hydro Developers Group ("KHDG") Settlement Agreement have, in at least a limited way, addressed survival. In fact, the NextEra Defendants have publicly represented (to the general public, to the resource agencies, and to FERC) that these studies provide survival estimates. Examples include:

- In a letter to Kimberly D. Bose, Secretary, Federal Energy Regulatory Commission, transmitting the "2007 Kennebec River Diadromous Fish Restoration Report" and FPL Energy Maine's responses to comments from the Maine Department of Marine Resources (MDMR) on the draft study reports prepared for evaluations conducted during 2007 at the Lockwood Project on Atlantic salmon smolts and kelts, FPL Energy Maine responded to the following general comment from MDMR:

  <u>MDMR</u> General Comments – Passage Through Turbines: "MDMR believes that fish passage via sluiceways and/or controlled spills is the preferred method for downstream fish passage, and that fish passage through turbines should be avoided. FPL Energy's studies have clearly shown that adult alewife, adult American shad, adult American eel, Atlantic salmon kelts, and Atlantic salmon smolts pass through the Lockwood project turbines, and sustain significant immediate mortality. However, the downstream passage studies did not quantify delayed mortality, which is usually measured by holding fish for up to 72 hours after they are passed through a turbine. Therefore, we recommend that all downstream passage survival estimates for all species be termed 'immediate survival.'"

FPL Energy Response: "Licensee recognizes that fish passage through turbines is not preferred by the fisheries agencies, but also recognizes that passage through turbines for certain species and life stages can be, and is on a practical basis, part of the overall passage scheme in effect at the projects. Successful passage through turbines, as well as through other routes, can be variable based upon the site characteristics, species, and life stages." The response further states: "The reports [a series of 5 studies conducted on Atlantic salmon smolts and kelts, adult river herring and American shad, and American eels at the Lockwood Project and American eels at the Shawmut Project] have been modified to include the '*immediate survival*' language." [Emphasis added].

Five additional times in this letter, FPL Energy Maine agrees with MDMR suggestions to change the wording in a final report to "immediate survival" from survival. (FPL Energy Maine 2008b).

- The 2007 diadromous fish passage report itself, which accompanied the above letter, repeatedly reports data regarding "immediate survival" of various fish species, including Atlantic salmon smolts (86% survival through turbine units; 32 of 37 fish), kelts (67% survival through Unit 7; 2 of 3 fish), and American shad (73% survival through Units 1-6; 11 of 15 fish). (FPL Energy Maine Hydro, LLC. 2008a). This report states: "Passage data indicate that *immediate survival of the smolts that passed via the units was 86% and 14% of the smolts were subject to turbine mortality. This data is similar to numerous other turbine passage studies throughout the country that indicated survival can be within that range for projects of this size (Table 3-4).*" [Emphasis added]. Table 3-4 of this report is entitled "Turbine passage survival of Atlantic Salmon Smolts at projects similar in size to the Lockwood Project". Table 3-4 represents a series of studies at other locations by Normandeau Associates, Inc. and others using balloon tags and reports survival for Kaplan and propeller turbines. Survival rates at these projects for 48 hours or less range from 88.0% to 100%. (Normandeau Associates, Inc. and FPL Energy Maine Hydro, LLC, 2008d).

- Eel survival data has also been collected at NextEra dams on the Kennebec. See Normandeau Associates, Inc. and FPL Energy Maine Hydro, LLC. 2009a , and Normandeau Associates, Inc. and NextEra™ Energy Maine Operating Services, LLC. 2009b. Eel survival data can be relevant to an assessment of turbine mortality for Atlantic salmon kelts because the length of these fish is similar.

- In a response to a specific comment from MDMR on the 2007 Atlantic salmon smolt passage study at Lockwood (Normandeau Associates, Inc. and FPL Energy Maine Hydro, LLC. 2008d), FPL Energy Maine responded as follows:

  MDMR Specific comments: Evaluation of Atlantic salmon smolt downstream passage at the Lockwood Project

  "Study objective was 'to determine what routes salmon smolts are using to migrate downstream through the Project and whether existing project measures, including the use of surface sluices and spillways, and other means are passing smolts successfully.' Since the study was not designed to be smolt survival study, information regarding survival through the project is, at best, guarded. Delayed mortality or injuries were not studied; little to no monitoring of smolt movements post Project passage is presented to support the survival conclusion."

  FPL Energy Response: "FPL Energy understands that the study was not designed to be a formal turbine survival study; however, the data is nonetheless valid within the limits of the study. In regards to survival, the results are similar to that of other projects on the East and West coasts." (FPL Energy Maine 2008b).

The results of the studies described above, limited as they may be, are consistent with other turbine mortality studies from Europe and the United States.

B. Conclusions Regarding Impacts on Fish– I have reached the following conclusions with respect to turbine passage at Lockwood:

I. There is a significant frequency, during critical downstream migration periods for Atlantic salmon smolts and/or kelts (April through June and October and November), when essentially the entire flow of the river passes through the Lockwood Project's turbines and bypass system. This is what is known as a "non-spill" condition. Please see the flows analysis below.

II. Given the fact that the data clearly show that the existing downstream fish bypass system is very ineffective at diverting downstream migrating Atlantic salmon away from the turbines, I conclude that during these non-spill conditions the majority of fish passing the dam do so through the Project's turbines. Even during conditions of spill (when water flows over the spillway), fish will still pass through the Project's turbines if they are operating.

III. A scientifically defensible estimate of immediate Atlantic salmon smolt mortality passing through the Francis turbines (Units 1-6) and Kaplan turbine (Unit 7) at Lockwood is approximately 15%. Immediate mortality levels for kelts will be higher, with a reasonable working value of 25-50%. It is important to note that these values do not include mortality associated with downstream predation due to injury or disorientation or latent mortality as a result of passing through the turbines.

IV. Given the preceding conclusions, the Lockwood Project is causing direct mortality to Atlantic salmon smolts and kelts by allowing fish to pass through the Project turbines. Although indirect and latent mortality have not been adequately assessed at this Project, it is reasonable to assume that some small percentage of indirect and latent mortality is also occurring as a result of turbine passage.

4. Upstream fishway for adult passage

A. Evaluation – No volitional upstream fish passage structure is part of the Project's infrastructure (that is, there is no structure allowing the fish to swim upstream past the dam on their own). The Project currently has an upstream fish trapping facility located adjacent to the west bank of the Kennebec River. The trapping facility appears to be operational from about May 1 through October 31 in most years, with some summer down periods due to high water temperature and/or annual maintenance. In addition, the trapping facility is operational generally only at flows < ~21,000 cfs (FPL Energy Maine Hydro, LLC. 2007, 2008a; NextEra™ Energy Maine Operating Services, LLC. 2009, 2010, 2011).

Since the installation of the fish trapping facility in 2006, the owners/operators of the Shawmut and Weston projects have explicitly stated that their fish passage requirement for adult Atlantic salmon is being met by the "trap and truck" program at the Lockwood Project. Although not explicitly stated, it is strongly implied that the owners/operators of the Lockwood Project believe that their upstream adult fish passage requirements are met by the trap and truck program as well (FPL Energy Maine Hydro, LLC. 2007, 2008a; NextEra™ Energy Maine Operating Services, LLC. 2009, 2010, 2011). The owner/operator of the Hydro Kennebec Project, located approximately one mile upstream from the Lockwood

Project, asserts that the Lockwood Project is a complete passage block for adult Atlantic salmon under all flow conditions and thus that there are no adult salmon that reach Hydro Kennebec. Given this conclusion, the Hydro Kennebec owners/operators conclude that no upstream passage facilities for adult Atlantic salmon are needed at their dam (Hydro Kennebec, LLC. 2011. Note: this document is under a court protective order).

A considered evaluation of the physical conditions at Lockwood does not support the conclusions reached by the various dam owners/operators. First, at some yet to be quantified flow volume, adult Atlantic salmon can pass the Lockwood Project spillway section and move upstream to the Hydro Kennebec Project simply because there will be sufficient water depth and/or flow turbulence at specific locations that will facilitate fish passage.

Second, it has not been established that all – or any known percentage of – returning adult Atlantic salmon in the immediate downstream area of Lockwood are actually captured at the fish trapping facility. The physical configuration and width of the river channel and the location of the fish trapping facility immediately adjacent to the west bank of the river strongly suggest that the probability of an adult fish actually finding the entrance to the facility varies with river flow. Given the behavior of adult Atlantic salmon to migrate upstream to the maximum extent possible, and the 1,300-foot section of channel leading up to the dam's spillway located to the east and *upstream* of the powerhouse, it is reasonable to assume that under spill or higher flow conditions adult fish will tend to stay nearer the east bank of the river, away from and upstream of the trapping facility. Only under non-spill flow conditions, or when the majority of flow entering the river channel passes through the Project's tailrace, is it more likely that fish would find the entrance to the trapping facility.

Finally, the fish trapping facility shuts down at river flows > ~ 21,000 cfs. Based on my personal observation of the Lockwood site, I do not believe that adult fish could pass the Lockwood spillway section at flow volumes in the low 20,000+ cfs range. It is therefore my opinion that Lockwood presents an impassable barrier to upstream migrating adult Atlantic salmon when river flows are > ~ 21,000 cfs but below the even higher flow volumes which would permit direct passage over the spillway section.

B. Conclusions Regarding Impacts on Fish – Given the information in the evaluation above, I have reached the following conclusions regarding upstream fish passage facilities at the Lockwood Project:

I. No volitional upstream adult passage facilities exist at the Lockwood Project. Accordingly, except when river flow is high enough to permit them to swim over the dam, upstream migrating Atlantic salmon must "find" the entrance to fish trapping facility under all flow conditions in order for them to be transported upstream via the trap and truck program.

II. It is unknown what percentage of adult Atlantic salmon that migrate from the ocean to the Lockwood Project site are actually captured and trucked to upstream summer holding and spawning areas.

III. The timing of adult Atlantic salmon upstream migration cannot be determined based on the capture data from the Lockwood fish trapping facility. The trap is operated on an apparently fixed time schedule, with no data available to me to suggest when the adults actually arrive at Lockwood.

IV. Given the physical configuration and width of the channel and the physical layout of the Lockwood Project, it is probable that upstream migrating adult fish will use the east side of the river as their initial migratory pathway and, depending on river flow volumes, may or may not move to the west side of the river channel towards the entrance to the fish trapping facility. Particularly given the dependency on favorable flow volumes, I do not believe that all adult Atlantic salmon find their way to the fish trapping facility.

V. The Lockwood Project is not a total block to upstream migrating adult Atlantic salmon under all flow conditions. At some yet to be quantified high flow volume, adult salmon can pass the Lockwood spillway section and move upstream to the Hydro Kennebec Project.

VI. At river flow volumes great enough to require the fish trapping facility to be shut down but below the higher river flow volumes sufficient to allow adult Atlantic salmon passage over the Lockwood spillway section, the Lockwood Project is an impassable barrier for upstream migrating adult Atlantic salmon.

VII. It is biologically unjustified to conclude that upstream passage requirements for adult Atlantic salmon are met by conditions and operations at the Lockwood Project.

VIII. Given these supporting conclusions, I conclude that – depending on flow conditions – the Lockwood Project blocks upstream migration of Atlantic salmon, delays their migration, or creates conditions that allow passage only under flow conditions that are different from those that existed before the Project was constructed. In addition, it is unknown what the fate of adult Atlantic salmon may be if they are unable to find a way to pass the Lockwood Project on their way upstream.

5. Size and configuration of the headpond upstream of the dam

A. Evaluation – According to published reports, the headpond area at the Lockwood Project is 81.5 acres in size (FPL Energy Maine Hydro, LLC. 2007). Although I am unable to verify this estimate, it appears reasonable, given the low height of the spillway section. However, it is not stated if this area estimate is with or without the flashboards installed. Installing the flashboards raises the effective height of the dam, thus increasing the area of the headpond. The headpond size is significant because in this area of the Lockwood Project, the habitat of the Kennebec River has been changed from a flowing river channel to a more slow-moving water habitat. The lake-like habitat is more likely to contain fish species that are predators on juvenile Atlantic salmon, and it may not contain the cover features for juvenile salmon that would normally be present in a natural river channel. I am unaware of any study or analysis that has specifically quantified the habitat characteristics of this area or quantified any predation rates on Atlantic salmon smolts.

B. Conclusions Regarding Impacts on Fish – I conclude that it is likely that levels of predation of Atlantic salmon smolts in the headpond area of the Lockwood Project are higher than what they would be in a natural river channel. But given the lack of any site-specific, quantitative studies or data, it is impossible to reach a defensible quantitative assessment of the increased predation rate or the potential impacts on the Atlantic salmon population.

6. Physical character of the river immediately downstream of the dam and tailrace areas as potential habitat for predators

A. Evaluation – Smolts can pass the Lockwood Project by going over the spillway, or passing through the turbines or downstream fish bypass system. Each of these routes may affect smolts in ways that make them more vulnerable to predation, as described in Section 5.2, above. No scientifically rigorous studies have been conducted to assess these impacts at Lockwood, although the authors of studies conducted at the Lockwood Project that focused on other passage issues conclude that some radio tagged smolts were taken by downstream predators, based on movement patterns of the tags after passage through the project ((FPL Energy

Maine Hydro, LLC. 2008a, Normandeau Associates, Inc. 2011c. Note this latter document is under a court protective order). The predation estimate in the 2011 study was 1.4%.

The configuration of the river channel and the effects of spill on juvenile Atlantic salmon passing over the spillway make these fish vulnerable to predation. Given the extensive bedrock ledges immediately downstream of the spillway section, I conclude that some yet to be quantified level of disorientation or injury increases vulnerability to predation.

Under low flow conditions, the majority of the river flow is passing through the power canal, which means fish are passing through the bypass system or turbines. In multiple reports, the published project description states that the water depth in the turbine tailrace is approximately 15 ft. This type of habitat is very conducive to harboring predators such as striped bass. Given the probability of fish being disoriented by passing through the turbines, it is likely that predation rates in this specific area of the Project are higher than other areas. However, no studies have specifically quantified the predation rate in this area.

B. **Conclusions Regarding Impacts to Fish and this Factor –**I conclude that the Lockwood Project's configuration and operations create conditions that result in increased predation of juvenile Atlantic salmon. There is one published estimate that would suggest a 1+% predation rate, but I do not believe that level is supported by scientifically reliable evidence. In my professional opinion, predation is occurring at some unknown level, likely in the low single digits. But given the lack of specific quantitative data, the actual level of predation below Lockwood and its impact on Atlantic salmon cannot be quantified at this time.

7. **River flow regime during time periods critical for Atlantic salmon (April through June and October through November) in relation to the hydraulic capacity of the turbines**

A. **Evaluation –** For a more detailed explanation of the data and procedure used to develop the figures below relating Kennebec River flow conditions and the potential for all of the river flow to pass through the Project's turbines, see Section 6.2 of this report. Results of this analysis are presented below:

Data from Figure 7.1.1 show that during the month of April there is a fairly consistent probability of 5% that river flows will be $\leq$ Project hydraulic capacity. This probability increases to nearly 10% during the last few days of the month.

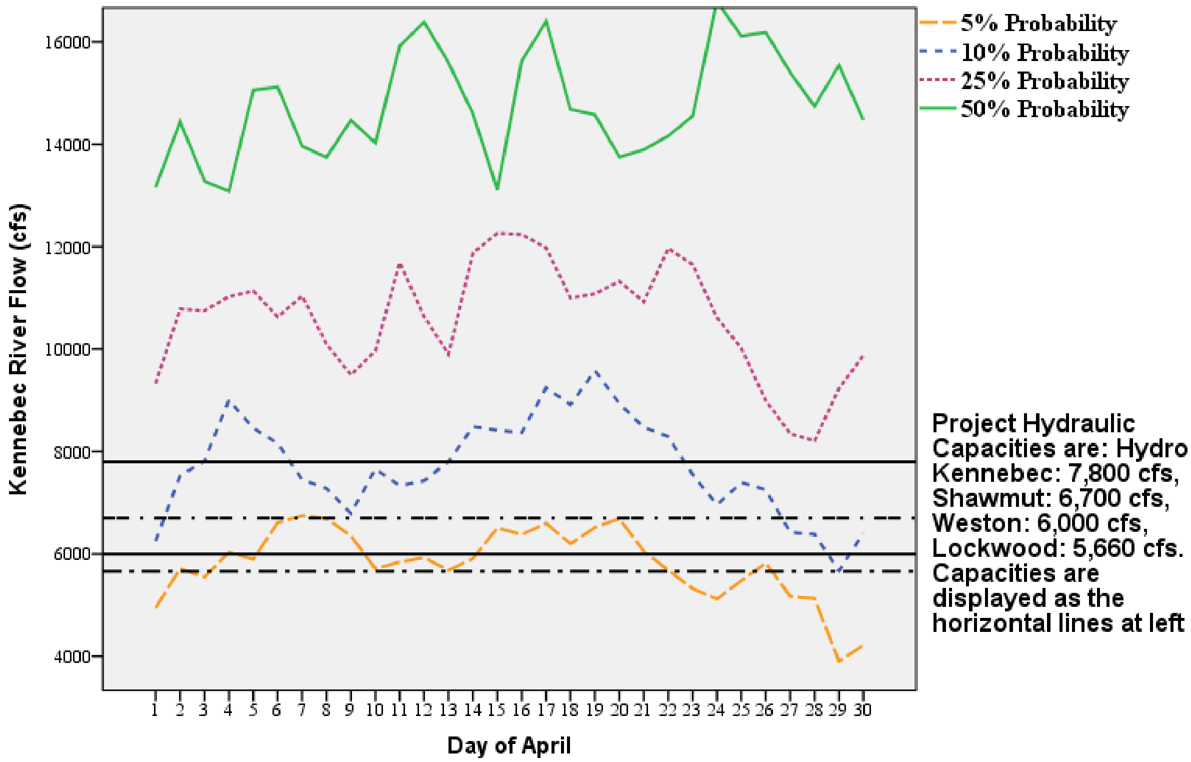


Figure 7.1.1. Relationship between Kennebec River mean daily flow in April and the hydraulic flow capacity of the Hydro Kennebec, Shawmut, Weston, and Lockwood projects. Flow curves represent the 5, 10, 25, and 50th mean daily flow percentiles. Flow volume is based on all days of record for the USGS gage at North Sidney, ME with flows from the Sebasticook River at Pittsfield, ME subtracted. No flow adjustment has been made for changes in watershed area.

Data from Figure 7.1.2 show that during the month of May there is a fairly consistent probability of 10% that river flows will be ≤ Project hydraulic capacity. This probability increases to nearly 25% during the last 10 days of the month.

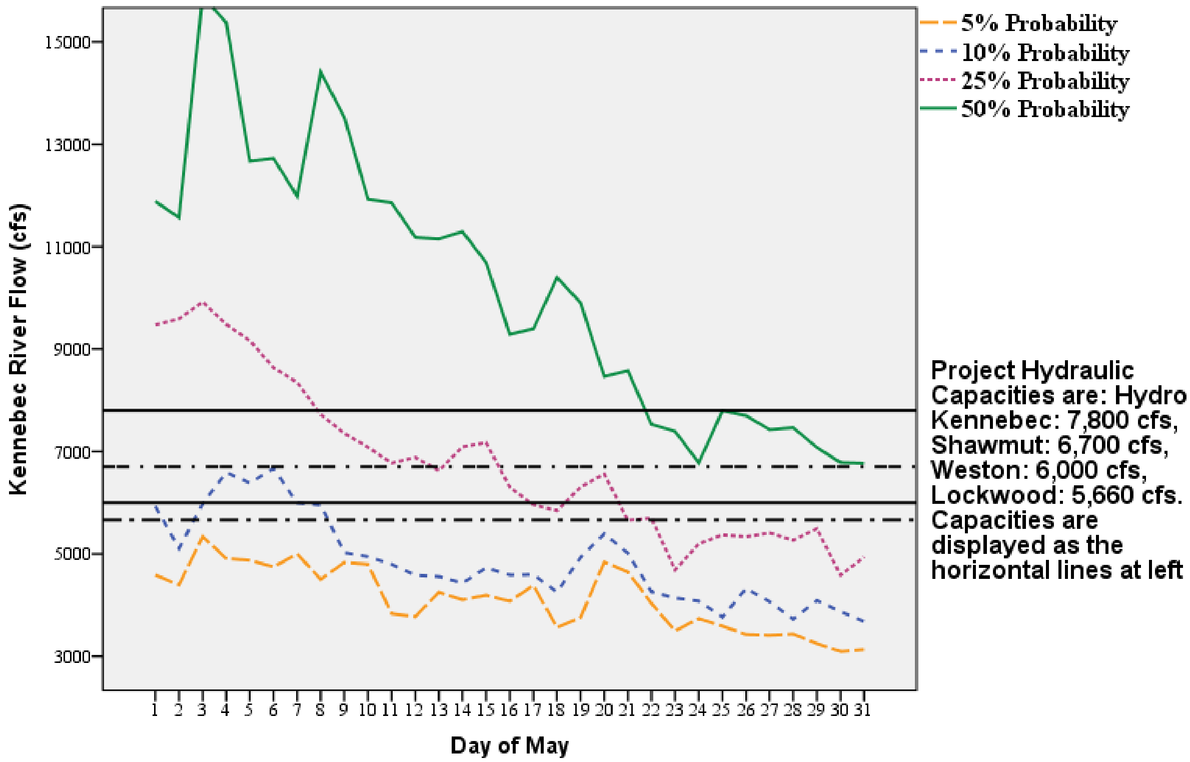


Figure 7.1.2. Relationship between Kennebec River mean daily flow in April and the hydraulic flow capacity of the Hydro Kennebec, Shawmut, Weston, and Lockwood projects. Flow curves represent the 5, 10, 25, and 50th mean daily flow percentiles. Flow volume is based on all days of record for the USGS gage at North Sidney, ME with flows from the Sebasticook River at Pittsfield, ME subtracted. No flow adjustment has been made for changes in watershed area.

Data from Figure 7.1.3 show that during the month of June there is a fairly consistent probability of 25% that river flows will be ≤ Project hydraulic capacity. This probability increases to nearly 50% during the last 10 days of the month.

Data from Figure 7.1.4 show that during the month of October there is a consistent probability of at least 50% that river flows will be ≤ Project hydraulic capacity.

Data from Figure 7.1.5 show that during the month of November there is a consistent probability of at least 25% that river flows will be ≤ Project hydraulic capacity.

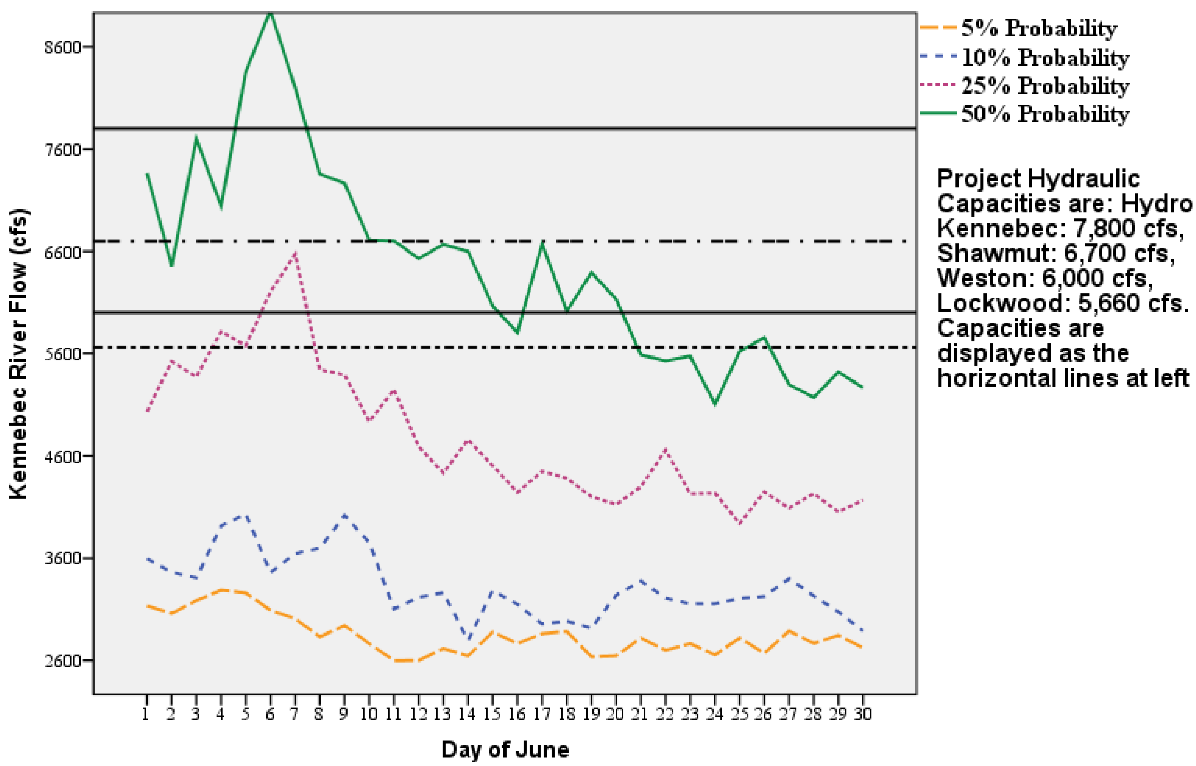


Figure 7.1.3. Relationship between Kennebec River mean daily flow in April and the hydraulic flow capacity of the Hydro Kennebec, Shawmut, Weston, and Lockwood projects. Flow curves represent the 5, 10, 25, and 50th mean daily flow percentiles. Flow volume is based on all days of record for the USGS gage at North Sidney, ME with flows from the Sebasticook River at Pittsfield, ME subtracted. No flow adjustment has been made for changes in watershed area.

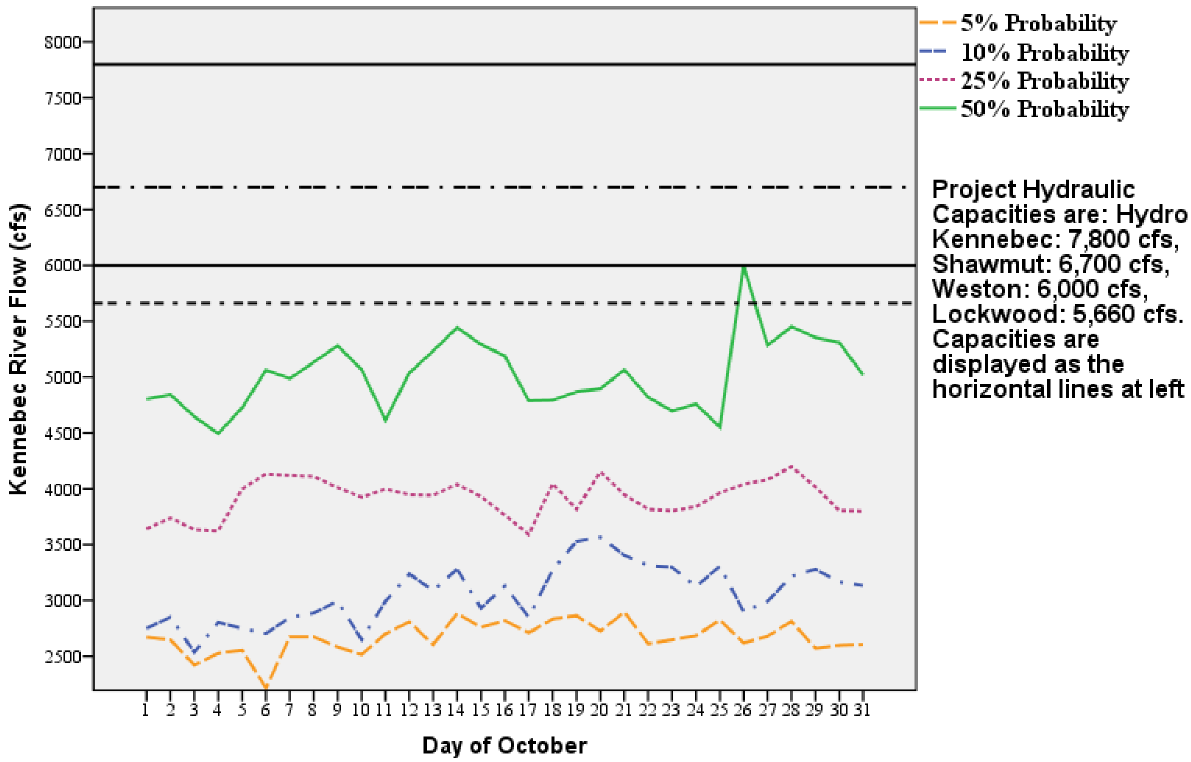


Figure 7.1.4. Relationship between Kennebec River mean daily flow in April and the hydraulic flow capacity of the Hydro Kennebec, Shawmut, Weston, and Lockwood projects. Flow curves represent the 5, 10, 25, and 50th mean daily flow percentiles. Flow volume is based on all days of record for the USGS gage at North Sidney, ME with flows from the Sebasticook River at Pittsfield, ME subtracted. No flow adjustment has been made for changes in watershed area.

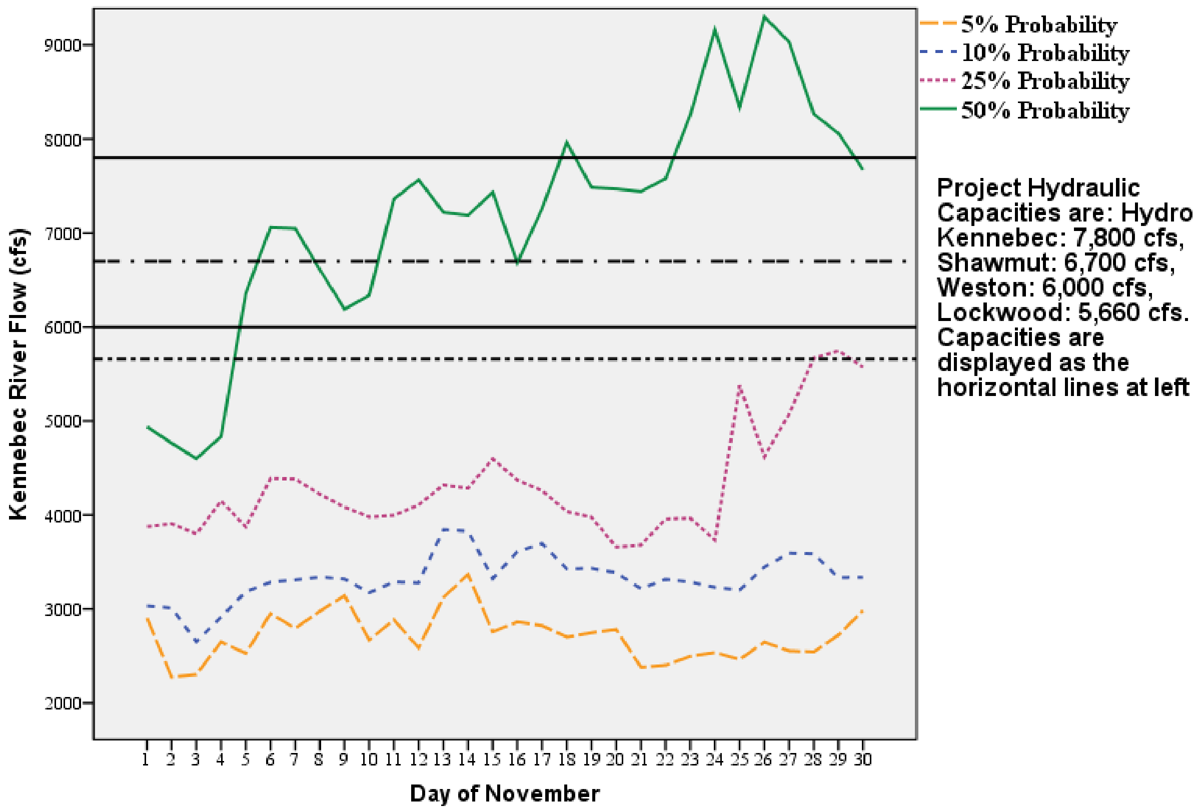


Figure 7.1.5. Relationship between Kennebec River mean daily flow in April and the hydraulic flow capacity of the Hydro Kennebec, Shawmut, Weston, and Lockwood projects. Flow curves represent the 5, 10, 25, and 50th mean daily flow percentiles. Flow volume is based on all days of record for the USGS gage at North Sidney, ME with flows from the Sebasticook River at Pittsfield, ME subtracted. No flow adjustment has been made for changes in watershed area.

B. Conclusions Regarding Impacts on Fish – The results of these analyses lead me to the following conclusions:

I. During the spring emigration period, the probabilities of river flow being $\leq$ the Lockwood Project's hydraulic capacity range from 5 to 50%. During the most likely time when the majority of smolts would migrate, the probabilities range from 10-25%. This level of resulting interaction with Project turbines is, in my opinion, unacceptable in terms of population survival and recovery, given the level of immediate turbine mortality at Lockwood Project and the current status of the Atlantic salmon population in the Kennebec River.

II. During the fall kelt emigration period, the analysis shows probabilities of > 50% for all of October and > 25% for all of November. This level of resulting interaction with Project turbines is, in my opinion, unacceptable in terms of population survival and recovery, given the level of immediate turbine mortality at Lockwood Project and the current status of the Atlantic salmon population in the Kennebec River.

III. This analysis clearly demonstrates that the use of median monthly flow values to assess potential project impacts is not appropriate or defensible. As this analysis shows, the use of median monthly flows greatly underestimates the amount of time that river flows will be less than or equal to project hydraulic capacity, and thus underestimates the percentage of time that the only downstream passage route available for Atlantic salmon is through the project turbines and the inadequate downstream bypass system. It is my understanding, based on my review of draft white papers commissioned by the NextEra Defendants, that these Defendants plan to use median flow data to assess each Project's impacts on Atlantic salmon for purposes of obtaining Incidental Take Permits.

IV. Given the current population levels, the age structure of adults captured at the Lockwood fish trapping facility, the decades it would take to rebuild even one year's loss of smolts due to project operations, and the cumulative effects of the four projects on the Kennebec River between Waterville and the Sandy River, I believe the impacts associated with low river flows result in critical levels of mortality to Atlantic salmon on a reasonably predictable and routine basis.

7.1.3 Impacts on Atlantic salmon in the Merrymeeting Bay SHRU and, consequently, the GOM DPS as a whole

In order to evaluate impacts of dam operations on the Merrymeeting Bay SHRU and the GOM DPS as a whole, I used five parameters related to the Lockwood Project, and these same parameters and conclusions are equally applicable to the Hydro Kennebec, Shawmut, and Weston projects as well.

1) **Percentage of the total habitat in comparison to the GOM DPS –** According to the NMFS (2009b), the Merrymeeting Bay SHRU comprises approximately 46% of the land area in the GOM DPS, with the Kennebec River watershed contributing 56% of the total for the Merrymeeting Bay SHRU. Therefore, the Kennebec River watershed has the potential to be the dominant contributor to recovery in the SHRU and the GOM DPS overall because of its land area and the quality of habitats suitable for Atlantic salmon upstream of the Weston Project.

2) **Population diversity and stability –** The Kennebec River watershed is the second largest in Maine that is part of the GOM DPS and contains extensive areas

designated as critical habitat. Historically, the Androscoggin, Kennebec, and Penobscot watersheds were the largest producers of Atlantic salmon in Maine, and probably the East Coast. These large watersheds provided a variety of habitats which resulted in genetic diversity among watersheds and overall population stability because of the variety of habitats and life history strategies necessary for salmon to persist in them (National Research Council 2002, 2004; Fay et al. 2006; National Marine Fisheries Service and U.S. Fish and Wildlife Service 2009).

3) **Location of habitats suitable to promote recovery of the species –** The overwhelming majority of habitats suitable to support Atlantic salmon spawning and juvenile rearing in the Kennebec River watershed are located upstream of the Weston Project. While the MDMR (2010) identified some habitat suitable for Atlantic salmon downstream of the Lockwood Project, a functional equivalent habitat analysis by NMFS found that all habitats downstream of the Lockwood Project received a zero rating for Atlantic salmon spawning and rearing. What this functional equivalent rating means is that the quantity and quality of downstream habitats are insufficient to adequately support the habitat and population recovery criteria for the SHRU (National Marine Fisheries Service (2009b). The NMFS analysis found that all of the habitat suitable to support the PCE requirements for spawning and rearing, and thus recovery, were upstream of the Weston Project.

4) **Blockage and/or delay to upstream migrating adult Atlantic salmon –** As demonstrated in various analyses I described earlier in this report, the Lockwood Project blocks migration of adult Atlantic salmon, delays their migration, or creates conditions that allow passage only under flow conditions that are different than those that existed before the Project was constructed. Any adults that are captured are trucked far upstream, which subjects them to the adverse impacts of trucking described in Section 5.3 and requires kelts to pass four hydroelectric dams in order to return to the sea after spawning.

5) **Mortality rate of Atlantic salmon smolts and kelts passing downstream through Lockwood Project turbines –** Smolts and kelts moving downstream through the Lockwood Project are subject to mortality associated with passage through the Project's turbines. During periods of non-spill at downstream migration time periods (see analyses of these time periods above), fish are forced to pass via the Project's power canal which contains several fish bypass sluices and the project turbines. Studies conducted on the effectiveness of the various bypass routes have shown, at best, about a 20% effectiveness of the bypass systems to successfully pass smolts through those routes (Normandeau

Associates, Inc. and FPL Energy Maine Hydro, LLC. 2008d; Normandeau Associates, Inc. 2011c. Note: this document is under a court protective order.). Immediate mortality of smolts passing through the turbines is about 15%, while immediate mortality of kelts is about twice that rate (Normandeau Associates, Inc. and FPL Energy Maine Hydro, LLC. 2008b, 2008d). Delayed turbine mortality, and additional adverse impacts on salmon going over the spillway or thru the bypass structures, are likely but have not been quantified.

Given the impacts of these five factors on individual Atlantic salmon, the effects of the Lockwood Project on the spawning and rearing and migration PCE's, and the overall negative impact on the likelihood that the recovery criteria for the Merrymeeting Bay SHRU will be met, I conclude that the Lockwood Project, as it is currently structurally configured and operated is having a significant adverse impact on the Merrymeeting Bay SHRU and the GOM DPS as a whole.

7.1.4 Interim Measures

Any or all of the following measures would either reduce the harm to Atlantic salmon currently being caused by the dams in question or contribute to efforts at restoration of the species.

7.1.4.1 Interim Measures Applicable to All Projects on the Kennebec and Androscoggin rivers

A. Ensure that when a project's turbines are operating, they are operating near peak efficiency. Running a turbine at near peak efficiency maximizes the survival of fish passing through the turbine. See Stone and Webster (1992) and Robson et al. (2011) for more detailed discussion.
B. Discontinue the use of Francis turbines during the spring migration period (April through June) and the Atlantic salmon kelt fall migration period (October and November). Francis turbines have higher mortality rates for juvenile salmonids passing through this type of turbine than do Kaplan type turbines. Temporary turbine shutdowns are specifically mentioned in the Kennebec Hydro Developers Group Settlement of 1998 (See Section IV. B.3.a (1) for example).
C. Alternatively, discontinue the use of all project turbines during the spring migration period (April through June) and the Atlantic salmon kelt fall migration period (October and November). Temporary turbine shutdowns are specifically mentioned in the Kennebec Hydro Developers Group Settlement of 1998 (See Section IV. B.3.a (1) for example).
D. Immediately fund on an annual basis, the collection and analysis of genetic samples from all returning adult Atlantic salmon entering the fish trap facilities at the Lockwood and Brunswick projects. These data are necessary to begin

monitoring the progress of restoration efforts in the Androscoggin and Kennebec river watersheds.

E. Evaluate as appropriate for an individual project, the effectiveness of an electrical guidance system to replace or supplement existing ineffective barrier or guidance booms. These systems have proven to be highly effective in providing fish guidance or barriers in situations similar to those prevailing in the Kennebec and Androscoggin (Palmisano and Burger 1988, Barrick and Miller 1990, S. P. Cramer and Associates, Inc. 1993). This technology can also be used to keep larger predators away while smaller juveniles pass. The evaluations conducted of boom guidance systems to date have demonstrated that they are ineffective at guiding fish away from project turbines and provide an inadequate level of protection to fish migrating downstream.

F. Give priority to providing alternate spill locations away from the turbine intakes to the extent practical. Many of the downstream fish bypass entrances are located in areas very close to the turbine intakes and have insufficient flow capacity to effectively attract fish from moving away from the turbine intakes and into the downstream bypass. Concentrating downstream bypass flows at one or more locations along the spillway of an individual project could improve downstream passage efficiency and potentially fish survival.

G. Increase the time period when upstream fish passage facilities are operated by beginning on April 1st.

H. Fund a series of quantitative studies to quantitatively determine fish mortality rates for the various routes of passage including through the turbines, fish bypass system(s), and spill, and to quantitatively determine mortality in the headpond upstream and tailrace downstream of the project. These studies should be conducted by an independent, unaffiliated organization such as the Maine Cooperative Fish and Wildlife Research Center at the University of Maine, Orono.

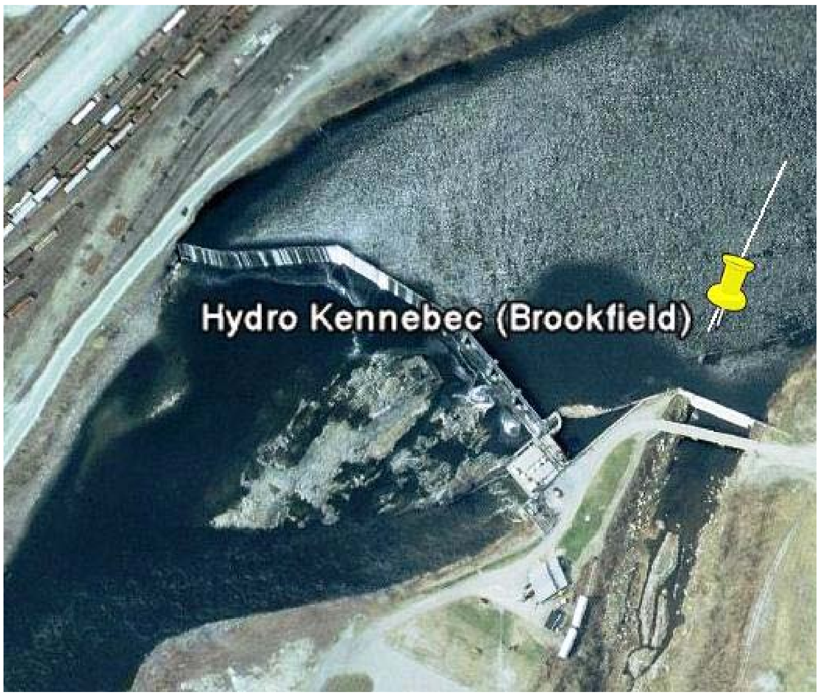
I. Complete the preliminary design of any new or additional permanent upstream and downstream fish passage facilities at each project, as needed, within 12 months. It is apparent that safe fish passage and habitat connectivity are going to be major components of any recovery plan developed for Atlantic salmon, and the impacts of project operations could be reduced much sooner if a proactive approach is taken.

J. Fund the development and construction of a genetics conservation hatchery facility in both the Kennebec and Androscoggin River watersheds. Each facility would hatch and rear fish to approximately three inches in length for release into their respective rivers. The purpose of a conservation hatchery in each watershed would be to begin the development of a river-specific stock, as recommended by the agencies' Atlantic salmon recovery team. Each facility could be constructed for approximately $1,000,000 and be fully operational in approximately 1 year. I have been personally involved in a similar effort for winter-run Chinook salmon from concept to completed construction; that facility led to the rapid expansion of the winter-run Chinook population within 10 years.

7.1.4.2 Additional Interim Measures Specifically for the Lockwood Project

- **A.** Install a downstream electrical guidance system to more effectively guide downstream migrating salmon and shad towards the project sluiceways. This system could be operated independently or in conjunction with the current boom system to increase the effectiveness of the boom system.
- **B.** Extend the discharge location of the sluiceway adjacent to Unit 1 from a point immediately adjacent to the powerhouse to a point east into the thalweg (deepest section) of the main river channel.

7.2 Hydro Kennebec Project (Brookfield)



7.2.1 Brief Project Description

The Hydro Kennebec Project is the second dam upstream on the Kennebec River. The Project consists of a 555-foot-long ungated concrete gravity spillway, a 200-foot-long gated spillway, downstream fish passage facilities and a powerhouse located adjacent to the east bank of the Kennebec River. Normal operating head is 28 feet. The powerhouse contains two horizontal Kaplan type units with a combined hydraulic flow capacity of approximately 7,800 cfs. No upstream fish passage facilities exist at the project. A downstream fishway consists of a 10' deep angled fish boom in the forebay leading to a 4' wide by 8' deep slot. That slot is capable of passing 4% of turbine flow and is located in the wall between the turbine intakes and the bascule gate structures. Flow through that slot discharges to a plunge pool next to the powerhouse (Hydro Kennebec, LLC. 2011; Normandeau Associates, Inc. 2011d).

7.2.2 Impact of Hydro Kennebec Project on Atlantic Salmon

7.2.2.1 Impact on Individual Fish

I have analyzed seven factors related to the physical structure of the dam and adjacent river channel and operational parameters and characteristics in evaluating impacts of the Project on Atlantic salmon. Below is my evaluation of these seven factors:

1. **Physical Structure of the Dam**

   A. **Evaluation –** The physical configuration, lack of upstream fish passage facilities, and height of the dam create a barrier to upstream migrating Atlantic salmon under normal flows. During my site visit to the Lockwood Project on December 8, 2011, staff at the Lockwood Project indicated that during the 1987 flood, that there was approximately 20 feet of water over the top of the dam. If these higher flows occur during the upstream migration period for salmon, then passage for adult Atlantic salmon past Lockwood is possible (see discussion in Section 7.1.2.1., above). This means that migrating adult Atlantic salmon could potentially reach and then be blocked from migrating to upstream spawning habitat by the Hydro Kennebec Project. I do not know whether, under extreme flow events, adult Atlantic salmon could pass the Hydro Kennebec Project, although I consider this possibility to be highly unlikely given the height of the Project.

      Atlantic salmon smolts migrating downstream to the ocean tend to move under low light or dark conditions. Given the physical shape of the spillway, it is likely that fish moving along the east bank of the river would move directly into the power canal towards the Project turbines. While the published flow capacity of the turbines at the Hydro Kennebec Project is 7,800 cfs, National Marine Fisheries Service staff commented that downstream juvenile passage via spill would probably not occur if depth of flow over the spillway/flashboards was <6 inches (Normandeau Associates, Inc., 2011b). Assuming this statement is correct, that would in effect direct juvenile fish towards the power canal at flows < ~8,000 cfs, increasing the probability of fish interacting with the downstream fish bypass system or the turbines.

      From my personal observation, it appears that fish passing via spill at Hydro Kennebec fall approximately 30+ feet onto a sloping face, bedrock ledges, or concrete sill at the base of the spillway, which is likely to cause injury to some fish. In addition, juvenile salmon may become entrained or impinged at specific locations where water is leaking through the dam's infrastructure. Two instances of such leaking were observed during my visit to the Hydro Kennebec dam.

B. Conclusions Regarding Impacts on Fish – Given the physical configuration of the spillway, its height, and the location of the power canal along the east bank of the river, I believe that the Hydro Kennebec Project is causing the following impacts to Atlantic salmon:

I. Upstream migrating adult Atlantic salmon that reach the Hydro Kennebec Project are blocked from moving further upstream towards spawning habitat areas that contain the characteristics outlined in the subcomponents of the PCE's detailed in Section 4 of this report, except conceivably under the highest possible flow conditions. Overall population productivity is decreased as a result of any such passage blockage.

II. The physical shape of the Project causes Atlantic salmon smolts and kelts emigrating to the ocean to enter the power canal, meaning that salmon will interact with one of the Project's turbines or the downstream fish bypass facility. This is especially likely at lower river flows, when river flows are near or below the Project's turbine flow capacity. Interaction with the Project's turbines and/or downstream bypass system causes Atlantic salmon mortality and injury. See the review of turbine mortality in Section 6.1 of this report.

III. The height of the dam, the shape of the dam face, and the presence of bedrock ledges immediately downstream of the spillway section causes some yet to be quantified level of mortality or injury to Atlantic salmon passing the Project via spill.

2. Downstream Fish Bypass System

A. Evaluation – To my knowledge, no quantitative mortality studies of fish passing via the various passage routes (spill, turbines, or bypass structure) have been completed. However, fish can be injured, killed, or disoriented in passing dams via spill or via bypass systems, as described in Section 5.2, above.

The Project currently has one location that serves as a downstream fish bypass system. This bypass is a hole cut in the west wall of the turbine intake structure that passes a maximum of 320 cfs. A guidance boom is intended to "lead" fish to the bypass entrance. The initial boom installation did not function as planned, and despite modifications it is unknown if the boom will function as planned in the future.

A 2008 downstream Atlantic salmon smolt passage study at the Project documented that 46% of the smolts in the study used the bypass (Madison Paper

Industries 2009). In a 2011 study of Atlantic salmon smolts released upstream of the Project, downstream passage routes were determined. Under high flow, spill conditions, 30 fish were confirmed passing via the bypass or through the turbines. Of these 30 fish, 14 (~54%) passed through the turbines (Table 4, Normandeau Associates, Inc. 2011d).

These studies demonstrate clearly that more than 50% of the Atlantic salmon smolts that do not (or cannot, because of low flow conditions) pass over the dam's spillway will pass via the Project's turbines, and that the guidance boom in the power canal is relatively ineffective at guiding fish away from the turbine intakes. Under high flow conditions, some fish will pass via spill (subject to the mortality described above), but the critical condition occurs when river flows are at or below the Project's turbine flow capacity of 7,800 cfs. The frequency of lower flow conditions will be discussed in detail below.

From my personal observations of Hydro Kennebec's fish bypass, I noted at least three points at which physical impacts or disorientation could occur: (a) where a highly turbulent discharge flows from the bypass opening against a concrete wall in the bypass spill chamber; (b) at a rock ledge alongside the fast-flowing narrow channel at the end of the bypass system; and (c) upon metal posts and hardware standing in the flow stream from the fish bypass.

B. Conclusions Regarding Impacts on Fish – Given the results of the 2008 and 2011 studies of smolts released upstream of Hydro Kennebec, which reflect the current infrastructure configuration at the Hydro Kennebec Project, along with my personal observations, I believe that the Hydro Kennebec Project is causing the following impacts to Atlantic salmon:

I. Approximately 54% of the smolts released at Hydro Kennebec that entered the forebay canal, and for which definitive passage routes were determined, passed the Project via the turbines and not the bypass system. It is clear that the current downstream bypass system at the Project is ineffective, resulting in a large percentage of smolts passing through the turbines with direct and indirect mortality occurring.

II. Under lower flow (non-spill) conditions, Atlantic salmon, both smolts and kelts, are forced to pass the Project via the fish bypass system or Project turbines. The bypass system is ineffective in diverting salmon from the turbines and therefore is inadequate to provide the level of protection to Atlantic salmon needed to prevent unacceptable (in terms of population recovery) levels of direct and/or indirect mortality.

III. Smolt and kelts passing Hydro Kennebec via the downstream fish bypass suffer death, injury, and disorientation as a result of that passage, at a rate yet to be quantified.

3. Types of turbines used to generate power

A. Evaluation – For an overview of turbine mortality rates see Section 6.1 of this report. The Project currently contains two horizontal Kaplan turbines. Change in barometric pressure is not a significant factor at the Project because the operation has a low hydraulic head. The primary direct cause of fish death or injury at Hydro Kennebec is blade strike.

A 2011 draft biological assessment for the Hydro Kennebec Project, commissioned by the project owner/operator, states: "Because of the few salmon returns and limited amount of juvenile stocking efforts, smolt survival has not been studied in the Kennebec River. Therefore, the licensee analyzed immediate turbine survival rates of Atlantic salmon smolts … estimated to potentially be entrained at the Hydro Kennebec Project under existing conditions based on the results of field trials compiled in the EPRI turbine passage survival database…"

I agree that site-specific empirical studies have not been conducted at the Project to asses: predation in the headpond area as a result of changing the type of habitat upstream of the dam; spill-related mortality; mortality associated with fish using the downstream bypass system; delayed or latent mortality associated with fish passing through the turbines and not immediately killed; and mortality due to predation at locations immediately downstream of the Project infrastructure due to fish being injured or disoriented during passage through the Project.

However, I disagree with the conclusion that *no* Kennebec River-specific information is available regarding mortality associated with Atlantic salmon smolts and kelts passing through Kaplan type turbines. For a more detailed evaluation of the studies on the Kennebec River at the Lockwood and Hydro Kennebec projects, please see the companion evaluation for the Lockwood Project above (Section 7.1). In short, these studies and associated annual restoration program reports to FERC and an associated transmittal letter continually assert that the results of the studies are consistent and comparable with other turbine mortality studies from Europe and the United States, which are discussed in Section 6.1 above.

B. Conclusions Regarding Impacts on Fish – Given the information in the references cited above in Sections 6.1 and 7.1, and the study results completed on a nearby project with similar turbine types, I have the following conclusions with respect to the impacts of turbine passage on Atlantic salmon:

I. There is a significant frequency, during critical downstream migration periods for Atlantic salmon smolts (April through June) and/or kelts (April through June and October and November), when the river flows are low enough that essentially the entire flow of the river passes through the Project's turbines and bypass system. Please see the flows analysis below.

II. Site-specific data clearly show that the existing downstream fish bypass system is less than 50% effective at diverting downstream migrating Atlantic salmon away from the turbines. In non-spill conditions the de facto majority route of passage is through the Project's turbines. Even during conditions of spill, fish will still pass through the Project's turbines if they are operating.

III. A scientifically defensible estimate of immediate mortality for Atlantic salmon smolts passing through the Kaplan turbines at Hydro Kennebec is approximately 15%. Immediate mortality levels for kelts will be higher, with a reasonable working value of 25-50%. It is important to note that these values do not include mortality associated with downstream predation due to injury or disorientation or latent mortality as a result of passing through the turbines.

IV. Given the preceding conclusions, I conclude that the Hydro Kennebec Project is causing direct mortality to Atlantic salmon smolts and kelts by allowing them to pass through the Project turbines. Although indirect and latent mortality have not been adequately assessed at this Project, it is reasonable to assume that some small percentage of indirect and latent mortality is also occurring as a result of turbine passage.

4. Upstream fishway for adult passage

A. Evaluation – No volitional upstream fish passage structure is part of the Project's infrastructure. The owner/operator of the Hydro Kennebec Project, which is located approximately one mile upstream from the Lockwood Project, asserts that the Lockwood Project is a complete passage block for adult Atlantic salmon under all flow conditions and that there are no adult salmon that reach Hydro Kennebec. The Hydro Kennebec owner/operator therefore concludes that no upstream passage facilities for adult Atlantic salmon are needed (Hydro Kennebec, LLC. 2011. Note: this document is under a court protective order).

As described more fully in Section 7.1.2.1(4) above, a considered evaluation of the physical conditions at Lockwood does not support the conclusions reached by the Hydro Kennebec Project. First, at some yet to be quantified flow volume, adult Atlantic salmon can pass the Lockwood Project spillway section and move upstream to the Hydro Kennebec Project simply because there will be sufficient water depth and/or flow turbulence at specific locations that will facilitate fish passage. Second, upstream migrating salmon that are trapped at Lockwood could be placed back in the river immediately above Lockwood and allowed to continue their migration if there were an effective volitional upstream passage structure at Hydro Kennebec.

B. **Conclusions Regarding Impacts on Fish –** Given the information in the evaluation above, I have reached the following conclusions regarding the impacts of upstream fish passage facilities at the Hydro Kennebec Project:

I. No volitional upstream adult passage facilities exist at the Hydro Kennebec Project. As a result, adult salmon that swim upstream over the Lockwood Project at high flows are blocked from swimming further upstream when they reach Hydro Kennebec. Similarly, adult salmon trapped at the Lockwood Project cannot be placed back into the river immediately above Lockwood, but must instead be trucked further upriver. Impacts of the trucking program on Atlantic salmon are discussed in Section 5.3 above.

II. The Lockwood Project is not a total block to adult Atlantic salmon under all flow conditions. At some yet to be quantified high flow volume, adult salmon can pass the Lockwood spillway section and move upstream to the Hydro Kennebec Project.

III. As described in Section 7.1.2.1(4), the Lockwood Project blocks migration of adult Atlantic salmon, delays their migration, or creates conditions that allow passage only under flow conditions that are different from those that existed before the Project was constructed. It is biologically unjustified to conclude that upstream passage requirements for adult Atlantic salmon are met by conditions and operations at the Lockwood Project. If the Hydro Kennebec Project is relying on the Lockwood Project fish trapping operations to meet its adult salmon passage requirements, then I conclude that that assumption is not justified by the current operational scenario at the Lockwood Project. The Hydro Kennebec Project therefore harms adult Atlantic salmon by blocking or delaying their migration.

5. **Size and configuration of the headpond upstream of the dam**

   A. **Evaluation –** According to published reports, the Hydro Kennebec Project's headpond has a gross impoundment of ~ 3,900 acre-ft. (Hydro Kennebec, LLC. 2011). Although I am unable to verify this estimate, it appears reasonable, given the height of the spillway section. However, it is not stated whether this estimate is with or without the flashboards installed. If it is without flashboards, then the headpond area will be larger when the flashboards are installed. In the headpond area of the Hydro Kennebec Project, the habitat of the Kennebec River has been changed from a flowing river channel to a more slow-moving water habitat. The lake-like habitat is more likely to contain fish species that are predators on juvenile Atlantic salmon and may not contain the cover features for juvenile salmon that would normally be present in a natural river channel. Results from the 2008 smolt study at Hydro Kennebec clearly show predatory fish stationary in the vicinity of the entrance to the downstream fish bypass and turbines, and predatory fish were observed chasing smolts; however, no quantitative evaluation of predation was completed (Madison Paper Industries 2009). I am unaware of any data that has specifically quantified the habitat characteristics of this area or quantified any predation rates on Atlantic salmon smolts.

   B. **Conclusions Regarding Impacts on Fish –** I conclude that, given the documented presence and behavior of predatory fish in the vicinity of the entrance to the downstream bypass and turbines, and the characteristics typical of such impoundments, levels of predation of Atlantic salmon smolts in the headpond area of the Hydro Kennebec Project are higher than what they would be in a natural river channel. But given the lack of any site-specific, quantitative studies or data, it is impossible to reach a defensible quantitative assessment of the increased predation rate or the potential impacts on the Atlantic salmon population.

6. **Physical character of the river immediately downstream of the dam and tailrace areas as potential habitat for predators**

   A. **Evaluation –** The configuration of the river channel and the effects caused by passing over the spillway section make juvenile Atlantic salmon passing the Hydro Kennebec Project more vulnerable to predation, as discussed in Section 5.2. No site-specific studies have been conducted to assess this condition.

      Given the extensive bedrock ledges immediately downstream of the spillway section, I conclude there is some yet to be quantified level of disorientation or injury that causes increased vulnerability to predation for salmon passing the Project via spill.

In addition, under low flow conditions, all or a majority of the river flow is passing through the power canal, which means fish must pass through the bypass system or turbines. Given the fact that fish become disoriented by passing through the turbines, I conclude that predation rates in this specific area of the Project are higher than other areas.

B. Conclusions Regarding Impacts on Fish – Although there is an absence of site-specific quantitative data, I am able to conclude, based on my observations of the site and my professional experience that the Project configuration and operations create conditions that result in increased predation on juvenile Atlantic salmon. In my professional opinion, predation is occurring at some yet to be quantified level, which is most likely in the low single digits. Given the lack of site-specific quantitative data, the level of predation below the Hydro Kennebec Project and its impact on the species cannot be quantified at this time.

7. River flow regime during time periods critical for Atlantic salmon (April through June and October through November) in relation to the hydraulic capacity of the turbines

A. Evaluation – For a more detailed explanation of the data and procedure used to develop the figures below relating Kennebec River flow conditions and the potential for all of the river flow to pass through the Project's turbines, see Section 6.2 of this report. Results of this analysis are presented below:

Figures referenced in this section of this report are located in Section 7.1.2.1(7) of the Lockwood Project evaluation (Section 7.1). Data from Figure 7.1.1 for the Hydro Kennebec Project show that during the month of April there is a consistent probability of 5% that river flows will be ≤ Project hydraulic capacity. This probability increases to nearly 10% during the last 10 to 15 days of the month.

Data from Figure 7.1.2 for the Hydro Kennebec Project show that during the month of May there is a consistent probability of 10% that river flows will be ≤ Project hydraulic capacity. This probability increases to nearly 25% during the last 20 days of the month.

Data from Figure 7.1.3 for the Hydro Kennebec Project show that during the month of June there is a consistent probability of 25% that river flows will be ≤ Project hydraulic capacity. This probability increases to 50% during the last 20 days of the month.

Data from Figure 7.1.4 for the Hydro Kennebec Project show that during the month of October there is a consistent probability of at least 50% that river flows will be ≤ Project hydraulic capacity.

Data from Figure 7.1.5 for the Hydro Kennebec Project show that during the month of November there is a consistent probability of at least 50% that river flows will be ≤ Project hydraulic capacity for the first 21 days of the month. During the last week of the month, the probability that river flows will be ≤ Project hydraulic capacity decreases to about 25%.

B. Conclusions Regarding Impacts on Fish – The results of these analyses lead me to the following conclusions:

I. During the spring emigration period, the probabilities of river flow being ≤ the Hydro Kennebec Project's hydraulic capacity range from about 10 to 50%. During the most likely time when the majority of smolts would migrate, the probabilities range from 10 to 25%. This level of interaction with Project turbines is, in my opinion, unacceptable in terms of population survival and recovery, given the level of immediate turbine mortality at Hydro Kennebec Project, the ineffectiveness of the fish bypass structure, and the current status of the Atlantic salmon population in the Kennebec River.

II. During the fall kelt emigration period, the analysis shows probabilities of > 50% for all of October and > 50% for most of November. This level of potential interaction with Project turbines is, in my opinion, unacceptable in terms of population survival and recovery, given the level of immediate turbine mortality at Hydro Kennebec Project, the ineffectiveness of the fish bypass structure, and the current status of the Atlantic salmon population in the Kennebec River.

III. This analysis clearly demonstrates that the use of median monthly flow values to assess potential project impacts is not appropriate or defensible. As this analysis shows, the use of median monthly flows greatly underestimates the amount of time that river flows can be ≤ Project hydraulic capacity and thus underestimates the percentage of time that the only downstream passage route available for Atlantic salmon is through the Project turbines and the inadequate downstream bypass system. And yet it is my understanding, based on my review of the draft biological assessment commissioned by Brookfield, that this Defendant plans to use median flow data to assess the Project's impacts on Atlantic salmon for purposes of obtaining an Incidental Take Statement.

IV. Given the current population levels, the age structure of adults captured at the Lockwood fish trapping facility, the decades it would take to rebuild even one year's loss of smolts due to Hydro Kennebec Project operations, and the cumulative effects of the four projects on the Kennebec River between Waterville and the Sandy River, I believe the impacts associated with low river flows result in critical levels of injury and mortality to Atlantic salmon on a reasonably predictable and routine basis.

7.2.3 Impacts on Atlantic salmon in the Merrymeeting Bay SHRU and, consequently, the GOM DPS as a whole

In order to evaluate impacts of dam operations on the Merrymeeting Bay SHRU and the GOM DPS as a whole, I used five parameters related to the Hydro Kennebec Project, and these same parameters and conclusions are equally applicable to the Lockwood, Shawmut, and Weston projects as well.

1) **Percentage of the total habitat in comparison to the GOM DPS –** According to the NMFS (2009b), the Merrymeeting Bay SHRU comprises approximately 46% of the land area in the GOM DPS, with the Kennebec River watershed contributing 56% of the total for the Merrymeeting Bay SHRU. Therefore, the Kennebec River watershed has the potential to be the dominant contributor to recovery in the SHRU and the GOM DPS overall because of its land area and the quality of habitats suitable for Atlantic salmon upstream of the Weston Project.

2) **Population diversity and stability –** The Kennebec River watershed is the second largest in Maine that is part of the GOM DPS and contains extensive areas designated as critical habitat. Historically, the Androscoggin, Kennebec, and Penobscot watersheds were the largest producers of Atlantic salmon in Maine, and probably the East Coast. These large watersheds provided a variety of habitats that have resulted in genetic diversity among watersheds and overall population stability because of the variety of habitats and life history strategies necessary for salmon to persist in them (National Research Council 2002, 2004; Fay et al. 2006; National Marine Fisheries Service and U.S. Fish and Wildlife Service 2009).

3) **Location of habitats suitable to promote recovery of the species –** The overwhelming majority of habitats suitable to support Atlantic salmon spawning and juvenile rearing in the Kennebec River watershed are located upstream of the Weston Project. While the MDMR (2010) identified some habitat suitable for

Atlantic salmon downstream of the Lockwood Project, a functional equivalent habitat analysis by NMFS found that all habitats downstream of the Lockwood Project received a zero rating for Atlantic salmon spawning and rearing. What this functional equivalent rating means is that the quantity and quality of downstream habitats are insufficient to adequately support the habitat and population recovery criteria for the SHRU (National Marine Fisheries Service (2009b). The NMFS analysis found that all of the habitat suitable for meeting the PCE requirements for spawning and rearing, and thus recovery, were upstream of the Weston Project.

4) **Blockage and/or delay to upstream migrating adult Atlantic salmon –** Hydro Kennebec has no provision for upstream fish passage; it relies on the operation of the trapping facility at Lockwood to achieve upstream passage. As demonstrated in various analyses described earlier in this report (see Section 7.1.2.1(4), the Lockwood Project blocks migration of adult Atlantic salmon, delays their migration, or creates conditions that allow passage only under flow conditions that are different than those that existed before the Project was constructed. Any adults that are captured are trucked far upstream, which subjects them to the adverse impacts of trucking described in Section 5.3 and requires kelts to pass four hydroelectric dams in order to return to the sea after spawning.

5) **Mortality rate of Atlantic salmon smolts and kelts passing downstream through Hydro Kennebec Project turbines –** Smolts and kelts moving downstream through the Hydro Kennebec Project are subject to mortality associated with passage through the Project's turbines. During periods of non-spill at downstream migration time periods (see analyses of these time periods above), all fish are forced to pass via the Project's power canal, which contains an ineffective guidance boom and fish bypass structure along with the Project turbines. Studies conducted on the effectiveness of the bypass system have shown that less than 50% of smolts entering the power canal are diverted from the turbines (Madison Paper Industries 2009, Hydro Kennebec, LLC. 2011). Immediate mortality of smolts passing through the turbines is about 15%, while the immediate mortality of kelts is about twice that rate (Normandeau Associates, Inc. and FPL Energy Maine Hydro, LLC. 2008b, 2008d). Delayed turbine mortality and additional adverse impacts on salmon going over the spillway or thru the bypass structure, are likely but have not been quantified.

Given the impacts of these five factors on individual Atlantic salmon, the effects of the Hydro Kennebec Project combined with the Lockwood Project's inability to consistently provide adult upstream passage or to achieve the spawning and rearing and migration PCE's, and the overall negative impact on the likelihood that the recovery criteria for the

Merrymeeting Bay SHRU will be met, I conclude that the Hydro Kennebec Project, as it is currently structurally configured and operated, is having a significant adverse impact on the Merrymeeting Bay SHRU and the GOM DPS as a whole.

7.2.4 Interim Measures

Any or all of the following measures would either reduce the harm to Atlantic salmon currently being caused by the dams in question or contribute to efforts at restoration of the species.

7.2.4.1 Interim Measures Applicable to All Projects on the Kennebec and Androscoggin rivers

A complete list of the interim measures applicable to all projects can be found in Section 7.1.4.1 of the Lockwood Project evaluation.

7.2.4.2 Additional Interim Measures Specifically for the Hydro Kennebec Project

A. Install a downstream electrical guidance system to more effectively guide downstream migrating salmon and shad towards the project fish bypass. This system could be operated independently or in conjunction with the current boom system to increase the effectiveness of the boom system. Documented evidence of predators adjacent to the existing downstream bypass entrance indicates a predation problem. Correct installation and operation of an electrical guidance system could also disperse these predators.
B. Provide a downstream passage route on the west side of the spillway during the downstream migration period of April through June. Consider closing the existing downstream bypass system and replacing it with a minimum one-foot-deep notch in the flashboards west of the project's gates.
C. Increase the water surface elevation in the downstream plunge pool of the existing fish bypass. Increase the water height by increasing the height of the weir between the concrete wall and the bedrock outcrop downstream of the pool. Step the flow down from the plunge pool to the project turbine tailrace.

7.3 Shawmut Project (NextEra)

7.3.1 Brief Project Description

The Project includes two powerhouses. The first powerhouse contains six horizontal Francis units (Units 1-6). The second powerhouse contains two horizontal fixed propeller units (Units 7 and 8). Propeller turbines are a type of Kaplan turbine. Total unit flow is approximately 6,700 cfs. Trash racks are located in front of the intake sections to limit debris from passing through the turbines. Trash rack “clear” spacing is 1.5 inches for Units 1-6 and 3.5 inches for Units 7 and 8. The spillway section of the dam is approximately 1,135 ft. long with an average height of about 24 ft., and consists of a hinged flashboard section, a 25 ft wide by 8 ft deep log sluice equipped with a timber and steel gate, and a four-foot high plywood flashboard section. The Project includes a 1,310-acre impoundment upstream of the spillway section. The Project has one surface sluice gate located in the forebay between the two powerhouses. The sluice gate is a manually adjustable gate containing three stop logs. The gate is 4 feet wide by 22 inches deep. With all stop logs removed; this gate passes flows in the range of 30 to 35 cfs. Flows from this sluice discharge over the downstream slope of the dam and drain into a pool connected to the river. The vertical distance from the gate discharge to the pool is approximately 20 feet. The project's tailrace channels are excavated riverbed located downstream of the powerhouses. The project boundary extends upstream about 12 miles (Normandeau Associates, Inc. and FPL Energy Maine Hydro, LLC, 2008e; Normandeau Associates, Inc., 2011f Note: this document is under a court protective order).

7.3.2 Impact of Shawmut Project on Atlantic Salmon

7.3.2.1 Impact on Individual Fish

I have analyzed seven factors related to the physical structure of the dam and adjacent river channel and operational parameters and characteristics in evaluating impacts of the project on Atlantic salmon. Below is my evaluation of these seven factors:

1. **Physical Structure of the Dam**

    A. **Evaluation –** The physical configuration and 24-foot height of the dam create a barrier to upstream migrating Atlantic salmon. Adult Atlantic salmon cannot pass this Project under normal flow conditions. It is unknown if extremely high flow events would allow upstream migrating salmon to reach this facility given the height of the Hydro Kennebec Project downstream.

        Atlantic salmon smolts migrating downstream to the ocean tend to move under low light or dark conditions. Given the location of the two powerhouses along the west bank of the river, it is likely that fish moving along the west bank of the river would move directly into the power canal towards the Project turbines. While the published flow capacity of the turbines at the Shawmut Project is 6,700 cfs, National Marine Fisheries Service staff commented that downstream juvenile passage via spill would probably not occur if depth of flow over the spillway/flashboards was <6 inches (Normandeau Associates, Inc.,2011b). Assuming this statement is correct, that would in effect direct juvenile fish towards the power canal at flows < ~7,000 cfs, increasing the probability of fish interacting with the downstream fish bypass system or the turbines.

    B. **Conclusions Regarding Impacts on Fish –** Given the physical configuration of the spillway, its height, and the location of the power canal along the west bank of the river, I believe that the Shawmut Project is causing the following impacts to Atlantic salmon:

I. Adult Atlantic salmon are blocked from moving upstream towards spawning habitat areas that contain the characteristics outlined in the subcomponents of the PCE's detailed in Section 4 of this report.

II. The physical shape of the Project makes it likely that Atlantic salmon smolts and kelts migrating downstream to the ocean will enter the power canal and, interact with one of the Project's turbines or with the downstream fish bypass facilities, especially when river flows are near or below the Project's turbine flow capacity. Interaction with the Project's turbines and/or downstream bypass systems causes mortality and injury.

2. Downstream Fish Bypass System

A. Evaluation – The Project currently has several locations that may serve as a downstream fish bypass system. There are inflatable dam spillway sections, the log/debris sluice, and a bypass sluice located between the two powerhouses that can pass a maximum of 30-35 cfs. However, no studies have been conducted to evaluate any of the potential downstream passage routes as to their effectiveness in attracting Atlantic salmon smolts or kelts emigrating to the ocean, or the mortality associated with any of the particular routes of passage.

B. Conclusions Regarding Impacts on Fish – I conclude that the Shawmut Project is causing the following impacts to Atlantic salmon:

I. In the absence of any contrary empirical data, and given the height of the dam and the configuration of the face of the spillway section, I believe that there is some mortality associated with the fish passing over the spillway section.

II. Under lower flow (non-spill) conditions, Atlantic salmon, both smolts and kelts, are forced to pass the Project via the fish bypass system or Project turbines. Given that the flow of water passing through the bypass system is only a maximum of about 35 cfs, in comparison to 6,700 cfs passing through the Project turbines, I conclude that the majority of smolts or kelts must be passing through the Project turbines, with the resultant mortality rate associated with each type of turbine installed. In my opinion, the design of the current downstream bypass system is ineffective and the system is inadequate under lower flow conditions to provide the level of protection to Atlantic salmon needed to prevent unacceptable (in terms of population recovery) levels of direct and/or indirect mortality.

3. **Types of turbines used to generate power**

   A. **Evaluation –** For an overview of turbine mortality rates see Section 6.1 of this report. The Project currently contains six horizontal Francis turbines (Units 1-6) and two fixed propeller turbines (Units 7 & 8). The Francis turbines at this Project have 10-13 blades, a smaller space between blades than the propeller turbines, and spin at about 200 rotations per minute (rpm). The fixed propeller turbines have three blades, more space between blades, and spin at about 900 rpm (Normandeau Associates, Inc. 2011h).

      In a 2011 draft white paper presented to the resource agencies, the NextEra Defendants reject the results of their own passage studies, saying they are inadequate to establish passage mortality at Shawmut. While I agree that site-specific empirical studies have not been conducted at the Shawmut Project to assess a variety of passage mortality factors (predation in the headpond area as a result of changing the type of habitat upstream of the dam; spill-related mortality; mortality associated with fish using the downstream bypass system; delayed or latent mortality associated with fish passing through the turbines and not immediately killed; and mortality due to predation at locations immediately downstream of the Project infrastructure due to fish being injured or disoriented during passage through the Project), I reject these Defendants' conclusion that *no* site-specific (or at least Kennebec River-specific) information is available regarding mortality associated with Atlantic salmon smolts and kelts passing through Francis and Kaplan type turbines. For a more detailed evaluation of the studies on the Kennebec River at the Lockwood and Hydro Kennebec projects, please see the companion evaluation for the Lockwood Project (Section 7.1).

   B. **Conclusions Regarding Impacts on Fish –** Given the information in the references cited above and in Sections 6.1 and 7.1, and the study results completed on a nearby project with similar turbine types, I have the following conclusions with respect to the impacts of turbine passage on Atlantic salmon:

      I. During critical downstream migration periods for Atlantic salmon smolts and/or kelts (April through June and October through November), when the river flows are low enough that essentially the entire flow of the river passes through the Project's turbines and bypass system. Please see the flows analysis below.

      II. I conclude that in non-spill conditions the de facto majority route of passage is through the Project's turbines. Even during conditions of spill, fish will still pass through the Project's turbines if they are operating.

III. A scientifically defensible estimate of immediate Atlantic salmon smolt mortality passing through the Francis turbines (Units 1-6) and the fixed propeller turbines (Units 7 & 8) at Shawmut is approximately 15%. Mortality levels for kelts will be higher, with a reasonable working value of 25-50%. It is important to note that these values do not include mortality associated with downstream predation due to injury or disorientation or latent mortality as a result of passing through the turbines.

IV. Given the preceding conclusions, I conclude that the Shawmut Project is causing direct mortality to Atlantic salmon smolts and kelts by allowing fish to pass through the Project turbines. Although indirect and latent mortality have not been adequately assessed at this Project, it is reasonable to assume that some small percentage of indirect and latent mortality is also occurring as a result of turbine passage.

4. Upstream fishway for adult passage

A. Evaluation – No volitional upstream fish passage structure is part of the Project's infrastructure. Since the installation of the Lockwood Project's fish trapping facility in 2006, the owners/operators of the Shawmut Project have explicitly stated that their fish passage requirement for adult Atlantic salmon is being met by the "trap and truck" program at the Lockwood Project (FPL Energy Maine Hydro, LLC. 2007, 2008a; NextEra™ Energy Maine Operating Services, LLC. 2009, 2010, 2011). For the reasons described in Sections 5.3 and 7.1.2.1(4) above, any reliance on the Lockwood fish trapping facility and the subsequent trucking program to provide adequate upstream passage for Atlantic salmon is misplaced.

B. Conclusions Regarding Impacts on Fish – Given the information in the evaluation above, I have reached the following conclusions regarding the impacts of upstream fish passage facilities at the Shawmut Project:

I. No volitional upstream adult passage facilities exist at the Shawmut Project. As a result, adult salmon trapped at the Lockwood Project must be trucked further upriver. Impacts of the trucking program on Atlantic salmon are discussed in Section 5.3 above.

II. As described in Section 7.1.2.1(4), the Lockwood Project blocks migration of adult Atlantic salmon, delays their migration, or creates conditions that allow passage only under flow conditions that are different than those that existed before the Project was constructed. It is biologically unjustified to conclude that upstream passage requirements for adult Atlantic salmon are met by conditions and operations at the Lockwood Project. Therefore, I conclude that the claim of the Shawmut Project owners/operators that the Lockwood trap and truck program "provides" their requirement to provide upstream adult passage for Atlantic salmon is simply not justified by the facts. The Shawmut Project therefore harms adult Atlantic salmon by blocking or delaying their migration.

5. **Size and configuration of the headpond upstream of the dam**

   A. **Evaluation –** The Shawmut Project includes a 1,310-acre impoundment upstream of the spillway section. The creation of this impoundment has changed the habitat of the Kennebec River from a flowing river channel to a more slow-moving water habitat. The lake-like habitat is more likely to contain fish species that are predators on juvenile Atlantic salmon and may not contain the cover features for juvenile salmon that would normally be present in a natural river channel. I am unaware of any data that have specifically quantified the habitat characteristics of this area or quantified any predation rates on Atlantic salmon smolts.

   B. **Conclusions Regarding Impacts on Fish –** I conclude that it is likely that levels of predation of Atlantic salmon smolts in the headpond area of the Shawmut Project are higher than what they would be in a natural river channel. But given the lack of any site-specific, quantitative studies or data, it is impossible to reach a defensible quantitative assessment of the increased predation rate or the potential impacts on the Atlantic salmon population.

6. **Physical character of the river immediately downstream of the dam and tailrace areas as potential habitat for predators**

   A. **Evaluation –** The configuration of the river channel and the effects caused by passing over the spillway section may make juvenile Atlantic salmon passing the Shawmut Project more vulnerable to predation, as discussed in Section 5.2. No site-specific studies have been conducted to assess this condition. However, given the height of the dam and the shape of the spillway section on the downstream face, I conclude there is some yet to be quantified level of disorientation or injury that causes increased vulnerability to predation. In addition, under low flow conditions, the majority of the river flow is passing through the power canal, which means fish are passing through the bypass system or turbines. In this situation, the flows are concentrated in two locations which allow predators to focus on specific locations. Predator concentration is highly likely in the excavated channel that serves as the tailrace for turbine Units 7 & 8.

This channel is highly confined and provides excellent predator habitat. Given the probability of fish being disoriented by passing through the turbines, I conclude that predation rates in these specific areas of the Project are higher than other areas. However, no studies have specifically quantified the predation rate in this area.

B. Conclusions Regarding Impacts on Fish – Although there is an absence of site-specific quantitative data, I am able to conclude, based on my observations of the site, the scientific literature, and my professional experience, that the project configuration and operations create conditions that result in increased predation on juvenile Atlantic salmon. In my professional opinion, predation is occurring at some yet to be quantified level, which is most likely in the low single digits. Given the absence of sire-specific quantitative data, the level of predation below the Shawmut Project and its impact on listed species cannot be quantified at this time.

7. River flow regime during time periods critical for Atlantic salmon (April through June and October through November) in relation to the hydraulic capacity of the turbines

A. **Evaluation –** For a more detailed explanation of the data and procedure used to develop the figures below relating Kennebec River flow conditions and the potential for all of the river flow to pass through the Project's turbines, see Section 6.2 of this report. I used a project hydraulic capacity of 6,700 cfs in evaluating the Shawmut Project. Results of this analysis are presented below:

Figures referenced in this section of this report are located in Section 7.1.2.1(7) of the Lockwood Project evaluation (Section 7.1).

Data from Figure 7.1.1 for the Shawmut Project show that during the month of April there is a consistent probability of 5% that river flows will be ≤ Project hydraulic capacity. This probability increases to approximately10% during the last few days of the month.

Data from Figure 7.1.2 for the Shawmut Project show that during the month of May there is a consistent probability of 10% that river flows will be ≤ Project hydraulic capacity. This probability increases to nearly 25% during the last 15 days of the month.

Data from Figure 7.1.3 for the Shawmut Project show that during the month of June there is a consistent probability of 25% that river flows will be ≤ Project hydraulic capacity. This probability increases to 50% during the last 20 days of the month.

Data from Figure 7.1.4 for the Shawmut Project show that during the month of October there is a consistent probability of at least 50% that river flows will be $\leq$ Project hydraulic capacity.

Data from Figure 7.1.5 for the Shawmut Project show that during the month of November there is a consistent probability of at least 25% that river flows will be $\leq$ Project hydraulic capacity.

B. Conclusions Regarding Impacts on Fish – The results of this analysis lead me to the following conclusions:

I. During the spring emigration period, the probabilities of river flow being $\leq$ the Shawmut Project's hydraulic capacity range from 5 to 50%. During the most likely time when the majority of smolts would migrate, the probabilities range from 10-25%. This level of interaction with Project turbines is, in my opinion, unacceptable in terms of population survival and recovery, given the level of immediate turbine mortality at Shawmut Project, the ineffectiveness of the fish bypass structure, and the current status of the Atlantic salmon population in the Kennebec River.

II. During the fall kelt emigration period, the analysis shows probabilities of > 50% for all of October and > 25% for all of November. This level of interaction with Project turbines is, in my opinion, unacceptable in terms of population survival and recovery, given the level of immediate turbine mortality at Shawmut Project, the ineffectiveness of the fish bypass structure, and the current status of the Atlantic salmon population in the Kennebec River.

III. This analysis clearly demonstrates that the use of median monthly flow values to assess potential project impacts is not appropriate or defensible. As this analysis shows, the use of median monthly flows greatly underestimates the amount of time that river flows can be $\leq$ to Project hydraulic capacity and thus underestimates the percentage of time that the only downstream passage route available for Atlantic salmon is through the Project turbines and the inadequate downstream bypass system. And yet it is my understanding, based on my review of draft white papers commissioned by the NextEra Defendants, that these Defendants plan to use median flow data to assess each Project's impacts on Atlantic salmon for purposes of obtaining Incidental Take Permits.

IV. Given the current population levels, the age structure of adults captured at the Lockwood fish trapping facility, the decades it would take to rebuild even one year's loss of smolts due to Shawmut Project operations, and the cumulative effects of the four projects on the Kennebec River between Waterville and the Sandy River, I believe the impacts associated with low river flows result in critical levels of mortality to Atlantic salmon on a reasonably predictable and routine basis.

7.3.3 Impacts on Atlantic salmon in the Merrymeeting Bay SHRU and, consequently, the GOM DPS as a whole

In order to evaluate impacts of dam operations on the Merrymeeting Bay SHRU and the GOM DPS as a whole, I used five parameters related to the Shawmut Project, and these same parameters and conclusions are equally applicable to the Lockwood, Hydro Kennebec, and Weston projects as well.

1) **Percentage of the total habitat in comparison to the GOM DPS –** According to the NMFS (2009b), the Merrymeeting Bay SHRU comprises approximately 46% of the land area in the GOM DPS, with the Kennebec River watershed contributing 56% of the total for the Merrymeeting Bay SHRU. Therefore, the Kennebec River watershed has the potential to be the dominant contributor to recovery in the SHRU and the GOM DPS overall because of its land area and the quality of habitats suitable for Atlantic salmon upstream of the Weston Project.

2) **Population diversity and stability –** The Kennebec River watershed is the second largest in Maine that is part of the GOM DPS and contains extensive areas designated as critical habitat. Historically, the Androscoggin, Kennebec, and Penobscot watersheds were the largest producers of Atlantic salmon in Maine, and probably the East Coast. These large watersheds provided a variety of habitats that have resulted in genetic diversity among watersheds and overall population stability because of the variety of habitats and life history strategies necessary for salmon to persist in them (National Research Council 2002, 2004; Fay et al. 2006; National Marine Fisheries Service and U.S. Fish and Wildlife Service 2009).

3) **Location of habitats suitable to promote recovery of the species –** The overwhelming majority of habitats suitable to support Atlantic salmon spawning and juvenile rearing in the Kennebec River watershed are located upstream of the Weston Project. While the MDMR (2010) identified some habitat suitable for Atlantic salmon downstream of the Lockwood Project, a functional equivalent habitat analysis by NMFS found that all habitats downstream of the Lockwood

Project received a zero rating for Atlantic salmon spawning and rearing. What this functional equivalent rating means is that the quantity and quality of downstream habitats are insufficient to adequately support the habitat and population recovery criteria for the SHRU (National Marine Fisheries Service (2009b). The NMFS analysis found that all of the habitat suitable to support the PCE requirements for spawning and rearing, and thus recovery, were upstream of the Weston Project.

4) **Blockage and/or delay to upstream migrating adult Atlantic salmon –** Shawmut has no provision at all for upstream fish passage; it relies on the operation of the trapping facility at Lockwood to achieve upstream passage. As demonstrated in various analyses described earlier in this report, the Lockwood Project blocks migration of adult Atlantic salmon, delays their migration, or creates conditions that allow passage only under flow conditions that are different than those that existed before the Project was constructed. Any adults that are captured are trucked far upstream, which subjects them to the adverse impacts of trucking described in Section 5.3 and requires kelts to pass four hydroelectric dams in order to return to the sea after spawning.

5) **Mortality rate of Atlantic salmon smolts and kelts passing downstream through Lockwood Project turbines –** Smolts and kelts moving downstream through the Shawmut Project are subject to mortality associated with passage through the Project's turbines. During periods of non-spill at downstream migration time periods (see analyses of these time periods above), fish are forced to pass via the Project's power canal, which contains an ineffective fish bypass sluice and the Project turbines. Immediate mortality of smolts passing through the turbines is about 15%, while immediate mortality of kelts is about twice that rate (Normandeau Associates, Inc. and FPL Energy Maine Hydro, LLC. 2008b, 2008d). Delayed turbine mortality and additional adverse impacts on salmon going over the spillway or thru the bypass structures, are likely but have not been quantified.

Given the impacts of these five factors on individual Atlantic salmon, the effects of the Shawmut Project combined with the Lockwood Project's inability to consistently provide adult upstream passage or to achieve the spawning and rearing and migration PCE's, and the overall negative impact on the likelihood that the recovery criteria for the Merrymeeting Bay SHRU will be met, I conclude that the Shawmut Project, as it is currently structurally configured and operated, is having a significant adverse impact on the Merrymeeting Bay SHRU and the GOM DPS as a whole.

7.3.4 Interim Measures

Any or all of the following measures would either reduce the harm to Atlantic salmon currently being caused by the dams in question or contribute to efforts at restoration of the species.

7.3.4.1 Interim Measures Applicable to All Projects on the Kennebec and Androscoggin rivers

A complete list of the interim measures applicable to all projects can be found in Section 7.1.4.1 of the Lockwood Project evaluation.

7.3.4.2 Additional Interim Measures Specifically for the Shawmut Project

A. Provide a downstream passage route on the west side of the spillway during the downstream migration period of April through June. This location should be east of the powerhouse and upstream and east of the entrance to the power canal and turbine forebays.
B. Increase the flow through the existing downstream bypass between the powerhouses and provide a more effective downstream plunge pool area in terms of size and configuration to prevent injury and predation.
C. Install a new fish guidance system, either electrical or a boom/electrical combination, to guide fish away from the west powerhouse turbine intakes.

7.4 Weston Project (NextEra)

7.4.1 Brief Project Description

The Weston Project includes a 930-acre impoundment, two dams, and one powerhouse. The Project impoundment extends 12.5 miles upstream. The two dams are constructed on the north and south channels of the Kennebec River where the river is divided by Weston Island.
The North Channel dam is a concrete gravity and buttress dam approximately 38 feet high and extends about 529 ft. from the north bank of the Kennebec River to Weston Island. The South Channel dam consists of the powerhouse, a log sluice and a stanchion gate section. A floating boom and metal plate curtain extending down about 10 ft. was installed in the South Channel and extends from the stream bank out to the edge of the log sluice. This structure is intended to act as a "fish guidance boom" to encourage fish to move away from the flow net associated with the turbines and use the sluice as a bypass. No evaluation of its effectiveness has been published to date. The log

sluice is located near the Unit 4 intake. It is 18-feet-wide by 14-feet-high with a resultant flow discharge into a deep plunge pool. Maximum flow through the gate at full pond is 2,250 cfs.

The powerhouse contains four vertical Francis units with a total unit flow of approximately 6,000 cfs. Trash racks are located in front of the intake sections to limit debris from passing through the turbines. Trash rack "clear" spacing is 4 inches for Units 1–4 (Normandeau Associates, Inc. and FPL Energy Maine Hydro, LLC, 2008g; Normandeau Associates, Inc., 2011g Note: this document is under a court protective order).

7.4.2 Impact of Weston Project on Atlantic Salmon

7.4.2.1 Impact on Individual Fish

I have analyzed seven factors related to the physical structure of the dam and adjacent river channel and operational parameters and characteristics in evaluating impacts of the Project on Atlantic salmon. Below is my evaluation of these seven factors:

1. **Physical Structure of the Dam**

    A. **Evaluation –** The physical configuration and height of the dam create a barrier to upstream migrating Atlantic salmon. At a height of 38 ft., adult Atlantic salmon cannot pass this Project under normal flow conditions. It is unknown if extremely high flow events would allow salmon to reach this facility given the heights of the Hydro Kennebec and Shawmut projects downstream.

    Atlantic salmon smolts migrating downstream to the ocean tend to move under low light or dark conditions. Given the location of the powerhouse along the north bank of the South Channel, it is likely that fish moving along the north bank of the river would follow the north and east shoreline of Weston Island towards the Project turbines. Under non-spill conditions, the majority of the river flow is towards the South Channel where the powerhouse is located. While the published flow capacity of the turbines at the Weston Project is 6,000 cfs, National Marine Fisheries Service staff commented that downstream juvenile passage via spill would probably not occur if depth of flow over the spillway/flashboards was <6 inches (Normandeau Associates, Inc. 2011b). Assuming this statement is correct, that would in effect direct juvenile fish towards the power canal at flows < ~6,200 cfs, increasing the probability of fish interacting with the downstream fish bypass system or the turbines.

    B. **Conclusions Regarding Impacts on Fish –** Given the physical configuration of the spillway, its height, and the location of the powerhouse, I believe that the Shawmut Project is causing the following impacts to Atlantic salmon:

I. Adult Atlantic salmon are blocked from moving upstream towards spawning habitat areas that contain the characteristics outlined in the subcomponents of the PCE's detailed in Section 4 of this report;

II. The physical shape of the Project makes it likely that Atlantic salmon smolts and kelts emigrating to the ocean will enter the power canal and interact with one of the Project's turbines or the downstream fish bypass facility, especially when river flows are near or below the Project's turbine flow capacity. Interaction with the Project's turbines and/or downstream bypass system causes mortality and injury.

2. Downstream Fish Bypass System

A. Evaluation – The Project currently uses only the log sluice on the South Channel dam as a downstream fish bypass system; there is no fish bypass system at the North Channel dam. The sluice is operated between April 1 and June 15 with a bypass flow of 120 cfs (Normandeau Associates, Inc., 2011g . Note: this document is under a court protective order). However, no studies have been conducted to evaluate any of the potential downstream passage routes as to their effectiveness in attracting Atlantic salmon smolts or kelts emigrating to the ocean, or the mortality associated with any of the particular routes of passage.

B. Conclusions Regarding Impacts on Fish – I conclude that the Weston Project is causing the following impacts to Atlantic salmon:

I. Given the height of the dam and the configuration of the face of the spillway section, it is unlikely that mortality rates associated with passing over the spillway sections are zero.

II. Under lower flow (non-spill) conditions, Atlantic salmon, both smolts and kelts, are forced to pass the Project via the fish bypass system (the log sluice) or Project turbines. Given that the bypass system routinely passes only a maximum of about 120 cfs, in comparison to 6,000 cfs passing through the Project turbines, I conclude that the majority of smolts or kelts pass through the Project turbines, with the resultant mortality rate associated with each turbine installed. Although no formal evaluation of the fish guidance boom has been conducted at the Project, evaluations of very similar systems at the Hydro Kennebec and Lockwood projects have demonstrated that guidance effectiveness ranges from < 50% at Hydro Kennebec to about 18% at Lockwood (Hydro Kennebec, LLC. 2011, Normandeau Associates, Inc. 2011e. Note: both of these documents are under a court protective order). In my opinion, the current downstream bypass system – which, like the guidance booms at Hydro Kennebec and Lockwood, extends only 10 feet below the surface while depths in the pool are as much as 20 feet, according to Project personnel – is ineffective in design and inadequate under lower flow conditions to provide the level of protection to Atlantic salmon needed to prevent unacceptable (in terms of population recovery) levels of direct and/or indirect mortality.

3. Types of turbines used to generate power

A. Evaluation – For an overview of turbine mortality rates see Section 6.1 of this report. The Project currently contains four vertical Francis turbines (Units 1-4). The Francis turbines at this Project have 13-16 blades, less distance between blades than do Kaplan turbines, and spin at about 200 rotations per minute (rpm) (Normandeau Associates, Inc. 2011h). Change in barometric pressure is not a significant factor at the Project because the operation has a low hydraulic head. The primary direct cause of fish death or injury for fish passing through turbines at Weston is blade strike.

In a 2011 draft white paper presented to the resource agencies, the NextEra Defendants reject the results of their own passage studies, saying they are inadequate to establish passage mortality at Weston. (Normandeau Associates, Inc. 2011g. Note: this document is under a court protective order). While I agree that site-specific empirical studies have not been conducted at the Weston Project to assess a variety of passage mortality factors (predation in the headpond area as a result of changing the type of habitat upstream of the dam; spill-related mortality; mortality associated with fish using the downstream bypass system; delayed or latent mortality associated with fish passing through the turbines and not immediately killed; and mortality due to predation at locations immediately downstream of the Project infrastructure due to fish being injured or disoriented during passage through the Project), I reject these Defendants' conclusion that *no* site-specific (or at least Kennebec River-specific) information is available regarding mortality associated with Atlantic salmon smolts and kelts passing through Francis and Kaplan type turbines. For a more detailed evaluation of the studies on the Kennebec River at the Lockwood and Hydro Kennebec projects, please see the companion evaluation for the Lockwood Project (Section 7.1).

B. Conclusions Regarding Impacts on Fish – Given the information in the references cited above in Sections 6.1 and 7.1, and the study results completed on a nearby project with similar turbine types, I have the following conclusions with respect to the impacts of turbine passage on Atlantic salmon:

I. There is a significant frequency, during critical downstream migration periods for Atlantic salmon smolts and/or kelts (April through June and October through November), when the river flows are low enough that essentially the entire flow of the river passes through the Project's turbines and bypass system. Please see the flows analysis below.

II. I conclude that in non-spill conditions the de facto majority route of fish passage is through the Project's turbines. Even during conditions of spill, fish will still pass through the Project's turbines if they are operating.

III. A scientifically defensible estimate of immediate mortality for Atlantic salmon smolts passing through the Francis turbines (Units 1 – 4) at Weston is approximately 15%. Immediate mortality levels for kelts will be higher, with a reasonable working value of 25-50%. It is important to note that these values do not include mortality associated with downstream predation due to injury or disorientation or latent mortality as a result of passing through the turbines.

IV. Given the preceding conclusions, I conclude that the Weston Project is causing direct mortality to Atlantic salmon smolts and kelts by allowing them to pass through the Project turbines. Although indirect and latent mortality have not been adequately assessed at this Project, it is reasonable to assume that some small percentage of indirect and latent mortality is also occurring as a result of turbine passage.

4. Upstream fishway for adult passage

A. Evaluation – No volitional upstream fish passage structure is part of the Project's infrastructure. Since the installation of the Lockwood Project's fish trapping facility in 2006, the owners/operators of the Weston Project have explicitly stated that their fish passage requirement for adult Atlantic salmon is being met by the "trap and truck" program at the Lockwood Project (FPL Energy Maine Hydro, LLC. 2007, 2008a; NextEra™ Energy Maine Operating Services, LLC. 2009, 2010, 2011). For the reasons described in Sections 5.3 and 7.1.2.1(4) above, any reliance on the Lockwood fish trapping facility and the subsequent trucking program to provide adequate upstream passage for Atlantic salmon is misplaced.

B. Conclusions Regarding Impacts on Fish – Given the information in the evaluation above, I have reached the following conclusions regarding the impacts of upstream fish passage facilities at the Weston Project:

I. No volitional upstream adult passage facilities exist at the Weston Project. As a result, adult salmon trapped at the Lockwood Project must be trucked further upriver. Impacts of the trucking program on Atlantic salmon are discussed in Section 5.3 above.

II. As described in Section 7.1.2.1 (4), the Lockwood Project blocks migration of adult Atlantic salmon, delays their migration, or creates conditions that allow passage only under flow conditions that are different than those that existed before the Project was constructed. It is biologically unjustified to conclude that upstream passage requirements for adult Atlantic salmon are met by conditions and operations at the Lockwood Project. Therefore, I conclude that the claim of the Weston Project owners/operators that the Lockwood trap and truck program "provides" their requirement to provide upstream adult passage for Atlantic salmon is simply not justified by the facts. The Weston Project therefore harms adult Atlantic salmon by blocking or delaying their migration.

5. Size and configuration of the headpond upstream of the dam

A. Evaluation – The Weston Project includes a 930-acre impoundment extending 12.5 miles upstream. The creation of this impoundment has changed the habitat of the Kennebec River from a flowing river channel to a more slow-moving water habitat. The lake-like habitat is more likely to contain fish species that are predators on juvenile Atlantic salmon and may not contain the cover features for juvenile salmon that would normally be present in a natural river channel. I am unaware of any data that has specifically quantified the habitat characteristics of this area or quantified any predation rates on Atlantic salmon smolts.

B. Conclusions Regarding Impacts on Fish – I conclude that it is likely that levels of predation of Atlantic salmon smolts in the headpond area of the Weston Project are higher than what they would be in a natural river channel. But given the lack of any site-specific, quantitative studies or data, it is impossible to reach a defensible quantitative assessment of the increased predation rate or the potential impacts on the Atlantic salmon population.

6. Physical character of the river immediately downstream of the dam and tailrace areas as potential habitat for predators

A. Evaluation – The configuration of the river channel and the effects caused by passing over the spillway section make juvenile Atlantic salmon passing the Weston Project more vulnerable to predation, as discussed in Section 5.2. No site-specific studies have been conducted to assess this condition. However, given the height of the dam and the shape of the spillway section on the downstream face, I conclude there is some yet to be quantified level of disorientation or injury that could cause increased vulnerability to predation. In addition, under low flow conditions the majority of the river flow is passing through the South Channel, which means fish are passing through the bypass system or turbines. In this situation, the flows are concentrated in two locations which allow predators to focus on specific locations. Given the probability of fish being disoriented by passing through the turbines, it is likely that predation rates in these specific areas of the Project are higher than other areas. However, no studies have specifically quantified the predation rate in this area.

B. Conclusions Regarding Impacts on Fish – Although there is an absence of site-specific quantitative data, I conclude, based on my observations of the site, the scientific literature, and my professional experience, that the Project configuration and operations do create conditions that result in increased predation on juvenile Atlantic salmon. In my professional opinion, predation is occurring at some yet to be quantified level, which is most likely in the low single digits. Given the absence of sire-specific quantitative data, the level of predation below the Weston Project and its impact on the species cannot be quantified at this time.

7. River flow regime during time periods critical for Atlantic salmon (April through June and October through November) in relation to the hydraulic capacity of the turbines

A. **Evaluation –** For a more detailed explanation of the data and procedure used to develop the figures below relating Kennebec River flow conditions and the potential for all of the river flow to pass through the Project's turbines, see Section 6.2 of this report. Results of this analysis are presented below:

Figures referenced in this section of this report are located in Section 7.1.2.1(7) of the Lockwood Project evaluation (Section 6.1).

Data from Figure 7.1.1 for the Weston Project show that during the month of April there is a fairly consistent probability of 5% that river flows will be ≤ Project hydraulic capacity. This probability increases to nearly 10% during the last few days of the month.

Data from Figure 7.1.2 for the Weston Project show that during the month of May there is a consistent probability of 10% that river flows will be ≤ Project hydraulic capacity. This probability increases to > 25% during the last 10 days of the month.

Data from Figure 7.1.3 for the Weston Project show that during the month of June there is a consistent probability of 25% that river flows will be ≤ Project hydraulic capacity. This probability increases to 50% during the last 10 days of the month.

Data from Figure 7.1.4 for the Weston Project show that during the month of October there is a consistent probability of at least 50% that river flows will be ≤ Project hydraulic capacity.

Data from Figure 7.1.5 for the Weston Project show that during the month of November there is a consistent probability of at least 25% that river flows will be ≤ Project hydraulic capacity.

B. Conclusions Regarding Impacts on Fish – The results of these analyses lead me to the following conclusions:

I. During the spring emigration period, the probabilities of river flow being ≤ the Weston Project's hydraulic capacity range from 5 to 50%. During the most likely time when the majority of smolts would migrate, the probabilities range from 10-25%. This level of interaction with Project turbines is, in my opinion, unacceptable in terms of population survival and recovery, given the level of immediate turbine mortality at Weston Project, the ineffectiveness of the fish bypass structure, and the current status of the Atlantic salmon population in the Kennebec River.

II. During the fall kelt emigration period, the analysis shows probabilities of > 50% for all of October and > 25% for all of November. This level of interaction with Project turbines is, in my opinion, unacceptable in terms of population survival and recovery, given the level of immediate turbine mortality at Weston Project, the ineffectiveness of the fish bypass structure, and the current status of the Atlantic salmon population in the Kennebec River.

III. This analysis clearly demonstrates that the use of median monthly flow values to assess potential project impacts is not appropriate or defensible. As this analysis shows, the use of median monthly flows greatly underestimates the amount of time that river flows can be ≤ to Project hydraulic capacity and thus underestimates the percentage of time that the only downstream passage route available for Atlantic salmon is through the Project turbines and the inadequate downstream bypass system. And yet it is my understanding, based on my review of draft white papers commissioned by the NextEra Defendants, that these Defendants plan to use median flow data to assess each Project's impacts on Atlantic salmon for purposes of obtaining Incidental Take Permits.

IV. Given the current population levels, the age structure of adults captured at the Lockwood fish trapping facility, the decades it would take to rebuild even one year's loss of smolts due to Weston Project operations, and the cumulative effects of the four projects on the Kennebec River between Waterville and the Sandy River, I believe the impacts associated with low river flows result in critical levels of mortality to Atlantic salmon on a reasonably predictable and routine basis.

7.4.3 Impacts on Atlantic salmon in the Merrymeeting Bay SHRU and, consequently, the GOM DPS as a whole

In order to evaluate impacts of dam operations on the Merrymeeting Bay SHRU and the GOM DPS as a whole, I used five parameters related to the Weston Project, but these same parameters and conclusions are equally applicable to the Lockwood, Hydro Kennebec, and Shawmut Projects as well.

1) **Percentage of the total habitat in comparison to the GOM DPS –** According to the NMFS (2009b), the Merrymeeting Bay SHRU comprises approximately 46% of the land area in the GOM DPS, with the Kennebec River watershed contributing 56% of the total for the Merrymeeting Bay SHRU. Therefore, the Kennebec River watershed has the potential to be the dominant contributor to recovery in the SHRU and the GOM DPS overall because of its land area and the quality of habitats suitable for Atlantic salmon upstream of the Weston Project.

2) **Population diversity and stability –** The Kennebec River watershed is the second largest in Maine that is part of the GOM DPS and contains extensive areas designated as critical habitat. . Historically, the Androscoggin, Kennebec, and Penobscot watersheds were the largest producers of Atlantic salmon in Maine, and probably the East Coast. These large watersheds provided a variety of habitats that have resulted in genetic diversity among watersheds and overall population stability because of the variety of habitats and life history strategies necessary for salmon to persist in them (National Research Council 2002, 2004; Fay et al. 2006; National Marine Fisheries Service and U.S. Fish and Wildlife Service 2009).

3) **Location of habitats suitable to promote recovery of the species –** The overwhelming majority of habitats suitable to support Atlantic salmon spawning and juvenile rearing in the Kennebec River watershed are located upstream of the Weston Project. While the MDMR (2010) identified some habitat suitable for

Atlantic salmon downstream of the Lockwood Project, a functional equivalent habitat analysis by NMFS found that all habitats downstream of the Lockwood Project received a zero rating for Atlantic salmon spawning and rearing. What this functional equivalent rating means is that the quantity and quality of downstream habitats are insufficient to adequately support the habitat and population recovery criteria for the SHRU (National Marine Fisheries Service (2009b). The NMFS analysis found that all of the habitat suitable to support the PCE requirements for spawning and rearing, and thus recovery, were upstream of the Weston Project.

4) **Blockage and/or delay to upstream migrating adult Atlantic salmon –** Weston has no provision for upstream fish passage; it relies on the operation of the trapping facility at Lockwood to achieve upstream passage. As demonstrated in various analyses described earlier in this report, the Lockwood Project blocks migration of adult Atlantic salmon, delays their migration, or creates conditions that allow passage only under flow conditions that are different than those that existed before the Project was constructed. Any adults that are captured are trucked far upstream, which subjects them to the adverse impacts of trucking described in Section 5.3 and requires kelts to pass four hydroelectric dams in order to return to the sea after spawning.

5) **Mortality rate of Atlantic salmon smolts and kelts passing downstream through Weston Project turbines –** Smolts and kelts moving downstream through the Weston Project are subject to mortality associated with passage through the Project's turbines. During periods of non-spill at downstream migration time periods (see analyses of these time periods above), all fish are forced to pass via the Project's power canal, which contains an ineffective fish bypass sluice and the Project turbines. Immediate mortality of smolts passing through the turbines is about 15%, while the immediate mortality of kelts is about twice that rate (Normandeau Associates, Inc. and FPL Energy Maine Hydro, LLC. 2008b, 2008d). Delayed turbine mortality and additional adverse impacts on salmon going over the spillway or through the bypass structure are likely but have not been quantified.

Given the impacts of these five factors on individual Atlantic salmon, the effects of the Weston Project combined with the Lockwood Project's inability to consistently provide adult upstream passage or to achieve the spawning and rearing and migration PCE's, and the overall negative impact on the likelihood that the recovery criteria for the Merrymeeting Bay SHRU will be met, I conclude that the Weston Project, as it is currently structurally configured and operated, is having a significant adverse impact on the Merrymeeting Bay SHRU and the GOM DPS as a whole.

7.4 Interim Measures

Any or all of the following measures would either reduce the harm to Atlantic salmon currently being caused by the dams in question or contribute to efforts at restoration of the species.

7.4.4.1 Interim Measures Applicable to All Projects on the Kennebec and Androscoggin rivers

A complete list of the interim measures applicable to all projects can be found in Section 7.1.4.1 of the Lockwood Project evaluation.

7.4.4.2 Additional Interim Measures Specifically for the Weston Project

A. Provide a downstream passage route on the north side of the spillway during the downstream migration period of April through June. This location should be in the North Channel.

7.5 Presence of Adult Atlantic Salmon and American Shad at Kennebec River Dams

I was asked to evaluate and provide responses to three questions relating to the Clean Water Act certifications for the four dams on the Kennebec River. My responses to these questions are included below:

7.5.1 Do adult salmon or shad currently inhabit the impoundments above the four Kennebec River dams (Weston, Shawmut, Hydro Kennebec, and Lockwood)?

Yes. Adult American shad have been transported from the fish trapping facility at Lockwood and released into the headpond upstream of Hydro Kennebec since 2006 (Maine Department of Marine Resources 2011b). An American shad stocking program was in place from 1991 through 2008. During this period, millions of juvenile shad fry were stocked in the Kennebec River upstream of the Hydro Kennebec Project (Maine Department of Marine Resources 2009). The MDMR completed an assessment of American shad habitat in the Kennebec River watershed, which shows roughly 70% of the shad production potential is upstream of the Lockwood Dam (Maine Department of Marine Resources 2009).

Since 2003, eggs or fry of Atlantic salmon have been planted or released into the Sandy River, which is a tributary to the Kennebec River upstream of the Weston Project (Maine Department of Marine Resources 2011b). Since 2006, adult Atlantic salmon captured at the Lockwood fish trapping facility have been transported to the Sandy River and released into the wild to spawn naturally (Maine Department of Marine Resources 2011b). The eggs planted and adults released are all part of the GOM DPS and the suitable habitats upstream and downstream of the Weston Project are all considered “occupied” by NMFS (National Marine Fisheries Service 2009b).

7.5.2 Given the current design of the dams and their related structures, are adult salmon or shad currently able to access the turbines at the four Kennebec River dams (Weston, Shawmut, Hydro Kennebec, and Lockwood)?

Adult American shad currently have access to the turbines at Hydro Kennebec and Lockwood projects. The only reason that adults do not have access to the turbines at Weston and Shawmut is that the adult runs have been so small that efforts have not been made to truck adult American shad upstream of the Weston Project. Plus, the MDMR estimates a 10% mortality factor for American shad at each project (Maine Department of Marine Resources 2009). Adult Atlantic salmon have access to the turbines at the four Kennebec River dams. At none of the dams is the trash rack bar spacing sufficiently narrow to prevent adult Atlantic salmon or shad from entering the turbines. No studies have been conducted on the impingement potential of the existing trash rack spacing to my knowledge. One study, completed at the Lockwood Project, found that 33% of Atlantic salmon kelts (post-spawning adults) passing through the Project’s turbines suffered “immediate mortality” (Normandeau Associates, Inc. and FPL Energy Maine Hydro, LLC 2008b). Studies of downstream bypass effectiveness indicated that they divert only 50% of Atlantic salmon adults away from the turbines with smolts only about 18% effective (Normandeau Associates, Inc. and FPL Energy Maine Hydro, LLC 2008b; Normandeau Associates, Inc. and FPL Energy Maine Hydro, LLC. 2008d; Normandeau Associates, Inc. 2011c. Note: this document is under a court protective order).

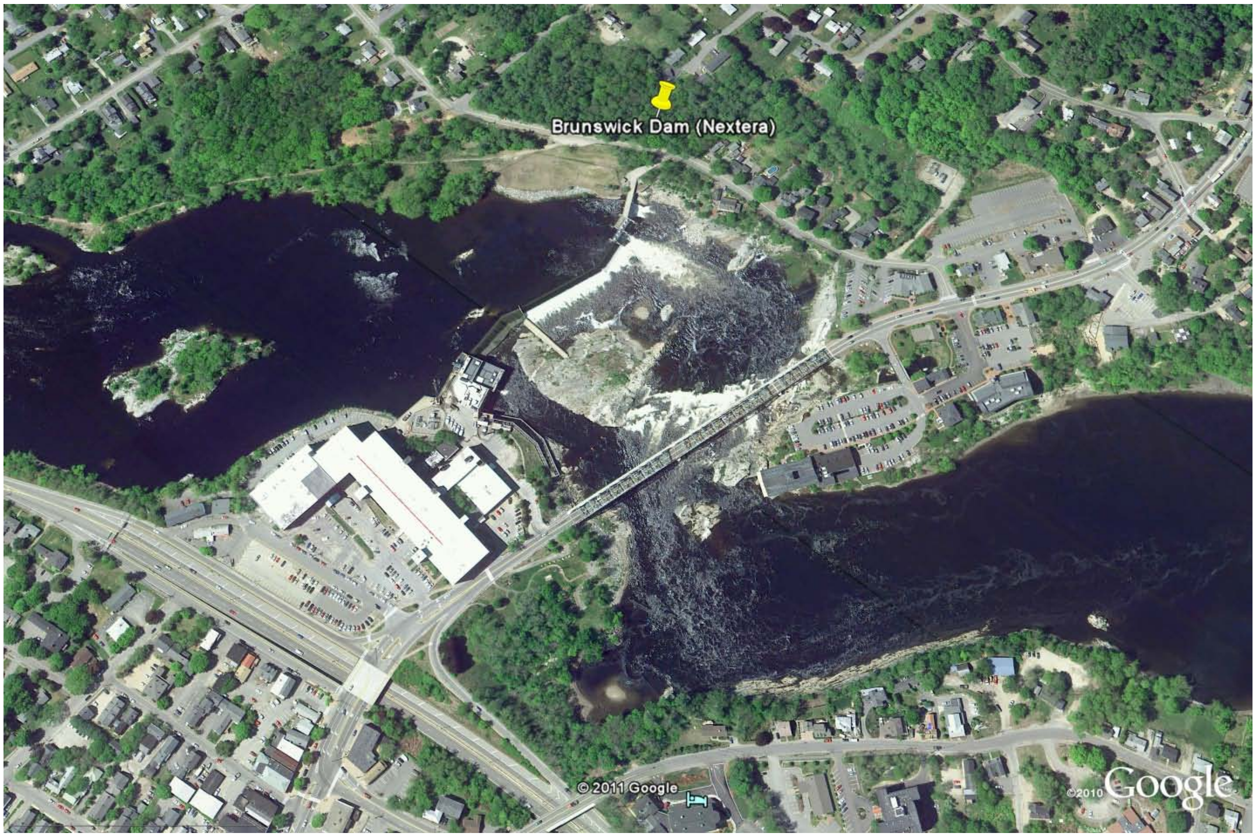
The NextEra Defendants have acknowledged, in a 2008 letter to FERC, that turbine passage for adult salmon and shad is part of normal operations at the Kennebec dams. In response to a comment by the Maine Department of Marine Resources that “FPL Energy’s studies have clearly shown that adult alewife, adult American shad, adult American eel, Atlantic salmon kelts, and Atlantic salmon smolts pass through the Lockwood project turbines, and sustain significant immediate mortality,” FPL Energy responded as follows: “Licensee recognizes that fish passage through turbines is not preferred by the fisheries agencies, but *also recognizes that passage through turbines for certain species and life stages can be, and is on a practical basis, part of the overall passage scheme in effect at the projects.* Successful passage through turbines, as well as through other routes, can be variable based upon the site characteristics, species, and life stages.” [Emphasis added]. (FPL Energy Maine 2008b).

7.5.3 Are there any site-specific, quantitative studies of any of the four Kennebec River dams (Weston, Shawmut, Hydro Kennebec, and Lockwood) that demonstrate that passage of adult salmon and shad through the turbines at such dams will not result in significant injury or mortality, immediate or delayed?

No. The owners/operators all state in their existing documents that no site-specific studies have been completed at any of the projects that address Atlantic salmon kelt mortality related to passage through project turbines (Hydro Kennebec, LLC. 2011; Normandeau Associates, Inc. 2011e,f, g.). Further, none of the studies that I have evaluated regarding any of the four dams is a site-specific, quantitative study demonstrating that turbine passage of adult salmon or shad will not result in significant injury or mortality, and to my knowledge no such study exists. The studies that have been done demonstrate that passage through turbines at these dams causes significant injury and mortality to adult salmon and shad. The site-specific data are consistent with the published literature cited in Section 6.1.

8.0 ANALYSIS OF ANDROSCOGGIN RIVER DAMS

8.1 Brunswick Project (NextEra)



8.1.1 Brief Project Description

The Brunswick Project includes a 300 acre impoundment, a 605 ft. concrete gravity dam approximately 40 ft. high, a gate section containing two Taintor gates and an emergency spillway, a powerhouse and intake, a fishway, a 21 ft. high fish barrier wall between the dam and Shad Island. The concrete gravity dam consists of two ogee overflow spillway sections separated by a pier and barrier wall. The right spillway section, about 128 ft. long, is topped wooden flashboards that are 2.6 ft. high. The left section does not have flashboards. The two Taintor gates each measuring 32.5 ft. wide by 22 ft. high and an emergency spillway are located at the left abutment on the Topsham shoreline. The intake structure and powerhouse are integral with the dam and located adjacent to the Brunswick shoreline. The powerhouse contains three turbines. Unit 1 is a vertical propeller turbine with a maximum flow capacity of 5,075 cfs, with peak efficiency at 4,519 cfs and runs at 90 rpm. Units 2 and 3 are horizontal propeller turbines that have a flow capacity of 1,336 cfs each and spin at 211.8 rpm. In the flows analysis, I used a figure of 7,191 cfs as the Project's hydraulic capacity, even though Unit 1 can pass an additional 566 cfs at maximum flow for the unit ((Normandeau Associates, Inc. 2011h, i).

Upstream passage for fish species is provided with a vertical slot fishway and associated trap and sort facility installed in 1983 along the west shore of the river. The fishway is 570 ft. long and consists of 42 individual pools, with a one-foot drop between each. The fishway is designed to pass American shad, river herring, and Atlantic salmon. Atlantic salmon are passed upstream of the Project. At the intake to the turbines and downstream fishway, a combination trash boom and fish screen direct downstream migrating fish to the downstream fishway which is located between the turbine intakes for the powerhouse.

The draft white paper prepared by NextEra, indicates that the Project operates in a near run-of-the-river mode. Unit 1 is generally operating at maximum efficiency at flows less than about 4,400 cfs. At flows between 4,400 to 5,000 cfs, the unit will run in an on-off mode with unit discharge approximating river flows. Unit 2 and 3 will then normally come on line for river flows at 6-7,000 cfs or greater. (Normandeau Associates, Inc. 2011i). Since the Project has a nominal hydraulic flow capacity of 7,191 cfs, I used this value in the flows analysis because the operational criteria mentioned above did not indicate any fixed rule on when Units 2 and 3 could come on line.

8.1.2 Impact of Brunswick Project on Atlantic Salmon

8.1.2.1 Impact on Individual Fish

I have analyzed seven factors (See section 4.3 for a detailed listing) related to the physical structure of the dam and adjacent river channel and operational parameters and characteristics in evaluating impacts of the project on Atlantic salmon. Below is my evaluation of these seven factors:

1. **Physical Structure of the Dam**

   A. **Evaluation –** The physical configuration and height of the dam creates a barrier to upstream migrating Atlantic salmon under most flows, in the absence of an effective upstream fishway. The Project installed a vertical slot fishway in 1983 and has been passing some adult Atlantic salmon since then. This upstream fishway appears to function acceptably under some circumstances. At river flow levels at or below the hydraulic capacity of the Project's turbines, most of the flow is exiting via the turbine tailraces, which are located adjacent to the entrance to the upstream fish entrance. This situation is acceptable for upstream passage. However, at flows above the Project's hydraulic capacity, flow is spilled on the north side of the Project, which could attract adult fish resulting in a delay or inability of adults to find the entrance to the upstream fishway. I am unaware of any studies that provide data on what percentage of the adults that approach the

Project from downstream actually use each channel. The "fish barrier wall" located between the dam and Shad Island prevents lateral movement along the downstream margin of the dam except at extreme flows.

The downstream fishway entrance is located between the powerhouses of Unit 1 and Units 2 and 3. The fishway entrance is a grate covering the upstream end of a pipe that I believe is approximately 18" in diameter and passes approximately 40 cfs directly through the dam and discharges into the tailraces below. The entrance is poorly located for use by salmon; it is immediately adjacent to the Unit 1 intake, which extends up to the water surface. The intakes for Units 2 and 3 are located approximately 20 ft. beneath the water surface to the immediate south of the downstream fishway entrance.

While I calculated the hydraulic flow capacity of the turbines at the Brunswick Project at 7,191 cfs, National Marine Fisheries Service staff commented that downstream juvenile passage via spill would probably not occur if depth of flow over the spillway/flashboards was <6 inches (Normandeau Associates, Inc. 2011b). Assuming this statement is correct, that would in effect direct juvenile fish towards the turbine intakes at flows < ~7,500 cfs, increasing the probability of fish interacting with the downstream fish bypass system or the turbines.

B. Conclusions Regarding Impacts on Fish – Given the physical location of the Taintor gates and spillway, the dam's height, and the fact that there is a "defacto" north channel that is for all practical purposes separated from the low flow channel along the south bank of the river by the fish barrier wall and Shad Island, I believe that the Brunswick Project is causing the following impacts to Atlantic salmon:

I. Under low flow conditions, upstream migrating adult Atlantic salmon follow the low flow (south) channel, because of the flow coming from the powerhouse tailrace and find the entrance to the upstream fishway;

II. Under certain flow conditions, adult Atlantic salmon may be delayed from migrating upstream because of an inability to locate the entrance to the upstream fishway in a timely fashion. It is also possible, under the right flow conditions that adult fish do not find the entrance to the upstream fishway and are thus blocked from passing upstream. I am unaware of any data or studies that address these issues, and thus I cannot assess the impacts to overall population productivity caused by any passage blockage and/or delay.

2. Downstream Fish Bypass System

A. **Evaluation –** As noted, the downstream fishway entrance is located between the powerhouses of Unit 1 and Units 2 and 3. The fishway entrance is a grate covering the upstream end of a pipe that I believe is approximately 18" in diameter. The pipe passes approximately 40 cfs of water directly through the dam and discharges into the tailraces below. The entrance is poorly located; it is immediately adjacent to the Unit 1 intake, which extends up to the water surface. The intakes for Units 2 and 3 are located approximately 20 ft. beneath the water surface to the immediate south of the downstream fishway entrance. In my professional opinion, a downstream fishway that has a flow capacity of approximately 40 cfs cannot effectively compete with a turbine intake of 5,075 cfs maximum capacity on one side and the intakes for Units 2 and 3 with a combined capacity of 2,672 cfs on the other side. I am unaware of any studies that have been conducted to look at the effectiveness of the trash boom/fish guidance device at diverting fish away from the turbine intakes and into the downstream fishway.

B. Conclusions Regarding Impacts on Fish – Given the poor location of the downstream fishway (between the turbine intakes) and the lack of sufficient flow to effectively "compete" with the flows passing into the turbines, I conclude that the downstream fishway is ineffective and does not adequately protect downstream migrating Atlantic salmon from passing through the Project's turbines. Mortality rates of various fish species and sizes passing through different turbines are reviewed in Section 6.1 of this report.

3. Types of turbines used to generate power

A. Evaluation – For an overview of turbine mortality rates see Section 6.1 of this report. The powerhouse contains three turbines. Unit 1 is a vertical propeller turbine with a maximum flow capacity of 5,075 cfs, with peak efficiency at 4,519 cfs and runs at 90 rpm. Units 2 and 3 are horizontal propeller turbines that have a flow capacity of 1,336 cfs each and spin at 211.8 rpm. Propeller turbines are a type of Kaplan turbine.

In a 2011 draft white paper presented to the resource agencies, the NextEra Defendants state there are no site-specific data regarding turbine passage survival at the Brunswick Project. The draft white paper states: "Due to the lack of site-specific information, estimates of turbine passage survival of Atlantic salmon smolts at Lockwood were developed using a combination of existing empirical studies and modeled calculations." (Normandeau Associates, Inc. 2011i).

I agree that site-specific empirical studies have not been conducted at the Project to assess the following causes of hydroelectric dam-related mortality: predation in the headpond area as a result of changing the type of habitat upstream of the dam, spill-related mortality, mortality associated with fish using the downstream bypass system, delayed or latent mortality associated with fish passing through the turbines and not immediately killed, and mortality due to predation at locations immediately downstream of the Project infrastructure due to fish being injured or disoriented during passage through the Project.

However, there are data from studies conducted at dams on the nearby Kennebec River which do offer some indication of the mortality rates associated with the types of turbines found at the Brunswick Project. Section 6.1 of this report summarizes some of the literature reporting turbine mortality rates for juvenile and adult Atlantic salmon-sized fish. For a more comprehensive review see Stone and Webster (1992) and Winchell and Amaral (1997).

B. Conclusions Regarding Impacts on Fish – I have reached the following conclusions with respect to turbine passage at Brunswick:

I. There is a significant frequency, during critical downstream migration periods for Atlantic salmon smolts and/or kelts (April through June and October and November), when the river flows are low enough that essentially the entire flow of the river passes through the Project's turbines and bypass system. Please see the flows analysis below.

II. Given the fact that the flows into the existing downstream fish bypass system cannot adequately compete with the flows entering the turbines, and thus cannot effectively divert downstream migrating Atlantic salmon away from the turbines, I conclude that in non-spill conditions most downstream migrating salmon will pass the Project through the Project's turbines. Even during conditions of spill, fish will still pass through the Project's turbines if they are operating.

III. A scientifically defensible estimate of immediate Atlantic salmon smolt mortality passing through Kaplan type turbines at Brunswick is approximately 15%. Mortality levels for kelts will be higher, with a reasonable working value of 25-50%. It is important to note that these values do not include mortality associated with downstream predation due to injury or disorientation or latent mortality as a result of passing through the turbines.

IV. Given the preceding conclusions, the Brunswick Project is causing direct mortality to Atlantic salmon smolts and kelts by allowing fish to pass through the Project turbines. Although indirect and latent mortality have not been adequately assessed at this Project, it is reasonable to assume that some smaller percentage of indirect and latent mortality is also occurring as a result of turbine passage.

4. Upstream fishway for adult passage

A. Evaluation – The Project installed a vertical slot fishway (fish "ladder") in 1983 and has been passing adult Atlantic salmon since then. Between 1983 and 2010 at total of 742 adult Atlantic salmon have been counted at the upstream fishway. In 2011, 47 adults were counted. The 2011 count of 47 fish is the third largest number in the history of the fishway. Although there are records of 4,000 Penobscot origin Atlantic salmon fry being stocked in the Androscoggin River in 2001 and 2003, a run of adult fish has been present in the river since the ladder was installed. Analysis of the hatchery versus wild components of the run shows 13.6% of the fish are of wild origin (Fay et al. 2006; Maine Department of Marine Resources. 2011a).

At river flow levels at or below the hydraulic capacity of the Project's turbines, most of the flow is exiting via the turbine tailraces which are located adjacent to the entrance to the upstream fish entrance. This situation is acceptable for upstream passage. However, at flows above the Project's hydraulic capacity, flow is spilled on the north side of the Project, which could attract adult fish resulting in a delay or inability of adults to find the entrance to the upstream fishway. I am unaware of any studies that provide data on what percentage of the adults that approach the Project from downstream actually use each channel. The "fish barrier wall" located between the dam and Shad Island prevents lateral movement along the downstream margin of the dam except at extreme flows.

B. Conclusions Regarding Impacts on Fish – Given the information in the evaluation above, I have reached the following conclusions regarding upstream fish passage facilities at the Brunswick Project:

I. Adult Atlantic salmon were captured in the very first year the Brunswick Project's fishway was installed, in 1983 – approximately 100 years since the last documented stocking of Atlantic salmon in the Androscoggin River (Fay et al. 2006). In addition, some percentage of returning fish have consistently been classified as wild origin since 1983. Given these facts, I conclude that there must have been a low level persistent run of

Atlantic salmon into the Androscoggin River. This run has continued to the present, although I do not know precisely where adult Atlantic salmon are spawning and rearing upstream of the Brunswick Project.

II. Under low flow conditions, adult Atlantic salmon follow the low flow (south) channel, because of the flow coming from the powerhouse tailrace and find the entrance to the upstream fishway.

III. Under certain flow conditions, adult Atlantic salmon may be delayed from migrating upstream because of an inability to locate the entrance to the upstream fishway in a timely fashion. It is also possible, under certain flow conditions, that adult fish do not find the entrance to the upstream fishway and are thus blocked from passing upstream. I am unaware of any data or studies that address these issues, and thus I cannot assess the impacts to overall population productivity because of any passage blockage and/or delay.

5. Size and configuration of the headpond upstream of the dam

A. Evaluation – According to published reports, the Brunswick Project headpond area is 300 acres (Normandeau Associates, Inc. 2011i). Although I am unable to verify this estimate, it appears reasonable, given the height of the spillway section. The headpond size is significant because in this area of the Brunswick Project, the habitat of the Androscoggin River has been changed from a flowing river channel to a more slow-moving water habitat. The lake-like habitat is more likely to contain fish species that are predators on juvenile Atlantic salmon and may not contain the cover features for juvenile salmon that would normally be present in a natural river channel. Species composition data from the upstream fishway captures document the presence of several predatory species of fish such as smallmouth and largemouth bass. I am unaware of any data that has specifically quantified the habitat characteristics of this area or quantified predation rates on Atlantic salmon smolts.

B. Conclusions Regarding Impacts on Fish – I conclude that levels of predation of Atlantic salmon smolts in the headpond area of the Brunswick Project are higher than what they would be in a natural river channel. But given the lack of any site-specific, quantitative studies or data, it is impossible to reach a defensible quantitative assessment of the increased predation rate or the potential impacts on the Atlantic salmon population.

6. **Physical character of the river immediately downstream of the dam and tailrace areas as potential habitat for predators**

   A. **Evaluation –** Smolts can pass the Brunswick Project by going over the spillway, or passing through the turbines or downstream fish bypass system. Each of these routes may affect smolts in ways that make them more vulnerable to predation, as described in Section 5.2, above. No scientifically rigorous studies have been conducted to assess these impacts at Brunswick, although the authors of studies conducted at the Lockwood Project that focused on other passage issues conclude that some radio tagged smolts were taken by downstream predators, based on movement patterns of the tags after passage through the project ((FPL Energy Maine Hydro, LLC. 2008a, Normandeau Associates, Inc. 2011c. Note this latter document is under a court protective order). The predation estimate in the 2011 study was 1.4%.

      The configuration of the river channel and the effects of spill on juvenile Atlantic salmon passing over the spillway section may make these fish vulnerable to predation. Given the extensive bedrock ledges immediately downstream of the spillway section and the presence of a concrete sill along the downstream base of the spillway section that can provide low velocity habitat for potential predators, I conclude that some yet to be quantified level of disorientation or injury to the salmon increases their vulnerability to predation.

      Under low flow conditions, the majority of the river flow is passing through the bypass system or turbines. The river channel immediately downstream of the powerhouse tailrace appears deep and highly confined. This type of habitat is very conducive to harboring predators such as striped bass. Given the probability of fish being disoriented by passing through the turbines, it is my opinion that predation rates in this specific area of the Project are higher than other areas. However, no studies have specifically quantified the predation rate in this area.

   B. **Conclusions Regarding Impacts to Fish and this Factor –**I conclude that the Brunswick Project's configuration and operations create conditions that are likely to result in increased predation of juvenile Atlantic salmon. There is one published estimate that would suggest a 1+% predation rate, but I do not believe that level is supported by scientifically reliable evidence. In my professional opinion, predation is occurring at some unknown level, likely in the low single digits. But given the lack of specific quantitative data, the actual level of predation below Brunswick and its impact on Atlantic salmon cannot be quantified at this time.

7. **River flow regime during time periods critical for Atlantic salmon (April through June and October through November) in relation to the hydraulic capacity of the turbines**

   A. **Evaluation –** For a more detailed explanation of the data and procedure used to develop the figures below relating Androscoggin River flow conditions and the potential for all of the river flow to pass through the Project's turbines, see Section 6.2 of this report. Results of this analysis are presented below:

   Data from Figure 8.1.1 show that during the month of April there is a fairly consistent probability of 5% that river flows will be ≤ Project hydraulic capacity. This probability increases to nearly 10% during the last few days of the month.

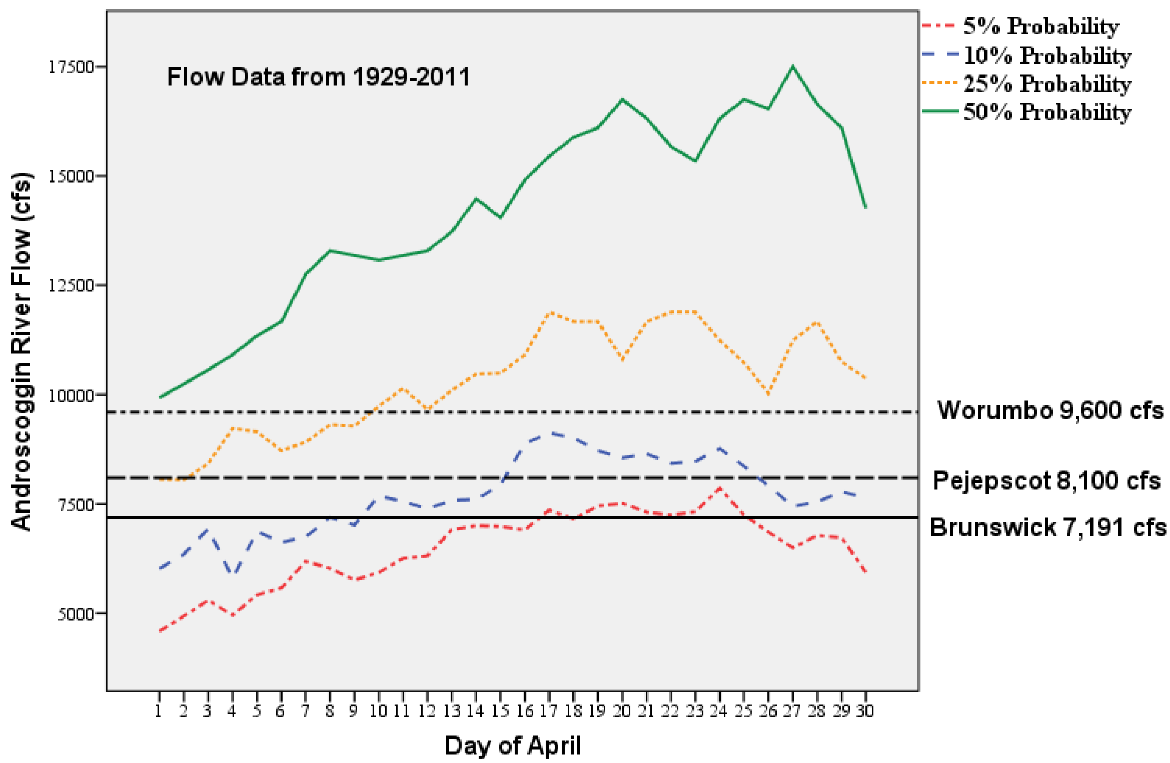


Figure 8.1.1 Relationship between Androscoggin River mean daily flow in April and the hydraulic flow capacity of the Brunswick, Pejepscot, and Worumbo projects. Flow curves represent the 5, 10, 25, 50, 75, and 90th mean daily flow percentiles. Flow volume is based on all days of record for the USGS gage at Auburn, ME for the period 1929-2011. Flows were adjusted upward by a factor of 1.0806 because of the difference in watershed area between the gaging station and the beginning of the watershed near Brunswick.

Data from Figure 8.1.2 show that during the month of May there is a fairly consistent probability of 10% that river flows will be ≤ Project hydraulic capacity.

This probability increases to 25% during the middle of the month and to 50% at the end of the month.

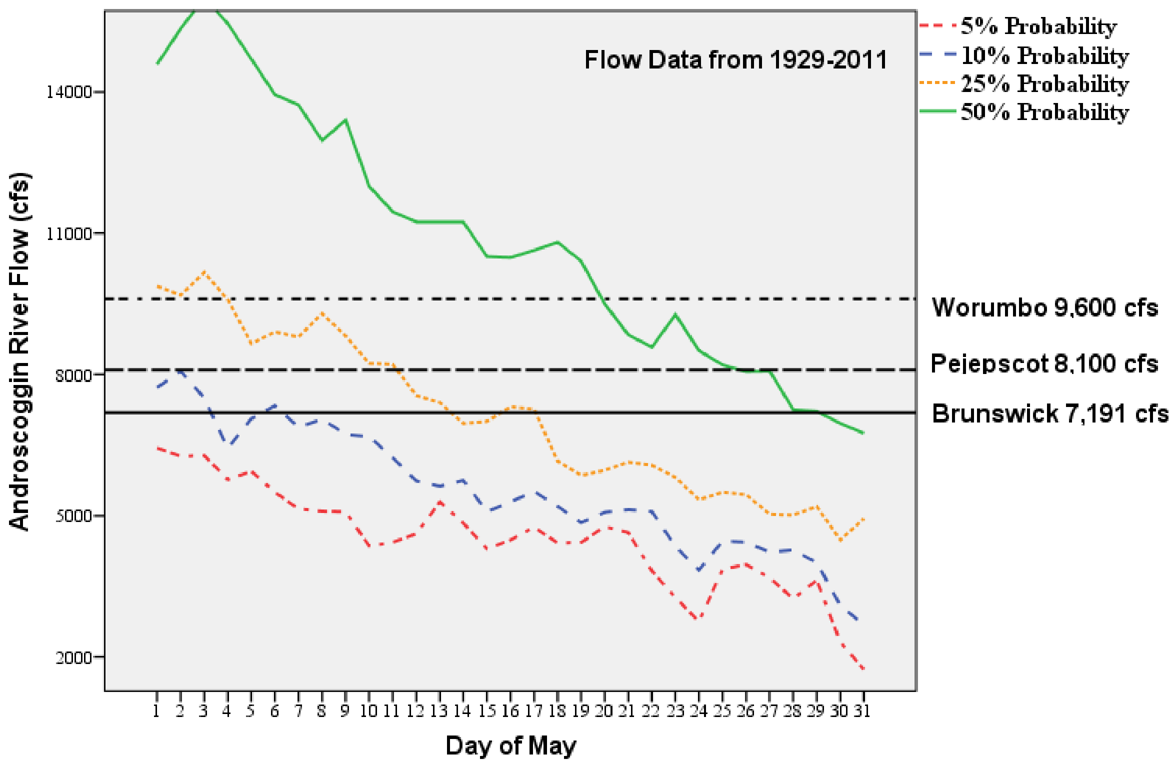


Figure 8.1.2 Relationship between Androscoggin River mean daily flow in May and the hydraulic flow capacity of the Brunswick, Pejepscot, and Worumbo projects. Flow curves represent the 5, 10, 25, 50, 75, and 90th mean daily flow percentiles. Flow volume is based on all days of record for the USGS gage at Auburn, ME for the period 1929-2011. Flows were adjusted upward by a factor of 1.0806 because of the difference in watershed area between the gaging station and the beginning of the watershed near Brunswick.

Data from Figure 8.1.3 show that during the month of June there is a consistent probability of more than 50% that river flows will be ≤ Project hydraulic capacity. This probability increases to about 75% during the last 10 days of the month.

Data from Figure 8.1.4 show that during the month of October there is a consistent probability of at least 75% that river flows will be ≤ Project hydraulic capacity. The probability is near 90% during the first 10 days of the month.

Data from Figure 8.1.5 show that during the month of November there is a consistent probability > 50% that river flows will be ≤ Project hydraulic capacity. The real probability is closer to 75% than it is to 50%.

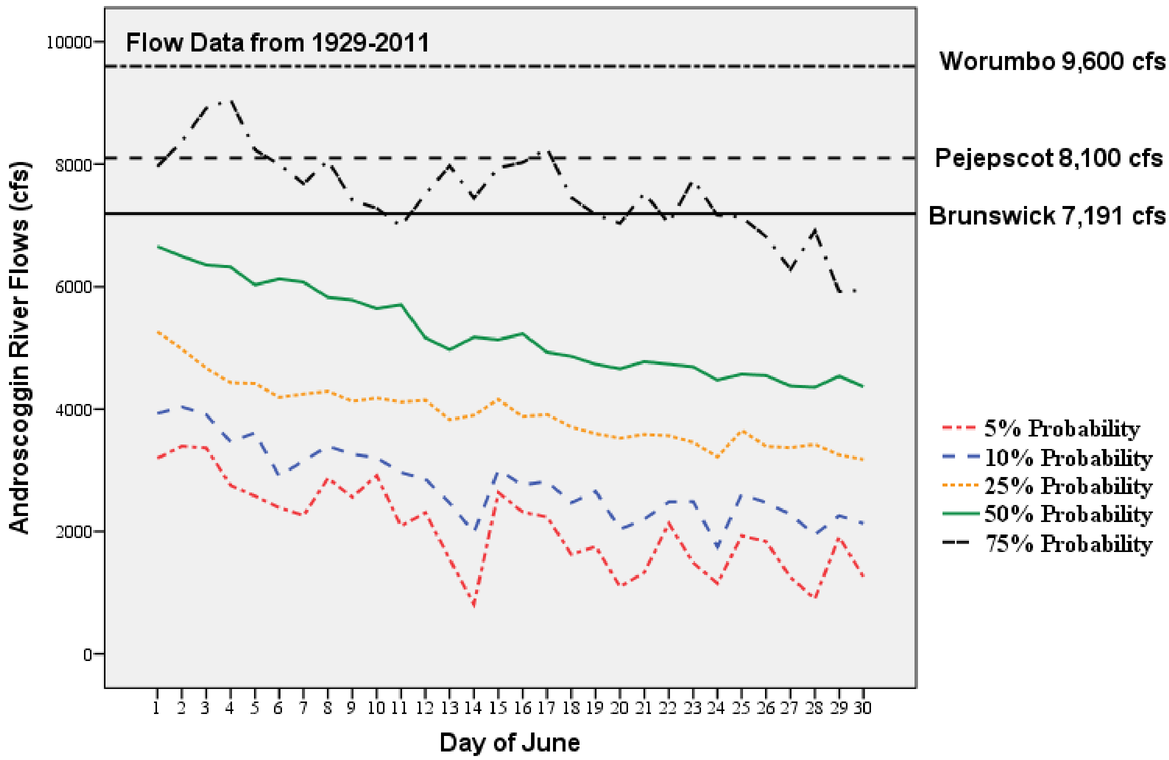


Figure 8.1.3 Relationship between Androscoggin River mean daily flow in June and the hydraulic flow capacity of the Brunswick, Pejepscot, and Worumbo projects. Flow curves represent the 5, 10, 25, 50, 75, and 90th mean daily flow percentiles. Flow volume is based on all days of record for the USGS gage at Auburn, ME for the period 1929-2011. Flows were adjusted upward by a factor of 1.0806 because of the difference in watershed area between the gaging station and the beginning of the watershed near Brunswick.

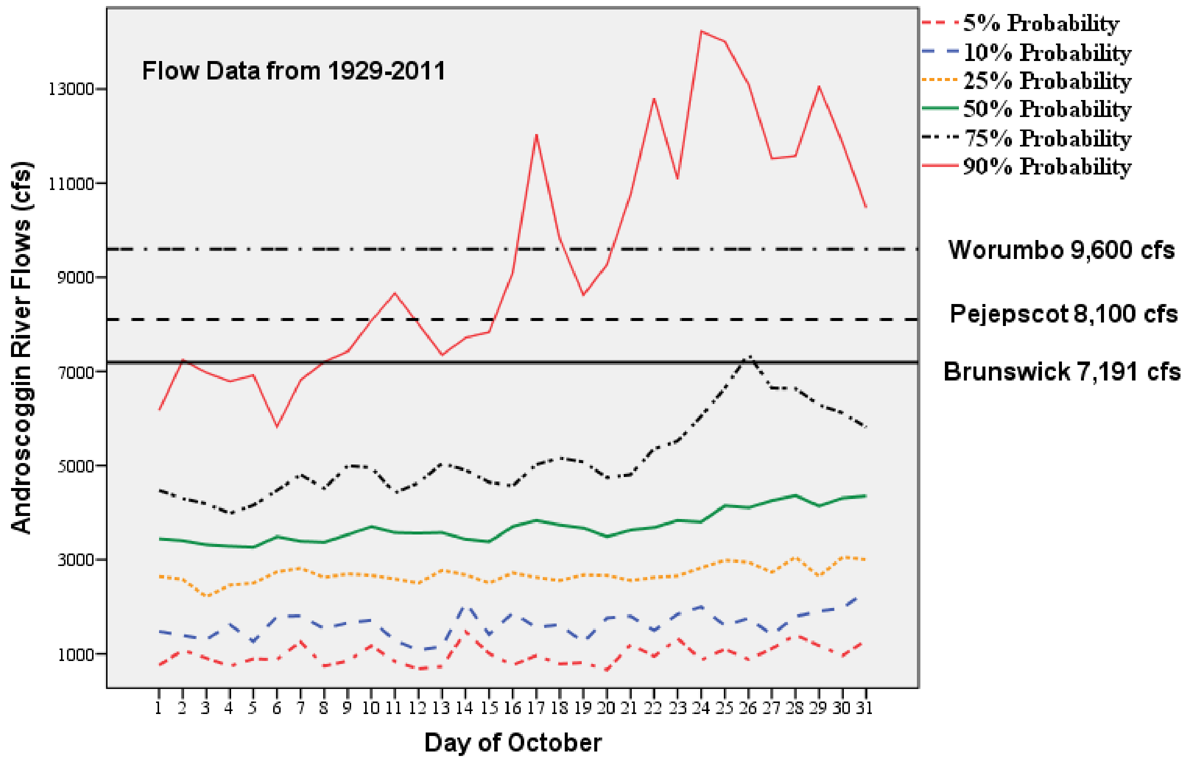


Figure 8.1.4 Relationship between Androscoggin River mean daily flow in October and the hydraulic flow capacity of the Brunswick, Pejepscot, and Worumbo projects. Flow curves represent the 5, 10, 25, 50, 75, and 90th mean daily flow percentiles. Flow volume is based on all days of record for the USGS gage at Auburn, ME for the period 1929-2011. Flows were adjusted upward by a factor of 1.0806 because of the difference in watershed area between the gaging station and the beginning of the watershed near Brunswick.

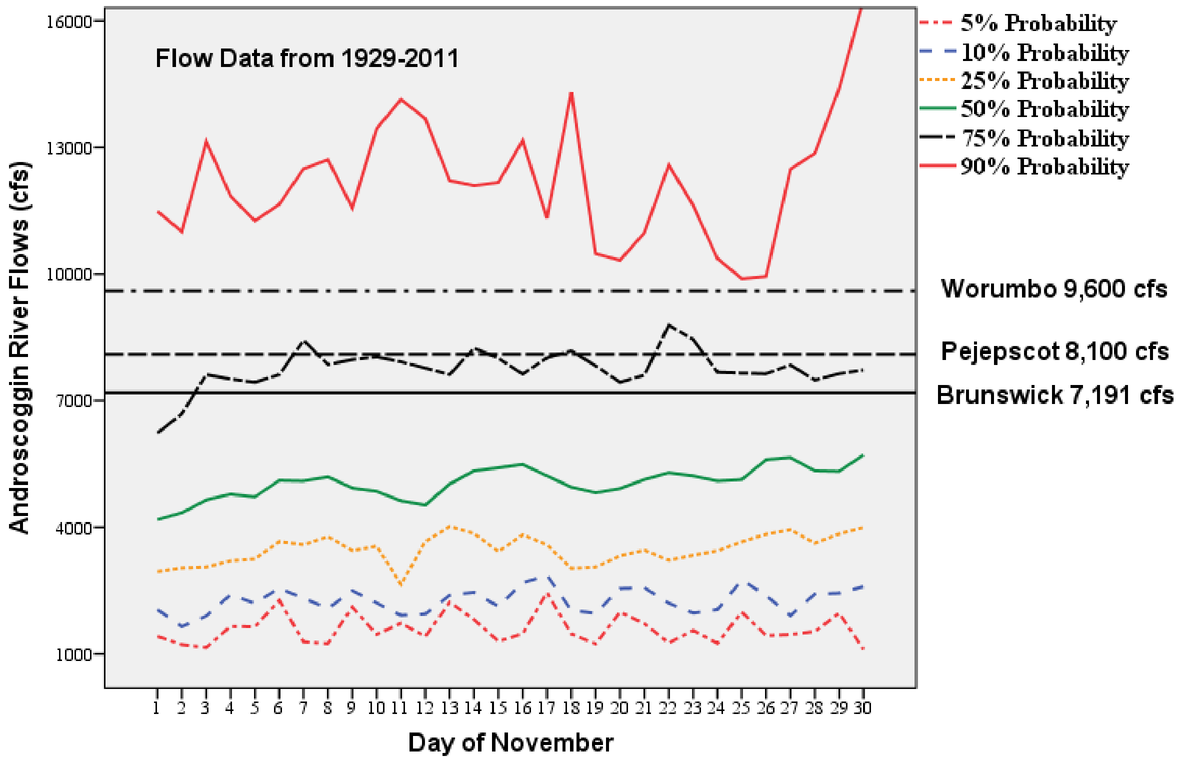


Figure 8.1.5 Relationship between Androscoggin River mean daily flow in November and the hydraulic flow capacity of the Brunswick, Pejepscot, and Worumbo projects. Flow curves represent the 5, 10, 25, 50, 75, and 90th mean daily flow percentiles. Flow volume is based on all days of record for the USGS gage at Auburn, ME for the period 1929-2011. Flows were adjusted upward by a factor of 1.0806 because of the difference in watershed area between the gaging station and the beginning of the watershed near Brunswick.

B. Conclusions Regarding Impacts on Fish – The results of these analyses lead me to the following conclusions:

I. During the spring emigration period, the probabilities of river flow being ≤ the Brunswick Project's hydraulic capacity range from 5 to 75%. During the most likely time when the majority of smolts would migrate, the probabilities range from 10-50%. This level of interaction with Project turbines is, in my opinion, unacceptable for population survival or restoration, given the level of immediate turbine mortality at Brunswick Project and the current status of the Atlantic salmon population in the Androscoggin River.

II. During the fall kelt emigration period, the analysis shows probabilities of > 75% for all of October and > 50% for all of November. This level of interaction with Project turbines is, in my opinion, unacceptable in terms of population survival and recovery, given the level of immediate turbine mortality at Brunswick Project and the current status of the Atlantic salmon population in the Androscoggin River.

III. This analysis clearly demonstrates that the use of median monthly flow values to assess potential project impacts is not appropriate or defensible. As this analysis shows, the use of median monthly flows greatly underestimate the amount of time that river flows can be $\leq$ to project hydraulic capacity and thus the percentage of time that the only downstream passage route available for Atlantic salmon is through the project turbines and the inadequate downstream bypass system. It is my understanding, based on my review of draft white papers commissioned by the NextEra Defendants, that these Defendants plan to use median flow data to assess each Project's impacts on Atlantic salmon for purposes of obtaining Incidental Take Permits.

Given the current population levels, the age structure of adults captured at the Brunswick fish trapping facility, the decades it would take to rebuild even one year's loss of smolts due to project operations, and the cumulative effects of the three projects on the Androscoggin River that are the subject of this litigation, I believe the impacts associated with low river flows result in critical levels of mortality to Atlantic salmon on a reasonably predictable and routine basis.

8.1.3 Impacts on Atlantic salmon in the Merrymeeting Bay SHRU and, consequently, the GOM DPS as a whole

In order to evaluate impacts of dam operations on the Merrymeeting Bay SHRU and the GOM DPS as a whole, I used five parameters related to the Brunswick Project, and these same parameters and conclusions are equally applicable to the Pejepscot and Worumbo projects as well.

1) **Percentage of the total habitat in comparison to the GOM DPS –** According to the NMFS (2009b), the Merrymeeting Bay SHRU comprises approximately 46% of the land area in the GOM DPS, with the Androscoggin River watershed contributing 33% of the total for the Merrymeeting Bay SHRU. Therefore, the Androscoggin River watershed has the potential to be a dominant contributor to recovery in the SHRU and the GOM DPS overall because of its land area and the quality of habitats suitable for Atlantic salmon upstream of the Lisbon Falls.

2) **Population diversity and stability –** The Androscoggin River watershed is the third largest in Maine that is part of the GOM DPS and contains a significant quantity of designated critical habitat. Historically, the Androscoggin, Kennebec, and Penobscot watersheds were the largest producers of Atlantic salmon in

Maine, and probably the East Coast. These large watersheds provided a variety of habitats that have resulted in genetic diversity among watersheds and overall population stability because of the variety of habitats and life history strategies necessary for salmon to persist in them (National Research Council 2002, 2004; Fay et al. 2006; National Marine Fisheries Service and U.S. Fish and Wildlife Service 2009).

3) **Location of habitats suitable to promote recovery of the species –** The majority of habitats suitable to support Atlantic salmon spawning and juvenile rearing in the Androscoggin River watershed are located upstream of Lisbon Falls. Analysis of the biological value of habitats in the Androscoggin watershed shows the highest and second highest value habitats in the Androscoggin basin. (National Marine Fisheries Service (2009b). The NMFS analysis found that a majority of the habitat suitable to support the PCE requirements for spawning and rearing, and thus recovery, were upstream of the Brunswick Project.

4) **Blockage and/or delay to upstream migrating adult Atlantic salmon –** As demonstrated in various analyses I described earlier in this report, the Brunswick Project may directly block or delay adult upstream migrants because of the presence of its spillway section and the potential for adult fish to use the river channel north of Shad Island. Under flow levels where spill is occurring on the north portion of the dam, adult fish may move towards this flow source. No fish passage facilities exist in this area of the Project. No studies have documented whether adults are blocked or delayed because of their transit into this area of the Project. The fate of any fish that does not find the upstream fishway is unknown.

5) **Mortality rate of Atlantic salmon smolts and kelts passing downstream through Brunswick Project turbines –** Smolts and kelts moving downstream through the Brunswick Project are subject to mortality associated with passage through the Project's turbines. During periods of non-spill at downstream migration time periods (see analyses of these time periods above), fish are forced to pass either via the Project's small and in my opinion ineffective downstream fishway or through the project turbines. Immediate mortality of smolts passing through Kaplan type turbines is about 15%, while immediate mortality of kelts is about twice that rate (See Section 6.1 of this report for a review of turbine mortality studies). It is likely that additional salmon die as a result of delayed turbine mortality, and that other salmon suffer adverse impacts as a result of going over the spillway or through the bypass structures, but these percentages have not been quantified.

Given the impacts of these five factors on individual Atlantic salmon, the effects of the Brunswick Project on the spawning and rearing and migration PCE's, and the overall negative impact on the likelihood that the recovery criteria for the Merrymeeting Bay SHRU will be met, I conclude that the Brunswick Project, as it is currently structurally configured and operated, is having a significant adverse impact on the Merrymeeting Bay SHRU and the GOM DPS as a whole.

8.1.4 Interim Measures

Any or all of the following measures would either reduce the harm to Atlantic salmon currently being caused by the dams in question or contribute to efforts at restoration of the species.

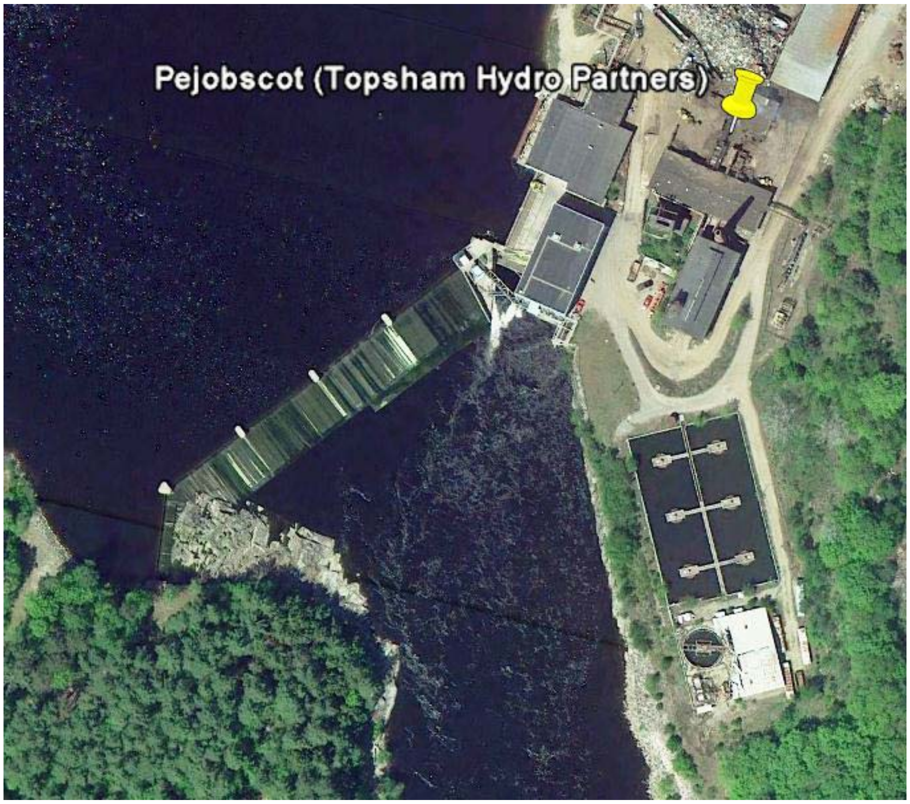
8.1.4.1 Interim Measures Applicable to All Projects on the Kennebec and Androscoggin rivers

A complete list of the interim measures applicable to all projects can be found in Section 7.1.4.1 of the Lockwood Project evaluation.

8.1.4.2 Additional Interim Measures Specifically for the Brunswick Project

A. Provide a downstream passage route on the north side of the spillway section adjacent to the spillway gates. Flow through this bypass should be provided during the downstream migration period of April through June and October through November.

8.2 Pejepscot Project (Topsham Hydro Partners)



8.2.1 Brief Project Description

The Project consists of a 560 ft. long overflow dam with five 3-foot-high crest gates, two powerhouses, and upstream and downstream fish passage facilities. Powerhouse A contains a vertical Kaplan turbine with a flow capacity of about 7,100 cfs which operates fairly consistently because of a minimum flow requirement in the Androscoggin River upstream of the Project. Powerhouse B consists of three horizontal Francis turbines with a combined capacity of about 1,000 cfs. Total hydraulic capacity of the Project is 8,100 cfs operating at a gross head of 25 ft.

The downstream fish bypass facilities consists of two separate entrances and conveyance pipes through the dam. One entrance is a 4-foot wide opening on the south wall of Powerhouse B (north side of the Powerhouse A intake) immediately adjacent to the trash racks and intake for the larger Kaplan unit. The second entrance is the same size and is immediately adjacent to the Kaplan intake on the south side. Each conveyance pipe has a capacity of approximately 40 cfs and flows directly through the dam, discharging about 4 ft. above the water surface below. Upstream adult passage is provided via a downstream trap, a fish lift, and a metal canal that allows fish from the lift to swim upstream of the dam.

8.2.2 Impact of Pejepscot Project on Atlantic Salmon

8.2.2.1 Impact on Individual Fish

I have analyzed seven factors (See section 4.3 for a detailed listing) related to the physical structure of the dam and adjacent river channel and operational parameters and characteristics in evaluating impacts of the project on Atlantic salmon. Below is my evaluation of these seven factors:

1. **Physical Structure of the Dam**

    A. **Evaluation –** The physical configuration and height of the dam create a barrier to upstream migrating Atlantic salmon under most flows, in the absence of an effective upstream fishway. The Project installed the trap and lift passage system in 1987 and has been passing some adult Atlantic salmon since then. At river flow levels at or below the hydraulic capacity of the Project's turbines, most of the flow is exiting via the turbine tailraces which are located adjacent to the entrance to the fish trap entrance.

    The spillway section of the dam consists of a concrete face on the downstream side, which is sloped at an angle of about 30 degrees. A concrete sill runs along the base of the spillway section, causing falling water to change direction from vertical to horizontal. No evidence of bedrock ledges was present during my site visit, except on the southwest corner of the spillway.

    B. **Conclusions Regarding Impacts on Fish –** Given the physical configuration of the sloping spillway section of the dam, I believe that the Pejepscot Project is causing the following impacts to Atlantic salmon:

        I. Under spill conditions, fish passing over the spillway can be killed or injured by striking the sloping concrete surface of the spillway or the concrete apron across the bottom of the spillway.

        II. Under certain flow conditions, adult Atlantic salmon may be delayed from migrating upstream because of an inability to locate the entrance to the upstream fishway in a timely fashion. It is also possible, under the right flow conditions that adult fish do not find the entrance to the upstream fishway and are thus blocked from passing upstream. I am unaware of any data or studies that address these issues, and thus I cannot assess the impacts to overall population productivity caused by any passage blockage and/or delay.

2. **Downstream Fish Bypass System**

   A. **Evaluation –** The two downstream fishway entrances are located on each side of the intake to Powerhouse A, which houses a Kaplan turbine that has a hydraulic capacity of 7,100 cfs. Each downstream fishway has a flow capacity of only 40 cfs. There is no effective bypass provided to "compete" with the flows entering the three Francis turbines, since the easternmost bypass entrance is "around the corner" and downstream from the Francis unit's intake. The second downstream fishway entrance is immediately adjacent to the Kaplan turbine intake on the opposite side of the forebay. Neither of the two downstream fishway bypass entrances is located where it might provide sufficient attraction flow to effectively compete with flows that pass through the Kaplan turbine, which runs almost continuously.

   B. Conclusions Regarding Impacts on Fish – Given the poor locations of the downstream fishway (immediately adjacent to the Kaplan turbine intake) and the lack of sufficient flow into the fishways to effectively "compete" with the flows passing into the turbines, I conclude that the downstream fishway is ineffective and does not adequately protect downstream migrating Atlantic salmon from passing through the Project's turbines. Mortality rates of various fish species and sizes passing through different turbines are reviewed in Section 6.1 of this report.

3. **Types of turbines used to generate power**

   A. Evaluation – For an overview of turbine mortality rates see Section 6.1 of this report. Powerhouse A contains a single Kaplan turbine that operates almost continuously and has a hydraulic capacity of about 7,100 cfs. Three Francis turbines are located in Powerhouse B and have a combined capacity of about 1,000 cfs, bringing the total project hydraulic capacity to 8,100 cfs.

   I am unaware of any site-specific empirical studies conducted at the Project to assess the following causes of hydroelectric dam-related mortality: predation in the headpond area as a result of changing the type of habitat upstream of the dam, spill-related mortality, mortality associated with fish using the downstream bypass system, delayed or latent mortality associated with fish passing through the turbines and not immediately killed, and mortality due to predation at locations immediately downstream of the Project infrastructure due to fish being injured or disoriented during passage through the Project.

   However, there are data from studies conducted at dams on the nearby Kennebec River which do offer some indication of the mortality rates associated with the types of turbines found at the Pejepscot Project. Section 6.1 of this report summarizes some of the literature reporting turbine mortality rates for juvenile and adult Atlantic salmon-sized fish. For a more comprehensive review see Stone and Webster (1992) and Winchell and Amaral (1997).

B. **Conclusions Regarding Impacts on Fish –** I have reached the following conclusions with respect to turbine passage at Pejepscot:

I. There is a significant frequency, during critical downstream migration periods for Atlantic salmon smolts and/or kelts (April through June and October and November), when the river flows are low enough that essentially the entire flow of the river passes through the Project's turbines and bypass system. Please see the flows analysis below.

II. Given the fact that the flows into the existing downstream fish bypass system cannot adequately compete with the flows entering the turbines and effectively divert downstream migrating Atlantic salmon away from the turbines, I conclude that in these non-spill conditions the majority of the fish passing through the dam do so through the Project's turbines. Even during conditions of spill, fish will still pass through the Project's turbines if they are operating.

III. A scientifically defensible estimate of immediate Atlantic salmon smolt mortality passing through Kaplan type turbines at Pejepscot is approximately 15%. Mortality levels for kelts will be higher, with a reasonable working value of 25-50%. It is important to note that these values do not include mortality associated with downstream predation due to injury or disorientation or latent mortality as a result of passing through the turbines.

IV. Given the preceding conclusions, the Pejepscot Project is causing direct mortality to Atlantic salmon smolts and kelts by allowing fish to pass through the Project turbines. Although indirect and latent mortality have not been adequately assessed at this Project, it is reasonable to assume that some smaller percentage of indirect and latent mortality is also occurring as a result of turbine passage.

4. Upstream fishway for adult passage

A. **Evaluation –** The Project installed an adult fish trap, fish lift, and upstream conveyance canal in 1987 and has been providing passage opportunity for adult Atlantic salmon since then. However, I am unaware of any documentation of fish passing the dam. But, between 1983 and 2010, a total of 742 adult Atlantic salmon have been counted at the upstream fishway at the Brunswick Project. In 2011, 47 adults were counted. The 2011 count of 47 fish is the third largest number in the history of the fishway. Analysis of the hatchery versus wild components of the run shows 13.6% of the fish are of wild origin (Fay et al. 2006; Maine Department of Marine Resources. 2011a). I am not aware of any data documenting where adult Atlantic salmon are spawning or rearing in the Androscoggin River watershed at this time. I understand that a radio telemetry study of some type was conducted in 2011, but I have not seen any report on the results of any study that may have been conducted.

At river flow levels at or below the hydraulic capacity of the Project's turbines, most of the flow is exiting via the turbine tailraces, which are located adjacent to the entrance to the upstream fish entrance. This situation is acceptable for upstream passage. However, at flows above the Project's hydraulic capacity, flow is spilled away from the entrance to the fish trap and it is unknown what the effectiveness of the flow attraction is to get fish to enter the trap. While the spill gates are adjacent to the fish trap, spill over the non-gate spillway section may result in a delay or inability of adults to find the entrance to the upstream fishway.

B. Conclusions Regarding Impacts on Fish – Given the information in the evaluation above, I have reached the following conclusions regarding upstream fish passage facilities at the Pejepscot Project:

I. Adult Atlantic salmon were captured in the very first year the Brunswick Project's fishway was installed in 1983 – approximately 100 years since the last documented stocking of Atlantic salmon in the Androscoggin River (Fay et al. 2006). In addition, some percentage of returning fish has consistently been classified as wild origin since 1983. Given these facts, I conclude that there must have been a low level persistent run of Atlantic salmon into the Androscoggin River. This run has continued but I do not know where adult Atlantic salmon are spawning and rearing and whether or not those areas are upstream of the Pejepscot Project.

II. Under low flow conditions, adult Atlantic salmon follow the low flow (south) channel, because of the flow coming from the powerhouse tailrace, and find the entrance to the upstream fishway.

III. Under certain flow conditions, adult Atlantic salmon may be delayed from migrating upstream because of an inability to locate the entrance to the upstream fishway in a timely fashion. It is also possible that under certain flow conditions adult fish do not find the entrance to the upstream fishway and are thus blocked from passing upstream. I am unaware of any data or studies that address these issues, and thus I cannot assess the impacts to overall population productivity caused by any passage blockage and/or delay.

5. **Size and configuration of the headpond upstream of the dam**

   A. **Evaluation –** Based on my personal observations, a review of Google Earth photos of the Pejepscot Project-to-Worumbo Project section of the Androscoggin River, and comments made by Worumbo staff during my site visit, I estimate the headpond area at about 100+ acres. Although I am unable to verify this estimate, it appears reasonable, given the height of the spillway section. The headpond size is significant because in this area of the Pejepscot Project the habitat of the Androscoggin River has been changed from a flowing river channel to a more slow-moving water habitat. This lake-like habitat is more likely to contain fish species that are predators on juvenile Atlantic salmon and may not contain the cover features for juvenile salmon that would normally be present in a natural river channel. I am unaware of any data that would allow specific quantification of the habitat characteristics of this area or the predation rates on Atlantic salmon smolts.

   B. **Conclusions Regarding Impacts on Fish –** I conclude that levels of predation on Atlantic salmon smolts in the headpond area of the Pejepscot Project are higher than what they would be in a natural river channel. Given the lack of any site-specific, quantitative studies or data, it is impossible to reach a defensible quantitative assessment of the increased predation rate or the potential impacts on the Atlantic salmon population.

6. **Physical character of the river immediately downstream of the dam and tailrace areas as potential habitat for predators**

   A. **Evaluation –** Smolts can pass the Pejepscot Project by going over the spillway or passing through the turbines or downstream fish bypass system. Each of these routes may affect smolts in ways that make them more vulnerable to predation, as described in Section 5.2, above. No scientifically rigorous studies have been conducted to assess these impacts at Pejepscot, although the authors of studies conducted at the Lockwood Project that focused on other passage issues conclude that some radio tagged smolts were taken by downstream predators, based on movement patterns of the tags after passage through the project ((FPL Energy Maine Hydro, LLC. 2008a, Normandeau Associates, Inc. 2011c. Note this latter document is under a court protective order). The predation estimate in the 2011 study was 1.4%.

The configuration of the river channel and the effects of spill on juvenile Atlantic salmon passing over the spillway section make these fish vulnerable to predation. Given the presence of a concrete sill along the downstream base of the spillway section that can provide low velocity habitat for potential predators, I conclude that some yet to be quantified level of disorientation or injury increases vulnerability to predation.

Under low flow conditions, the majority of the river flow is passing through the bypass system or turbines. The river channel immediately downstream of the powerhouse tailrace appears deep. This type of habitat is very conducive to harboring predators. Given the probability of fish being disoriented by passing through the turbines, it is my opinion that predation rates in this specific area of the Project are higher than in other areas. However, no studies have specifically quantified the predation rate in this area.

B. Conclusions Regarding Impacts to Fish – I conclude that the Pejepscot Project's configuration and operations create conditions that result in increased predation of juvenile Atlantic salmon. There is one published estimate that would suggest a 1+% predation rate, but I do not believe that level is supported by scientifically reliable evidence. In my professional opinion, predation is occurring at some unknown level, likely in the low single digits. But given the lack of specific quantitative data, the actual level of predation below Pejepscot and the resultant impact on Atlantic salmon cannot be quantified at this time.

7. River flow regime during time periods critical for Atlantic salmon (April through June and October through November) in relation to the hydraulic capacity of the turbines

A. **Evaluation –** For a more detailed explanation of the data and procedure used to develop the figures below relating Androscoggin River flow conditions and the potential for all of the river flow to pass through the Project's turbines, see Section 6.2 of this report. Results of this analysis are presented below:

Figures referenced in this section are found in Section 8.1.2.1(7) above.

Data from Figure 8.1.1 for the Pejepscot Project show that during the month of April there is a consistent probability of over 5% that river flows will be ≤ Project hydraulic capacity. The probability varies close to 10% during most of the entire month.

Data from Figure 8.1.2 for the Pejepscot Project show that during the month of May there is a consistent probability of more than 10% that river flows will be ≤ Project hydraulic capacity. This probability increases to 25% during the last 20 days of the month and to 50% at the end of the month.

Data from Figure 8.1.3 for the Pejepscot Project show that during the month of June there is a consistent probability of 75% that river flows will be ≤ Project hydraulic capacity.

Data from Figure 8.1.4 for the Pejepscot Project show that during the month of October there is a probability of about 90% that river flows will be ≤ Project hydraulic capacity during the first 15 days of the month. The probability decreases to between 75% and 90% during the last 15 days of the month.

Data from Figure 8.1.5 for the Pejepscot Project show that during the month of November there is a consistent probability of approximately 75% that river flows will be ≤ Project hydraulic capacity.

B. **Conclusions Regarding Impacts on Fish –** The results of these analyses lead me to the following conclusions:

I. During the spring emigration period, the probabilities of river flow being ≤ the Pejepscot Project's hydraulic capacity range from 5 to 75%. During the most likely time when the majority of smolts would migrate, the probabilities range from 10-50%. This level of interaction with Project turbines is, in my opinion, unacceptable in terms of population survival and recovery, given the level of immediate turbine mortality at Pejepscot Project and the current status of the Atlantic salmon population in the Androscoggin River.

II. During the fall kelt emigration period, the analysis shows probabilities of > 75% for all of October and > 50% for all of November. This level of interaction with Project turbines is, in my opinion, unacceptable in terms of population survival and recovery, given the level of immediate turbine mortality at Pejepscot Project and the current status of the Atlantic salmon population in the Androscoggin River.

III. This analysis clearly demonstrates that the use of median monthly flow values to assess potential project impacts is not appropriate or defensible. As this analysis shows, the use of median monthly flows greatly underestimates the amount of time that river flows can be ≤ to project hydraulic capacity and thus the percentage of time that the only downstream passage route available for Atlantic salmon is through the project turbines and the inadequate downstream bypass system.

Given the current population levels, the age structure of adults captured at the Brunswick fish trapping facility, the decades it would take to rebuild even one year's loss of smolts due to project operations, and the cumulative effects of the three projects on the Androscoggin River that are the subject of this litigation, I believe the impacts associated with low river flows result in critical levels of mortality to Atlantic salmon on a reasonably predictable and routine basis.

8.2.3 Impacts on Atlantic salmon in the Merrymeeting Bay SHRU and, consequently, the GOM DPS as a whole

In order to evaluate impacts of dam operations on the Merrymeeting Bay SHRU and the GOM DPS as a whole, I used five parameters related to the Pejepscot Project, and these same parameters and conclusions are equally applicable to the Brunswick and Worumbo projects as well.

1) **Percentage of the total habitat in comparison to the GOM DPS –** According to the NMFS (2009b), the Merrymeeting Bay SHRU comprises approximately 46% of the land area in the GOM DPS, with the Androscoggin River watershed contributing 33% of the total for the Merrymeeting Bay SHRU. Therefore, the Androscoggin River watershed has the potential to be a dominant contributor to recovery in the SHRU and the GOM DPS overall because of its land area and the quality of habitats suitable for Atlantic salmon upstream of the Lisbon Falls.

2) **Population diversity and stability –** The Androscoggin River watershed is the third largest in Maine that is part of the GOM DPS and contains a significant quantity of designated critical habitat. Historically, the Androscoggin, Kennebec, and Penobscot watersheds were the largest producers of Atlantic salmon in Maine, and probably the East Coast. These large watersheds provided a variety of habitats that have resulted in genetic diversity among watersheds and overall population stability because of the variety of habitats and life history strategies necessary for salmon to persist in them (National Research Council 2002, 2004; Fay et al. 2006; National Marine Fisheries Service and U.S. Fish and Wildlife Service 2009).

3) **Location of habitats suitable to promote recovery of the species –** The majority of habitats suitable to support Atlantic salmon spawning and juvenile rearing in the Androscoggin River watershed are located upstream of Lisbon Falls. Analysis of the biological value of habitats in the Androscoggin watershed

shows the highest and second highest value habitats in the Androscoggin basin. (National Marine Fisheries Service (2009b). The NMFS analysis found that a majority of the habitat suitable to support the PCE requirements for spawning and rearing, and thus recovery, were upstream of the Brunswick Project.

4) **Blockage and/or delay to upstream migrating adult Atlantic salmon –** As demonstrated in various analyses I described earlier in this report, the Brunswick Project may directly block or delay adult upstream migrants because of the presence of its spillway section and the potential for adult fish to use the river channel north of Shad Island. Under flow levels where spill is occurring on the north portion of the dam, adult fish may move towards this flow source. No fish passage facilities exist in this area of the Brunswick Project. No studies have documented whether adults are blocked or delayed because of their transit into this area of that Project. The fate of any fish that does not find the upstream fishway is unknown. I also conclude, given the configuration of the Pejepscot Project, that there is a low (non-zero) level of probability that some fish will be unable to find the fish trap entrance at Pejepscot.

5) **Mortality rate of Atlantic salmon smolts and kelts passing downstream through Pejepscot Project turbines –** Smolts and kelts moving downstream through the Pejepscot Project are subject to mortality associated with passage through the Project's turbines. During periods of non-spill at downstream migration time periods (see analyses of these time periods above), fish are forced to pass either via the Project's small and in my opinion ineffective downstream fishway or through the project turbines. Immediate mortality of smolts passing through Kaplan type turbines is about 15%, while immediate mortality of kelts is about twice that rate (See Section 6.1 of this report for a review of turbine mortality studies). It is likely that additional salmon die as a result of delayed turbine mortality, and that other salmon suffer adverse impacts as a result of going over the spillway or through the bypass structures, but these percentages have not been quantified.

Given the impacts of these five factors on individual Atlantic salmon, the effects of the Pejepscot Project on the spawning and rearing and migration PCE's, and the overall negative impact on the likelihood that the recovery criteria for the Merrymeeting Bay SHRU will be met, I conclude that the Pejepscot Project, as it is currently structurally configured and operated is having a significant adverse impact on the Merrymeeting Bay SHRU and the GOM DPS as a whole.

8.2.4 Interim Measures

Any or all of the following measures would either reduce the harm to Atlantic salmon currently being caused by the dams in question or contribute to efforts at restoration of the species.

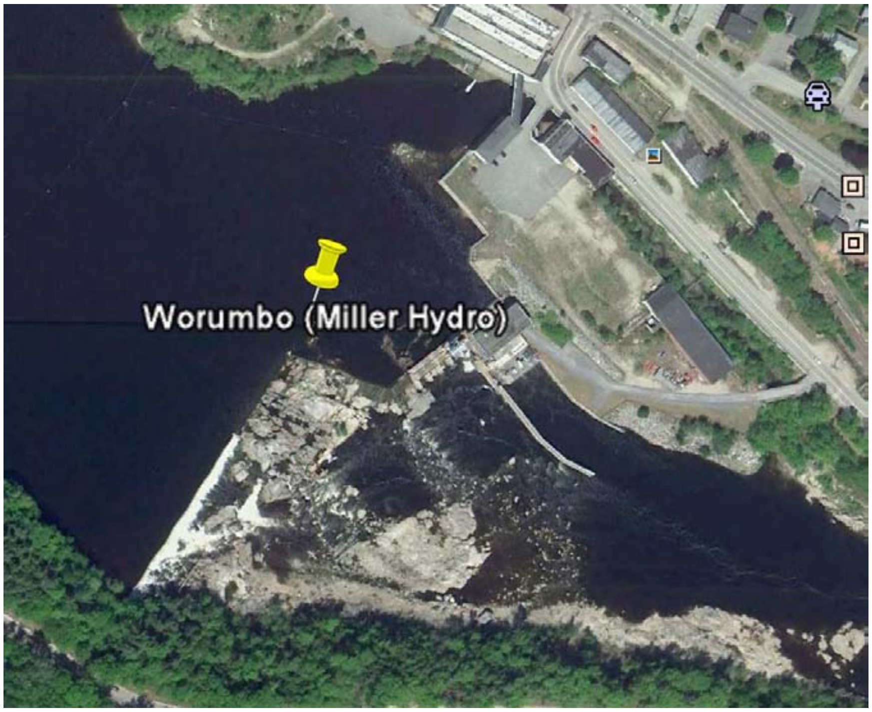
8.2.4.1 Interim Measures Applicable to All Projects on the Kennebec and Androscoggin rivers

A complete list of the interim measures applicable to all projects can be found in Section 7.1.4.1 of the Lockwood Project evaluation.

8.2.4.2 Additional Interim Measures Specifically for the Pejepscot Project

A. Increase the water velocity in the upstream conveyance channel for adult salmon to a minimum of 1.5 ft/sec.
B. Provide a downstream passage route on the southwest side of the spillway during the downstream migration period. Flow through this bypass should be provided during the downstream migration period of April through June and October through November.

8.3 Worumbo Project (Miller Hydro)



8.3.1 Brief Project Description

The Project consists of an approximately 850 ft. long overflow dam plus three gates, which are located adjacent to the downstream fish bypass and powerhouse on the northeast bank of the river. The height of the spillway section appears to be about 10 ft., but this section was being reconstructed during my site visit and I have no published height data. An upstream adult trapping facility is located inside the turbine tailrace, which is contained by a rock wall on one side and a concrete retaining wall on the southwest side. The adult trap lifts fish into an upstream conveyance channel, which allows fish to pass upstream of the dam. The downstream fish bypass located between the easternmost gate and the turbine intakes passes an unknown volume of water, but it appears to be in the 100-125 cfs range. I have been unable to find a published value for this discharge. The powerhouse contains two Kaplan turbines with a flow capacity of about 4,800 cfs each. Total hydraulic capacity of the Project is 9,600 cfs.

8.3.2 Impact of Worumbo Project on Atlantic Salmon

8.3.2.1 Impact on Individual Fish

I have analyzed seven factors (See section 4.3 for a detailed listing) related to the physical structure of the dam and adjacent river channel and operational parameters and characteristics in evaluating impacts of the project on Atlantic salmon. Below is my evaluation of these seven factors:

1. **Physical Structure of the Dam**

   A. **Evaluation –** The physical configuration and height of the dam creates a barrier to upstream migrating Atlantic salmon under most flows, in the absence of an effective upstream fishway. The Project installed the trap and lift passage system in 1988 and has providing passage opportunities for adult Atlantic salmon since then. At river flow levels at or below the hydraulic capacity of the Project's turbines, most of the flow is exiting via the turbine tailraces which are located adjacent to the fish trap entrance.

   The spillway section of the dam contains extensive bedrock ledges, except immediately downstream of the three gates and powerhouse tailrace.

   B. **Conclusions Regarding Impacts on Fish –** Given the physical configuration of the sloping spillway section of the dam, I believe that the Worumbo Project is causing the following impacts to Atlantic salmon:

      I. Under spill conditions, fish passing over the spillway are subject to death or injury caused by striking the bedrock ledges immediately downstream of the dam.

      II. Under certain flow conditions, adult Atlantic salmon may be delayed from migrating upstream because of an inability to locate the entrance to the upstream fishway in a timely fashion since considerable flow will be concentrated in the southwest corner of the spillway section. It is also possible, under certain flow conditions, adult fish do not find the entrance to the upstream fishway and are thus blocked from passing upstream. I am unaware of any data or studies that address these issues, and thus I cannot assess the impacts to overall population productivity caused by any passage blockage and/or delay.

2. **Downstream Fish Bypass System**

   A. **Evaluation –** The downstream fishway entrance is located adjacent to the turbine intakes. I do not have any published values for the flow through the bypass; it appears from photos to be in the range of 100-125 cfs. The outfall of the bypass discharges into the pool area below the spillway gates.

   B. **Conclusions Regarding Impacts on Fish –** Given the poor location of the downstream fishway (immediately adjacent to the Kaplan turbines intakes) and the lack of sufficient flow into the fishway to effectively "compete" with the flows passing into the turbines, I conclude that the downstream fishway is ineffective and does not adequately protect downstream migrating Atlantic salmon from passing through the Project's turbines. Mortality rates of various fish species and sizes passing through different turbines are reviewed in Section 6.1 of this report.

3. Types of turbines used to generate power

A. Evaluation – For an overview of turbine mortality rates see Section 6.1 of this report. The powerhouse contains two Kaplan turbines with a flow capacity of about 4,800 cfs each. Total hydraulic capacity of the Project is 9,600 cfs.

I am unaware of any site-specific empirical studies conducted at the Project to assess the following causes of hydroelectric dam-related mortality: predation in the headpond area as a result of changing the type of habitat upstream of the dam, spill-related mortality, mortality associated with fish using the downstream bypass system, delayed or latent mortality associated with fish passing through the turbines and not immediately killed, and mortality due to predation at locations immediately downstream of the Project infrastructure due to fish being injured or disoriented during passage through the Project.

However, there are data from studies conducted at dams on the nearby Kennebec River which do offer some indication of the mortality rates associated with the types of turbines found at the Worumbo Project. Section 6.1 of this report summarizes some of the literature reporting turbine mortality rates for juvenile and adult Atlantic salmon-sized fish. For a more comprehensive review see Stone and Webster (1992) and Winchell and Amaral (1997).

B. Conclusions Regarding Impacts on Fish – I have reached the following conclusions with respect to turbine passage at Worumbo:

I. There is a significant frequency, during critical downstream migration periods for Atlantic salmon smolts and/or kelts (April through June and October and November), when the river flows are low enough that essentially the entire flow of the river passes through the Project's turbines and bypass system. Please see the flows analysis below.

II. Given the fact that the flows into the existing downstream fish bypass system in all likelihood cannot adequately compete with the flows entering the turbines and effectively divert downstream migrating Atlantic salmon away from the turbines, I conclude that in these non-spill conditions the majority of the salmon passing through the Project do so through the Project's turbines. Even during conditions of spill, fish will still pass through the Project's turbines if they are operating.

III. A scientifically defensible estimate of immediate Atlantic salmon smolt mortality passing through Kaplan type turbines at Worumbo is approximately 15%. Mortality levels for kelts will be higher, with a reasonable working value of 25-50%. It is important to note that these values do not include mortality associated with downstream predation due to injury or disorientation or latent mortality as a result of passing through the turbines.

IV. Given the preceding conclusions, the Worumbo Project is causing direct mortality to Atlantic salmon smolts and kelts by allowing fish to pass through the Project turbines. Although indirect and latent mortality have not been adequately assessed at this Project, it is reasonable to assume that some smaller percentage of indirect and latent mortality is also occurring as a result of turbine passage.

4. Upstream fishway for adult passage

A. Evaluation – The Project installed an adult fish trap, fish lift, and upstream conveyance canal in 1988 and has been providing passage opportunity for adult Atlantic salmon since then. However, I am unaware of any documentation of fish passing the dam. But between 1983 and 2010 at total of 742 adult Atlantic salmon have been counted at the upstream fishway at the Brunswick Project. In 2011, 47 adults were counted. The 2011 count of 47 fish is the third largest number in the history of the fishway. Analysis of the hatchery versus wild components of the run shows 13.6% of the fish are of wild origin (Fay et al. 2006; Maine Department of Marine Resources 2011a). I am not aware of any data documenting where adult Atlantic salmon are spawning or rearing in the Androscoggin River watershed at this time. I understand that a radio telemetry study of some type was conducted in 2011, but I have not seen any report on the results of any study that may have been conducted.

At river flow levels at or below the hydraulic capacity of the Project's turbines, most of the flow is exiting via the turbine tailraces which are located adjacent to the entrance to the upstream fish entrance. This situation is acceptable for upstream passage. However, at flows above the Project's hydraulic capacity, flow is spilled away from the entrance to the fish trap and it is unknown what the effectiveness of the flow attraction is to get fish to enter the trap. While the spill gates are adjacent to the fish trap, spill over the non-gate spillway section, particularly in the southwest portion of the spillway, may result in a delay or inability of adults to find the entrance to the upstream fishway.

B. Conclusions Regarding Impacts on Fish – Given the information in the evaluation above, I have reached the following conclusions regarding upstream fish passage facilities at the Worumbo Project:

I. Adult Atlantic salmon were captured the first year the Brunswick Project's fishway was installed in 1983. This is approximately 100 years since the last documented stocking of Atlantic salmon in the Androscoggin River (Fay et al. 2006). However, with fish to appearing in the first year of the fishway operation, I conclude that there must have been a low level persistent run of Atlantic salmon into the Androscoggin River given the lack of previous stocking and the percentage of the fish classified as wild origin since 1983. This run has continued but I do not know where adult Atlantic salmon are spawning and rearing and whether or not those areas are upstream of the Worumbo Project.

II. Under low flow conditions, adult Atlantic salmon follow the northeast channel, because of the flow coming from the powerhouse tailrace and find the entrance to the upstream fishway;

III. Under certain flow conditions, adult Atlantic salmon may be delayed from migrating upstream because of an inability to locate the entrance to the upstream fishway in a timely fashion. It is also possible that under certain conditions adult fish do not find the entrance to the upstream fishway and are thus blocked from passing upstream. I am unaware of any data or studies that address these issues, and thus cannot assess the impacts to overall population productivity caused by any passage blockage and/or delay.

5. Size and configuration of the headpond upstream of the dam

A. Evaluation – Based on my personal observations and review of Google Earth photos of the Worumbo project section of the Androscoggin River, I estimate the headpond area at about 10+ acres. Although I am unable to verify this estimate, it appears reasonable, given the height of the spillway section. The headpond can provide habitat for predators, because in this area of the Worumbo Project, the habitat of the Androscoggin River has been changed from a flowing river channel to a more slow-moving water habitat. This lake-like habitat is more likely to contain fish species that are predators on juvenile Atlantic salmon and may not contain the cover features for juvenile salmon that would normally be present in a natural river channel. I am unaware of any data that has specifically quantified the habitat characteristics of this area or quantified predation rates on Atlantic salmon smolts.

B. Conclusions Regarding Impacts on Fish – I conclude that it is likely that levels of predation of Atlantic salmon smolts in the headpond area of the Worumbo Project are higher than what they would be in a natural river channel. But given the lack of any site-specific, quantitative studies or data, it is impossible to reach a defensible quantitative assessment of the increased predation rate or the potential impacts on the Atlantic salmon population.

6. Physical character of the river immediately downstream of the dam and tailrace areas as potential habitat for predators

A. Evaluation – Smolts can pass the Worumbo Project by going over the spillway, or passing through the turbines or downstream fish bypass system. Each of these routes may affect smolts in ways that make them more vulnerable to predation, as described in Section 5.2, above. No scientifically rigorous studies have been conducted to assess these impacts at Worumbo, although the authors of studies conducted at the Lockwood Project that focused on other passage issues conclude that some radio tagged smolts were taken by downstream predators, based on movement patterns of the tags after passage through the project ((FPL Energy Maine Hydro, LLC. 2008a, Normandeau Associates, Inc. 2011c. Note this latter document is under a court protective order). The predation estimate in the 2011 study was 1.4%.

The configuration of the river channel and the effects of spill on juvenile Atlantic salmon passing over the spillway section may make these fish vulnerable to predation. Given the presence of a concrete sill along the downstream base of the spillway section that can provide low velocity habitat for potential predators, I conclude that some yet to be quantified level of disorientation or injury increases vulnerability to predation. Also, the extensive bedrock ledges greatly increase the risk of death or injury to fish passing over the spillway during higher flows. The "pond-like" area downstream of the spillway in the southwest corner of the Project also provides an area suitable for predators to congregate.

Under low flow conditions, the majority of the river flow is passing through the bypass system or turbines. The river channel immediately downstream of the powerhouse tailrace is relatively deep. This type of habitat is very conducive to harboring predators. Given the probability of fish being disoriented by passing through the turbines, it is my opinion that predation rates in this specific area of the Project are higher than other areas. However, no studies have specifically quantified the predation rate in this area.

B. Conclusions Regarding Impacts to Fish and this Factor – I conclude that the Worumbo Project's configuration and operations create conditions that are likely to result in increased predation of juvenile Atlantic salmon. There is one published estimate that would suggest a 1+% predation rate, but I do not believe that level is supported by scientifically reliable evidence. In my professional opinion, predation is occurring at some unknown level, likely in the low single digits. But given the lack of specific quantitative data, the actual level of predation below Worumbo, and the resultant impact on Atlantic salmon, cannot be quantified at this time.

7. River flow regime during time periods critical for Atlantic salmon (April through June and October through November) in relation to the hydraulic capacity of the turbines

A. **Evaluation –** For a more detailed explanation of the data and procedure used to develop the figures below relating Androscoggin River flow conditions and the potential for all of the river flow to pass through the Project's turbines, see Section 6.2 of this report. Results of this analysis are presented below:

Figures referenced in this section are found in Section 8.1.2.1(7) above.

Data from Figure 8.1.1 for the Worumbo Project show that during the month of April there is a consistent probability of between 10% and 25% that river flows will be ≤ Project hydraulic capacity.

Data from Figure 8.1.2 for the Worumbo Project show that during the month of May there is a consistent probability of more than 25% that river flows will be ≤ Project hydraulic capacity. This probability increases to more than 50% during the last 10 days of the month.

Data from Figure 8.1.3 for the Worumbo Project show that during the month of June there is a consistent probability of >75% that river flows will be ≤ Project hydraulic capacity.

Data from Figure 8.1.4 for the Worumbo Project show that during the month of October there is a probability of about 90% that river flows will be ≤ Project hydraulic capacity during the first 15 days of the month. The probability decreases to between 75% and 90% during the last 15 days of the month.

Data from Figure 8.1.5 for the Worumbo Project show that during the month of November there is a consistent probability of > 75% that river flows will be ≤ Project hydraulic capacity.

B. Conclusions Regarding Impacts on Fish – The results of these analyses lead me to the following conclusions:

I. During the spring emigration period, the probabilities of river flow being ≤ the Worumbo Project's hydraulic capacity range from 10% to 75%. During the most likely time when the majority of smolts would migrate, the probabilities range from 10-50%. This level of interaction with Project turbines is, in my opinion, unacceptable in terms of population survival and recovery, given the level of immediate turbine mortality at Worumbo Project and the current status of the Atlantic salmon population in the Androscoggin River.

II. During the fall kelt emigration period, the analysis shows probabilities of > 90% for the first half of October and > 75% for all of November. This level of interaction with Project turbines is, in my opinion, unacceptable in terms of population survival and recovery, given the level of immediate turbine mortality at Worumbo Project and the current status of the Atlantic salmon population in the Androscoggin River.

III. This analysis clearly demonstrates that the use of median monthly flow values to assess potential project impacts is not appropriate or defensible. As this analysis shows, the use of median monthly flows greatly underestimate the amount of time that river flows can be ≤ to project hydraulic capacity and thus the percentage of time that the only downstream passage route available for Atlantic salmon is through the project turbines and the inadequate downstream bypass system.

Given the current population levels, the age structure of adults captured at the Brunswick fish trapping facility, the decades it would take to rebuild even one year's loss of smolts due to project operations, and the cumulative effects of the three projects on the Androscoggin River that are the subject of this litigation, I believe the impacts associated with low river flows result in critical levels of mortality to Atlantic salmon on a reasonably predictable and routine basis.

8.3.3 Impacts on Atlantic salmon in the Merrymeeting Bay SHRU and, consequently, the GOM DPS as a whole

In order to evaluate impacts of dam operations on the Merrymeeting Bay SHRU and the GOM DPS as a whole, I used five parameters related to the Worumbo Project, and these same parameters and conclusions are equally applicable to the Brunswick and Pejepscot projects as well.

1) **Percentage of the total habitat in comparison to the GOM DPS –** According to the NMFS (2009b), the Merrymeeting Bay SHRU comprises approximately 46% of the land area in the GOM DPS, with the Androscoggin River watershed contributing 33% of the total for the Merrymeeting Bay SHRU. Therefore, the Androscoggin River watershed has the potential to be a dominant contributor to recovery in the SHRU and the GOM DPS overall because of its land area and the quality of habitats suitable for Atlantic salmon upstream of the Lisbon Falls.

2) **Population diversity and stability –** The Androscoggin River watershed is the third largest in Maine that is part of the GOM DPS and contains a significant quantity of designated critical habitat. Historically, the Androscoggin, Kennebec, and Penobscot watersheds were the largest producers of Atlantic salmon in Maine, and probably the East Coast. These large watersheds provided a variety of habitats that have resulted in genetic diversity among watersheds and overall population stability because of the variety of habitats and life history strategies necessary for salmon to persist in them (National Research Council 2002, 2004; Fay et al. 2006; National Marine Fisheries Service and U.S. Fish and Wildlife Service 2009).

3) **Location of habitats suitable to promote recovery of the species –** The majority of habitats suitable to support Atlantic salmon spawning and juvenile rearing in the Androscoggin River watershed are located upstream of Lisbon Falls. Analysis of the biological value of habitats in the Androscoggin watershed shows the highest and second highest value habitats in the Androscoggin basin. (National Marine Fisheries Service (2009b). The NMFS analysis found that a majority of the habitat suitable to support the PCE requirements for spawning and rearing, and thus recovery, were upstream of the Brunswick Project.

4) **Blockage and/or delay to upstream migrating adult Atlantic salmon –** As demonstrated in various analyses I described earlier in this report, the Brunswick Project may directly block or delay adult upstream migrants because of the presence of its spillway section and the potential for adult fish to use the river channel north of Shad Island. Under flow levels where spill is occurring on the

north portion of the dam, adult fish may move towards this flow source. No fish passage facilities exist in this area of the Brunswick Project. No studies have documented whether or not adults are blocked or delayed because of their transit into this area of the Project. The fate of any fish that does not find the upstream fishway is unknown. I also conclude, given the configuration of the Pejepscot Project, that there is a low level of probability that some fish are unable to find the fish trap entrance at Pejepscot, but that probability is not zero. The probability of Atlantic salmon being blocked at the Worumbo Project is higher than at Pejepscot because of the configuration of the dam and the presence of essentially a second channel on the southwest portion of the Worumbo Project. This makes it more likely that fish may be attracted to this area and will not find the entrance to the Worumbo fish trap.

5) **Mortality rate of Atlantic salmon smolts and kelts passing downstream through Worumbo Project turbines –** Smolts and kelts moving downstream through the Worumbo Project are subject to mortality associated with passage through the Project's turbines. During periods of non-spill at downstream migration time periods (see analyses of these time periods above), fish are forced to pass via the Project's small and in my opinion ineffective downstream fishway or the project turbines. Immediate mortality of smolts passing through Kaplan type turbines is about 15%, while immediate mortality of kelts is about twice that rate (See Section 6.1 of this report for a review of turbine mortality studies). It is likely that additional salmon die as a result of delayed turbine mortality, and that other salmon suffer adverse impacts as a result of going over the spillway or through the bypass structures, but these percentages have not been quantified.

Given the impacts of these five factors on individual Atlantic salmon, the effects of the Worumbo Project on the spawning and rearing and migration PCE's, and the overall negative impact on the likelihood that the recovery criteria for the Merrymeeting Bay SHRU will be met, I conclude that the Worumbo Project, as it is currently structurally configured and operated is having a significant adverse impact on the Merrymeeting Bay SHRU and the GOM DPS as a whole.

8.3.4 Interim Measures

Any or all of the following measures would either reduce the harm to Atlantic salmon currently being caused by the dams in question or contribute to efforts at restoration of the species.

8.3.4.1 Interim Measures Applicable to All Projects on the Kennebec and Androscoggin rivers

A complete list of the interim measures applicable to all projects can be found in Section 7.1.4.1 of the Lockwood Project evaluation.

8.3.4.2 Additional Interim Measures Specifically for the Worumbo Project

A. Create an opening in the west turbine tailrace training wall to allow upstream migrating adult salmon swimming up the west side of the wall to cross over to the actual tailrace and find the upstream trapping facility.

9.0 Consequences of Delay in Requiring Improvements to Fish Passage

The Maine Department of Marine Resources (MDMR) has embarked on an aggressive egg planting program in the Sandy River, upstream of the four Hydro Kennebec Development Group dams, in order to “jump-start” restoration of Atlantic salmon in the Kennebec River watershed. From 2004 to 2007, an average of ~22,000 eggs was planted in the Sandy River. Beginning in 2008, the egg planting program has expanded by factors of 10-40X, with 245,000, 166,000, 567,000, and 900,000 eggs being planted in 2008-2011, respectively (Maine Department of Marine Resources 2011; Paul Christman, MDMR, pers. comm.). In addition, in 2011 over 60 adult Atlantic salmon were trapped at the Lockwood fish trapping facility and transported to the Sandy River. Assuming that approximately 25% of the 60 fish were females, based on the sex composition at the Lockwood trap, this equates to an additional 100,000 eggs being deposited in the Sandy River.

The consequence of increased egg plantings and the number of adults being released in the Sandy River is that more listed Atlantic salmon smolts and kelts will be moving downstream through the dams on the lower Kennebec River. In addition, given the age at maturity, adult fish from the 2008 increased egg planting could begin returning to Lockwood as early as spring 2012. Given the lack of adult upstream passage facilities and the poor location of the adult trap at Lockwood, it is my opinion that the full benefits of the egg planting and adult release programs will not be realized. Also, given the lack of effective barriers to keep smolts and kelts from entering project turbines and the general ineffectiveness of the currently installed downstream bypass systems, it is my opinion that there will be significant losses of Atlantic salmon at all four of the Kennebec dams. This situation will be particularly acute during low flow years when all of the river flow essentially passes through the project turbines or ineffective downstream fish bypass systems. In my opinion, any delay in immediately implementing improved upstream adult fish passage facilities and in greatly reducing the ability of smolts and kelts to enter the projects' turbines will only result in increased mortality or harm to listed species, and will effectively negate the current efforts to restore Atlantic salmon to the Kennebec River.

While the three dams in question on the Androscoggin River have all installed upstream adult passage facilities, only the Brunswick Project has a formal fishway constructed. The others have a trap, lift, and upstream conveyance channel. The trapping facilities all need to be evaluated in terms of their ability to handle ESA listed fish more effectively and with less harm. However, the critical issue with all three Androscoggin River projects is that it is currently unknown how effective these facilities are at passing adult Atlantic salmon upstream. There are potential problems with delay or blockage of migrating adults that have not been assessed. Given the physical configurations of all three dams, additional upstream passage facilities at other locations on each dam are warranted.

Generally the downstream bypass facilities at the Androscoggin dams are poorly located and inadequate to protect fish from entering the project turbines, resulting in higher mortality rates than is acceptable in terms of population recovery.

10.0 Comparison of Efforts Undertaken by, or Proposed for, Maine Dam Owners with Efforts Taken by Government Agencies and Dam Owners Elsewhere in the U.S.

I have been personally involved in watershed scale Pacific salmon and steelhead restoration efforts in the Columbia River, Klamath River, and Central Valley of California. My involvement has included: 1) development and implementation of site specific habitat restoration projects, 2) development of both small and large scale watershed restoration plans, 3) development and review of project effectiveness monitoring programs, and 4) evaluation of the effectiveness of hundreds of millions of dollars in project expenditures for restoration of habitats and populations of listed species.

Based on my experiences in the Western U.S., restoration of the various salmon populations began even before the fish were listed under ESA. Sport and commercial fishing groups, Native American tribes, resource agency staffs, and environmental groups all pushed to develop programs aimed specifically at restoring salmon habitats and populations along the West Coast. The Bonneville Power Administration in the Columbia River watershed has had a $700 million/yr. program for the past 30+ years. California passed a multi-billion dollar bond issue to fund restoration activities in the Central Valley. In addition, federal agencies such as the U.S. Bureau of Reclamation have been forced to acknowledge their responsibilities for salmon restoration through proactive agency response and court order. In the West, the question is not longer whether to restore anadromous fish populations, but rather how can it be done in the most efficient and cost effective manner. The public takes great pride in the restoration successes of the Redfish Lake sockeye salmon and winter-run Chinook salmon populations.

Comparing what I have seen in the documentation from the various studies and reports I reviewed from the Kennebec and Androscoggin rivers to what has happened in the West provides a "night and day" contrast. In Maine, I see a process that appears designed to delay the acquisition of the appropriate data, and studies designed with insufficient rigor and/or scope to answer the critical questions necessary to form the foundation of a real restoration program. Despite all of the positive words regarding restoration in the KHDG annual reports and all of the pronouncements in the results of the various studies conducted, the KHDG Settlement Agreement studies program comes down to the various dam owners asserting – in the white papers and biological assessment developed for the ESA incidental take permitting process – that no site-specific quantitative data exist at the various projects, and therefore data from other hydroelectric projects must be used to assess the projects' impacts. My conclusion, based on my experience and review of the documentation, is that there has been a concerted effort to *not* collect the appropriate data, despite numerous suggestions by resource agencies to the contrary, and it appears that the agency staff are not able to compel the scientifically rigorous studies needed to provide data to support a truly science-based restoration program.

Further, some of the obvious solutions to problems do not need study results to support an implementation program. The best example of this is the obvious need to provide effective upstream adult Atlantic salmon passage at the Weston, Shawmut, Hydro Kennebec, and Lockwood Projects. To assert that the current trap and truck program is adequate to provide upstream passage, or that the Lockwood Dam presents a total barrier to upstream adult Atlantic salmon passage under all flow conditions, borders on the absurd. In my opinion, the restoration program at the dams that are the subject of this litigation has been underfunded, plagued by poor quality scientific studies, and has accomplished much less than should have been achieved since 1998 on the Kennebec River.

Randy Bailey

______________________________ January 16, 2012

Randy Bailey

References

Barrick, D. H. and L. E. Miller. 1990. Effectiveness of an electrical barrier in blocking fish movements. Research Report PES/90-07. Production Environmental Services, Duke Power Company, Huntersville, NC

Fay C., M. Bartron, S. Craig, A. Hecht, J. Pruden, R. Saunders, T. Sheehan, and J. Trial. 2006. Status review for anadromous Atlantic salmon (S*almo salar*) in the United States. Report to the National Marine Fisheries Service and U.S. Fish and Wildlife Service.

FPL Energy Maine Hydro, LLC. 2007. Diadromous fish passage report for the lower Kennebec River watershed during the 2006 migration season. FPL Energy Maine Hydro, LLC.

FPL Energy Maine Hydro, LLC. 2008a. Diadromous fish passage efforts for the lower Kennebec River watershed during the 2007 migration season. FPL Energy Maine Hydro, LLC.

FPL Energy Maine Hydro, LLC. 2008b. Transmittal letter and response to agency comments on the 2007 Kennebec River Diadromous Fish Restoration Annual Reports to Kimberly D. Bose, Secretary, Federal Energy Regulatory Commission, dated June 4, 2008.

Holbrook, C. M., M. T. Kinnison, and J. Zydlewski. 2011. Survival of migrating Atlantic salmon smolts through the Penobscot River, Maine: a prerestoration assessment. Transactions of the American Fisheries Society 140: 1255-1268.

Hydro Kennebec, LLC. 2011. Hydro Kennebec Project, FERC No. 2611 draft biological assessment for Gulf of Maine Distinct Population Segment of Atlantic salmon. Hydro Kennebec, LLC, Winslow, ME. (Note: this document is under a court protective order).

Kircheis, D. and T. Liebich. 2007. Draft report on: Habitat requirements and management considerations for Atlantic salmon (*Salmo salar*) in the Gulf of Maine Distinct Population Segment (DPS). NOAA-Fisheries, Northeast Region Protected Resources Division. Gloucester, MA

Madison Paper Industries. 2009. Hydro Kennebec Project, FERC NO. 2611 2008 study evaluating interim downstream fish passage effectiveness final report. Package includes the final report and the initial study plan (Appendix A), plus transmittal correspondence. Madison Paper Industries, Madison, Maine

Madison Paper Industries. 2010. Hydro Kennebec Project (FERC NO. 2611) 2009 Downstream Atlantic salmon smolt passage study. Draft report. Madison Paper Industries, Madison, Maine.

Maine Department of Marine Resources. 2009. Kennebec River anadromous fish restoration: annual progress report – 2008. Bureau of Sea-Run Fisheries and Habitat. Augusta, Maine.

Maine Department of Marine Resources. 2010. Kennebec River anadromous fish restoration: annual progress report – 2009. Bureau of Sea-Run Fisheries and Habitat. Augusta, Maine.

Maine Department of Marine Resources. 2011a. 2010 Brunswick Fishway Report. Bureau of Sea-Run Fisheries and Habitat. Augusta, Maine.

Maine Department of Marine Resources. 2011b. Kennebec River anadromous fish restoration: annual progress report – 2010. Bureau of Sea-Run Fisheries and Habitat. Augusta, Maine.

McCaw, D. E., P. M. Christman, C. A. King, and J. E. Overlock. 2009. 2008-2009 Kennebec River radio telemetry study. Included as part of Appendix E in the Kennebec River anadromous fish restoration annual report. Bureau of Sea-Run Fisheries and Habitat, Maine Department of Marine Resources. Hallowell, Maine.

National Marine Fisheries Service. 2009a. Designation of critical habitat for Atlantic salmon (*Salmo salar*) in the Gulf of Maine Distinct Population Segment: Final ESA Section 4(b)(2) report. Northeast Region, National Marine Fisheries Service. Gloucester, MA.

National Marine Fisheries Service. 2009b. Biological valuation of Atlantic salmon habitat within the Gulf of Maine Distinct Population Segment. Northeast Region, National Marine Fisheries Service. Gloucester, MA.

National Marine Fisheries Service and U.S. Fish and Wildlife Service. 2009. Endangered and threatened species; determination of endangered status for the Gulf of Maine Distinct Population Segment of Atlantic salmon; Final Rule. June 19, 2009. 74 Federal Register: 29344-29387.

National Marine Fisheries Service, Maine Department of Marine Resources, U.S. Fish and Wildlife Service, and Penobscot Indian Nation. 2010. Atlantic salmon recovery framework: August 2010 draft.

National Research Council. 2002. Genetic status of Atlantic salmon in Maine: Interim Report from the Committee on Atlantic Salmon in Maine. Committee on Atlantic Salmon in Maine, Board on Environmental Studies and Toxicology, Ocean Studies Board. National Research Council, National Academy of Sciences.

National Research Council. 2004. Atlantic salmon in Maine. Committee on Atlantic Salmon in Maine, Board on Environmental Studies and Toxicology, Ocean Studies Board, Division on Earth and Life Sciences. National Research Council, National Academy of Sciences.

NextEra™ Energy Maine Operating Services, LLC. 2009. NextEra diadromous fish passage report for the lower Kennebec River watershed during the 2008 migration season. NextEra™ Energy Maine Operating Services, LLC. Hallowell, Maine.

NextEra™ Energy Maine Operating Services, LLC. 2010. NextEra diadromous fish passage report for the lower Kennebec River watershed during the 2009 migration season. NextEra™ Energy Maine Operating Services, LLC. Hallowell, Maine.

NextEra™ Energy Maine Operating Services, LLC. 2011. NextEra diadromous fish passage report for the lower Kennebec River watershed during the 2010 migration season. Includes: transmittal correspondence and agency comments. NextEra™ Energy Maine Operating Services, LLC. Hallowell, Maine.

Normandeau Associates, Inc. 2011b. A review of the effects of the Lockwood Project on the Kennebec River, Maine on Atlantic salmon (Salmo salar) smolt and kelt downstream passage and adult upstream passage. August 2011 Draft White Paper prepared for The Merimil Limited Partnership, Hallowell, Maine.

Normandeau Associates, Inc. 2011c. Downstream bypass effectiveness for the passage of Atlantic salmon smolts at the Lockwood Project (FERC Project No. 2574, Kennebec River, Maine. Report prepared for The Merimil Limited Partnership, Hallowell, Maine. NOTE: Contains Lockwood portion of the data for the concurrent Hydro Kennebec study and is under a court protective order.

Normandeau Associates, Inc. 2011d. Downstream bypass effectiveness for the passage of Atlantic salmon smolts at the Hydro-Kennebec Project, Kennebec River, Maine. Report prepared for Great Lakes Hydro America, LLC. Millinocket, Maine.

Normandeau Associates, Inc. 2011e. A review of the effects of the Lockwood Project on the Kennebec River, Maine on Atlantic salmon (Salmo salar) smolt and kelt downstream passage and adult upstream passage. December 2011 Draft White Paper prepared for The Merimil Limited Partnership, Hallowell, Maine. Note: this document is under a court protective order.

Normandeau Associates, Inc. 2011f. A review of the effects of the Shawmut Project on the Kennebec River, Maine on Atlantic salmon (Salmo salar) smolt and kelt downstream passage and adult upstream passage. December 2011 Draft White Paper prepared for FPL Energy Maine Hydro, LLC., Hallowell, Maine. Note: this document is under a court protective order.

Normandeau Associates, Inc. 2011g. A review of the effects of the Weston Project on the Kennebec River, Maine on Atlantic salmon (Salmo salar) smolt and kelt downstream passage and adult upstream passage. December 2011 Draft White Paper prepared for FPL Energy Maine Hydro, LLC., Hallowell, Maine. Note: this document is under a court protective order.

Normandeau Associates, Inc. 2011h. Submission 00003964 from Normandeau Associates, Inc. which is an Excel spreadsheet containing characteristics of the turbines found at the Lockwood, Shawmut, Weston, and Brunswick projects.

Normandeau Associates, Inc. 2011i. A review of the Brunswick Project on the Androscoggin River, Maine on Atlantic salmon (Salmo salar) smolt and kelt downstream passage and adult upstream passage. August 2011 Draft White Paper prepared for FPL Energy Maine Hydro, LLC., Hallowell, Maine.

Normandeau Associates, Inc. and FPL Energy Maine Hydro, LLC. 2008b. Evaluation of Atlantic salmon kelt downstream passage at the Lockwood Project Kennebec River, Maine. Report to FPL Energy Maine Hydro, LLC. Lewiston, Maine.

Normandeau Associates, Inc. and FPL Energy Maine Hydro, LLC. 2008c. Evaluation of adult river herring and American shad downstream passage at the Lockwood Project Kennebec River, Maine. Report to FPL Energy Maine Hydro, LLC. Lewiston, Maine.

Normandeau Associates, Inc. and FPL Energy Maine Hydro, LLC. 2008d. Evaluation of Atlantic salmon smolt downstream passage at the Lockwood Project Kennebec River, Maine. Report to FPL Energy Maine Hydro, LLC. Lewiston, Maine.

Normandeau Associates, Inc. and FPL Energy Maine Hydro, LLC. 2008e. Evaluation of silver American eel downstream passage at the Shawmut Project, Kennebec River, Maine. Report to FPL Energy Maine Hydro, LLC. Lewiston, Maine.

Normandeau Associates, Inc. and FPL Energy Maine Hydro, LLC. 2008g. Upstream passage evaluation of the Weston Project eelway (FERC No. 2325). Report to FPL Energy Maine Hydro, LLC. Lewiston, Maine.

Normandeau Associates, Inc. and FPL Energy Maine Hydro, LLC. 2009a. Evaluation of silver American eel downstream passage at the Shawmut Project, Kennebec River, Maine. Report to FPL Energy Maine Hydro, LLC. Lewiston, Maine.

Normandeau Associates, Inc. and NextEra™ Energy Maine Operating Services, LLC. 2009b. Evaluation of silver American eel downstream passage at the Weston Project, Kennebec River, Maine. Report to NextEra™ Energy Maine Operating Services, LLC. Augusta, Maine.

Palmisano, A. D. and C. V. Burger. 1988. Use of a portable electric barrier to estimate Chinook salmon escapement in a turbid Alaskan river. North American Journal of Fisheries Management 8:475-480.

Robson, A., I. G. Cowx, and J. PL. Harvey. 2011. Impact of run-of river hydro-schemes upon fish populations: Phase I literature review. Report prepared for the Scotland & Northern Ireland Forum for Environmental Research. Edinburgh, Scotland, UK.

S. P. Cramer and Associates, Inc. 1993. Biological assessment for evaluation of sound and electrical guidance systems at the Wilkins Slough Diversion operated by Reclamation District 108. Report prepared for Reclamation District 108, Grimes, CA

Stone & Webster Environmental Services. 1992. Fish entrainment and turbine mortality review and guidelines. EPRI Research Project No. 2694-01. EPRI Product ID: TR-101231. Palo Alto CA.

Winchell, F. C. and S. V. Amaral. 1997. Turbine entrainment and survival database - field tests. Report and database prepared by Alden Research Laboratories, Inc. for the Electric Power Research Institute, Palo Alto, CA. EPRI Report: TR-108630.

U.S. Atlantic Salmon Assessment Committee. 2011. Annual report of the U.S. Atlantic Salmon Assessment Committee. Report 23-2010 Activities. U.S. Atlantic Salmon Assessment Committee.