Friends of Merrymeeting Bay

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Comments on Kennebec Dam DEIS

6/4/24

VIA E-FILING

Debbie-Ann A. Reese, Acting Secretary
Federal Energy Regulatory Commission
888 First Street, N.E., Room 1A
Washington, DC 20426

Re: **DRAFT ENVIRONMENTAL IMPACT STATEMENT FOR AMENDMENT OF LICENSES TO INCORPORATE AN INTERIM SPECIES PROTECTION PLAN FOR THE SHAWMUT PROJECT AND A FINAL SPECIES PROTECTION PLAN FOR THE WESTON, LOCKWOOD, AND HYDRO KENNEBEC PROJECTS; AND THE RELICENSING OF THE SHAWMUT PROJECT:**

SHAWMUT, WESTON, LOCKWOOD, AND HYDRO KENNEBEC HYDROELECTRIC PROJECTS
FERC Nos. 2322-069, -071; 2325-100; 2574-092; and 2611-091

Dear Acting Secretary Reese,

Friends of Merrymeeting Bay (FOMB) submit the following Comment in the titled proceeding.

Comments:
On January 31, 2011, Friends of Merrymeeting Bay (FOMB) and Environment Maine filed lawsuits in US District Court (Maine) against owners of all dams on the lower Kennebec and Androscoggin Rivers for violating take provisions of the Endangered Species Act (ESA) and in some cases for violating the Clean Water Act given non-compliance with their Water Quality Certifications (WQC) for salmon and shad passage. At the time NextEra owned Weston, Shawmut and with Merimil, Lockwood while Brookfield owned HydroKennebec.

At the time, dam removal was not on the table for Shawmut given its term of licensure so our claims (Appendices 3 and 4) and expert opinions (Appendices 5, 6 [Bailey and Hutchings-biological impacts of dams on the GOM DPS] and 7 [Chang-economic impacts of hydropower and seasonal closures for passage]) focused on improvements that could be made with the dams in place.

Thirteen years later, fish passage conditions remain much the same despite a certain amount of studies. Any artificial fish passage requires a good deal of human intervention and management, hence dam removal is always the better option to maximize river restoration and one FOMB recommends particularly since alternative and cleaner forms of power, particularly solar, are now more readily available.

As FERC is well aware, subject Kennebec River dams harass, harm, and kill –and thus “take” – Atlantic salmon in a number of ways. Among these are the following:

a. The dams’ turbines kill and injure out-migrating salmon (and other diadromous species) when the salmon and others attempt to pass through them. (See Shawmut eel photos Appendix 1)

b. The dams severely limit upstream passage of salmon and other diadromous species, preventing access to significant amounts of spawning and rearing habitat.

c. Facilities meant to allow the salmon and other diadromous species to pass around or through the dams cause delays in passage, resulting in incremental losses of salmon smolts, pre-spawn adults, and adults.

d. The dams are barriers to the migration of other fish species whose presence is optimally necessary for the salmon to complete their life cycle.

e. Turbine mortality of out-migrating eels at dams releases large amounts of organochlorines and other contaminants that would otherwise be carried out of our rivers. (See Appendix 2-Chart showing PCB levels in silver eels out-migrating through Benton Falls dam on the Sebasticook River)

f. The dams adversely alter predator-prey assemblages, such as the ability of the salmon to detect and avoid predators.

g. The dams create slow-moving impoundments in formerly free-flowing reaches. These altered habitats are less suitable for spawning and rearing of salmon and contribute to the dams’ significant impairment of essential behavior patterns of the salmon. In addition, these conditions may favor non-native competitors at the expense of the native salmon.

h. The dams result in adverse hydrological changes, adverse changes to stream and river beds, interruption of natural sediment and debris transport, and changes in water temperature, all of which contribute to the dams’ significant impairment of essential behavior pattern for salmon and other diadromous species.

In their decision to include the Kennebec and Androscoggin River populations of Atlantic salmon on the Endangered Species List, the Services (NMFS and USFWS) found dams on those rivers play a major role in imperiling the salmon. The Services stated: “*The National Research Council stated in 2004 that the greatest impediment to self-sustaining Atlantic salmon populations in Maine is obstructed fish passage and degraded habitat caused by dams … Dams are known to typically kill or injure between 10 and 30 percent of all fish entrained at turbines [cite omitted]. With rivers containing multiple hydropower dams, these cumulative losses could compromise entire year classes of Atlantic salmon … Thus, cumulative losses at passage facilities can be significant … Dams remain a direct and significant threat to Atlantic salmon.*” 74 Fed. Reg. at 29362.

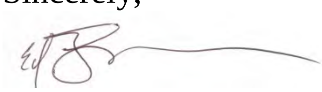
Similarly, the Services stated: "*Dams are among the leading causes of both historical declines and contemporary low abundance of the GOM DPS of Atlantic salmon [cite omitted]*." The Services also stated that the *"effects [of dams] have led to a situation where salmon abundance and distribution has been greatly reduced, and thus the species is more vulnerable to extinction … Therefore, dams represent a significant threat to the survival and recovery of the GOM DPS*." 74 Fed. Reg. at 29366-29367.

In the DEIS Summary section at 416 the Commission states: "*Overall, while dam removal would result in greater improvement of upstream and downstream passage survival for Atlantic salmon, alosines, American eel, and sea lamprey than relicensing the project, the upstream and downstream fish passage measures included in the Staff Alternative with mandatory conditions would nevertheless sufficiently enhance fish passage over existing conditions without the need to remove the dam*."

And yet, the Commission DEIS recommends neither dam removal or the Staff Alternative with Mandatory Conditions, instead opting for a straightforward Staff Alternative. The implication

from these contradictory conclusions and recommendations is that FERC is not only rejecting Shawmut dam removal as recommended by various conservation groups, MDMR and NMFS but is also opting for less than sufficient improvements in fish passage by recommending the Staff Alternative rather than the Staff Alternative with Mandatory Conditions which would in theory "sufficiently enhance fish passage over existing conditions…" Could the existing conditions bar be set any lower?

Sincerely,



Ed Friedman, Chair
207-666-3372

Enclosure:

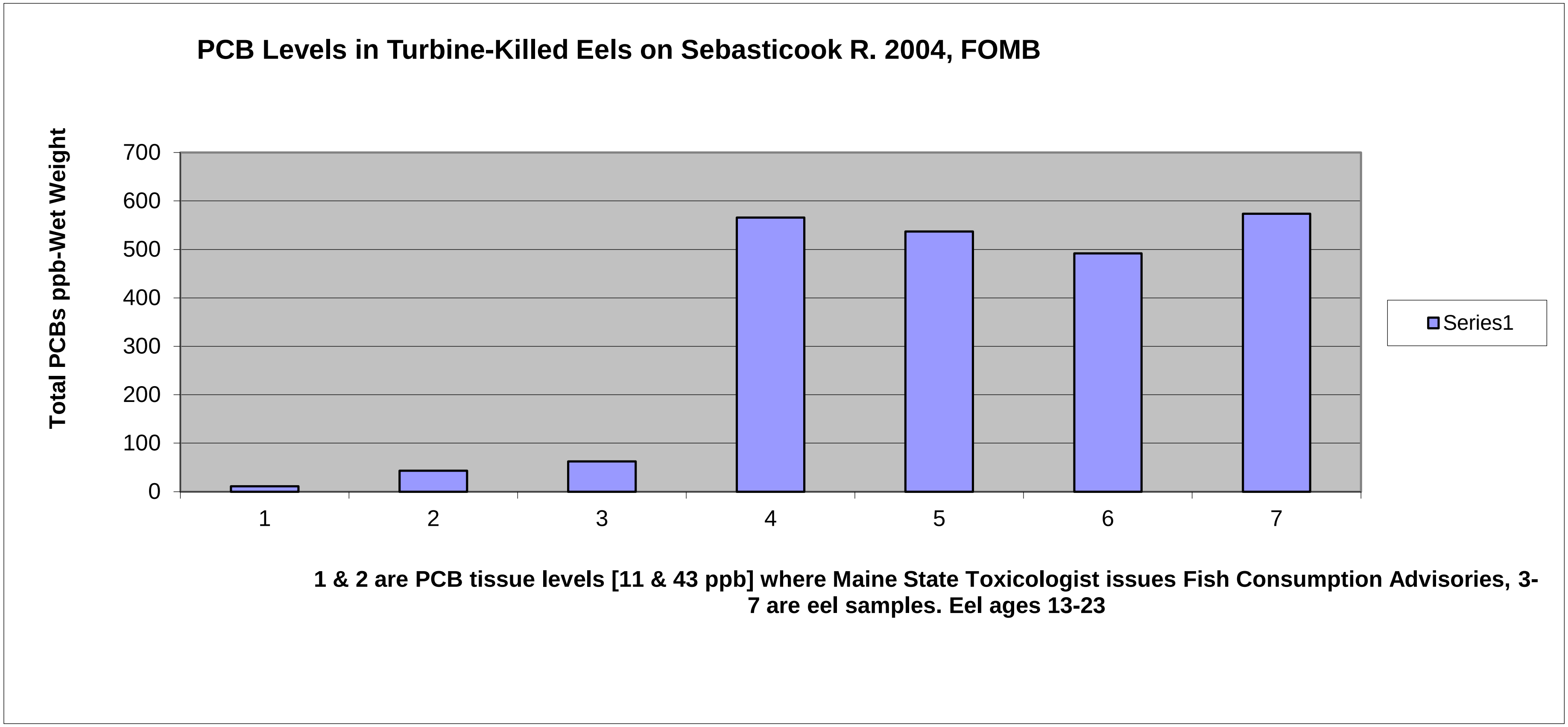
Founded in 1975, Friends of Merrymeeting Bay (FOMB) utilizes research, education, advocacy, and land conservation to preserve, protect, and improve the unique ecosystems of Merrymeeting Bay. Diadromous fish restoration in the Bay and Gulf of Maine is an important focus of the group.

FOMB Kennebec Appendix 1

P-2322-069 Photos: MDMR

FOMB Kennebec Appendix 2

P-2322-069



UNITED STATES DISTRICT COURT
DISTRICT OF MAINE

FRIENDS OF MERRYMEETING BAY and
ENVIRONMENT MAINE,

Plaintiffs,

v.

BROOKFIELD RENEWABLE POWER, INC.
and HYDRO KENNEBEC, LLC,

Defendants.

Civil Action No.

COMPLAINT

INTRODUCTION

1. Defendants Brookfield Renewable Power, Inc. and Hydro Kennebec LLC are violating the federal Endangered Species Act ("ESA"), 16 U.S.C. § 1531 *et seq.*, by killing, harming, and harassing endangered Atlantic salmon at their Hydro Kennebec hydroelectric dam on the Kennebec River. Defendants are, in ESA parlance, illegally "taking" this endangered species. More specifically, Defendants' dam: kills and injures salmon with its rotating turbine blades when the fish try to pass through them; impedes upstream and downstream salmon passage, which prevents salmon from gaining access to significant amounts of spawning and rearing habitat; alters the natural habitat to such a degree that the essential behavior patterns of the fish are significantly impaired; and has other deleterious effects on the salmon.

2. The ESA allows the National Marine Fisheries Service ("NMFS") and United States Fish and Wildlife Service ("USFWS") (collectively, the "Services"), under certain

circumstances, to authorize an otherwise prohibited taking of an endangered species if such taking is "incidental" to, and not the purpose of, the carrying out of an otherwise lawful activity. 16 U.S.C. § 1539(a)(1)(B). Defendants do not have authorization from the Services to commit an "incidental take" of salmon at Hydro Kennebec dam.

3. Defendants are also violating the federal Clean Water Act ("CWA") water quality certification issued for their Kennebec River dam. This certification prohibits Defendants from allowing downstream-migrating adult salmon and adult shad to pass through the turbines of the dam unless Defendants have conducted a studies proving that such passage does not result in significant injury or mortality. Although Defendants are allowing adult salmon and adult shad to pass through their turbines, they have not conducted the requisite study. Plaintiffs believe such a study would show that turbine passage results in significant injury and mortality, as other studies have shown.

4. Neither the federal nor state government has taken enforcement action against Defendants to redress these violations. However, Congress authorized citizens to bring "citizen suits" in United States District Courts to enforce the ESA and CWA directly against violators. 16 U.S.C. § 1540(g) (ESA citizen suit provision); 33 U.S.C. § 1365 (CWA citizen suit provision).

5. Defendants' dam is a major reason the Kennebec population of salmon has declined to perilously low levels. Although they have long been aware of this fact, Defendants have not taken a number of basic, feasible steps, such as keeping fish from swimming into their spinning turbine blades, that would reduce the detrimental effects of their dam on this endangered population. Without a court order directing them to so,

Defendants will not comply expeditiously with the ESA and with their CWA water quality certification.

PARTIES

6. Plaintiff Friends of Merrymeeting Bay ("FOMB") is a non-profit Maine corporation with over 400 members. FOMB is dedicated to preserving the ecological, aesthetic, historical, recreational, and commercial values of Maine's Merrymeeting Bay and its watershed, which includes the Kennebec River. FOMB accomplishes its mission through research, advocacy, land conservation, education, and litigation.

7. Plaintiff Environment Maine is a non-profit Maine corporation. It is a statewide environmental organization that advocates for clean air, clean water, and preservation of Maine's natural resources on behalf of approximately 3,460 citizen members from across the state of Maine. Among other activities, Environment Maine researches and distributes analytical reports on environmental issues, advocates before legislative and administrative bodies, engages in litigation when necessary, and conducts public education.

8. Defendant Brookfield Renewable Power, Inc. ("Brookfield"), either in its own name or through a subsidiary, owns and operates Hydro Kennebec dam on the Kennebec River. Brookfield operates, and exercises fundamental control over, this dam. www.brookfieldpower.com/_Global/5/documents/relatedlinks/1699.pdf. Brookfield is itself a wholly-owned subsidiary of Brookfield Asset Management, a Toronto-based conglomerate.

9. The Federal Energy Regulatory Commission ("FERC") license for Hydro Kennebec dam is in the name of defendant Hydro Kennebec LLC. Hydro Kennebec LLC operates Hydro Kennebec dam.

JURISDICTION AND VENUE

10. Subject matter jurisdiction is conferred upon this Court by 16 U.S.C. § 1540(g)(1) (ESA citizen suit provision), 33 U.S.C. § 1365(a) (CWA citizen suit provision), and 28 U.S.C. § 1331 (federal question jurisdiction). Venue lies within this District pursuant to 16 U.S.C. § 1540(g)(3)(A) (ESA venue provision), 33 U.S.C. 1365(c)(1) (CWA venue provision), and 28 U.S.C. § 1391(e) (federal venue provision).

11. Plaintiffs gave Defendants notice of the violations alleged in this Complaint more than 60 days prior to commencement of this lawsuit by a letter addressed and mailed to: Brookfield's Chief Operating Office for U.S. Operations, Kim Osmars, and the Managers of Brookfield New England and Hydro Kennebec LLC, Craig Laurie and Mark Brown. A copy of this letter is attached as Exhibit 1 and incorporated by reference herein. Copies of the notice letter were mailed to (a) Defendants' registered agents, (b) the Secretaries of Commerce and Interior, (c) the Administrator of the U.S. Environmental Protection Agency ("EPA") and the Regional Administrator of the EPA for New England, (d) the Acting Commissioner of the Maine Department of Environmental Protection, and (e) Brian Stetson of Brookfield. The notice letters satisfy the pre-suit notice requirements of 16 U.S.C. 1540 § (g)(2)(A)(i) (ESA) and 33 U.S.C. § 1365(b)(1)(A) (CWA).

FACTUAL BACKGROUND

The Life Cycle Of Atlantic Salmon.

12. Atlantic salmon are anadromous, meaning they are born in fresh water, migrate to the ocean, and then return to fresh water to spawn.

13. In late autumn, female Atlantic salmon deposit eggs in a series of nests (called "redds") in a stream or river bed. Once the eggs are fertilized by spawning adult male salmon, the female salmon uses her tail to cover those eggs with gravel. After spawning, adult salmon, called "kelts," return to the ocean in early winter or the following spring. Eggs hatch in March or April; at this point the newborn fish are referred to as "alevin" or "sac fry." Three to six weeks after hatching, alevins emerge from their redds seeking food, and are at that point called "fry." Fry quickly develop into "parr," with camouflaging vertical stripes. They feed and grow for one to three years in their native streams or rivers before becoming "smolts." Smolts are silver colored and approximately six inches long. In the spring, the body chemistry of smolts change and they are able to enter salt water. Smolts migrate to the ocean where they develop over two to three years into mature salmon weighing 8 to 25 pounds. Mature adult salmon begin returning in the spring to their native streams to repeat the spawning cycle. Atlantic salmon are capable of spawning and completing this cycle several times.

There Are Almost No Atlantic Salmon Returning To The Kennebec River.

14. The Maine Atlantic Salmon Commission ("MASC") monitors the abundance and status of Atlantic salmon in many Maine rivers. On the Kennebec River, MASC traps and counts returning adult salmon at the lower-most dam, Lockwood dam. This trapping and counting is conducted annually, typically between May and November.

15. Historically, the Kennebec and Androscoggin Rivers, which share a common estuary, Merrymeeting Bay, had the largest Atlantic salmon runs in the United States, estimated at more than 100,000 adults each year. Now, according to the recent annual surveys done by MASC, the number of adult Atlantic salmon returning to the Kennebec River each year is dangerously low. In 2010, 5 adult salmon returned to the Kennebec River; in 2009, 29 returned; in 2008, 22 returned; in 2007, 16 returned; in 2006, 15 returned.

COUNT I
DEFENDANTS ARE VIOLATING
THE ENDANGERED SPECIES ACT

16. Plaintiffs reallege and incorporate by reference paragraphs 1 through 15.

The Kennebec Population Of Atlantic Salmon
Is On The Endangered Species List.

17. In enacting the Endangered Species Act, Congress expressly found that species of fish, wildlife, and plants in danger of or threatened with extinction are of "esthetic, ecological, educational, historical, recreational, and scientific value to the Nation and its people." 16 U.S.C. § 1531(a)(3). Congress stated that the purposes of the ESA "are to provide a means whereby the ecosystems upon which endangered species and threatened species depend may be conserved [and] to provide a program for the conservation of such endangered and threatened species…" 16 U.S.C. § 1531(b). By enacting the Endangered Species Act, Congress intended protection of endangered species to be afforded the highest of priorities. Under the ESA, an "endangered species" is a species of animal or plant (other than certain dangerous insect pests) which is in danger of extinction throughout all or a significant portion of its range. 16 U.S.C. § 1532(6).

18. The Secretary of Commerce (for endangered species in the ocean) and the Secretary of the Interior (for all other species) are responsible for administering and implementing the ESA, with the Services acting on their behalf. Because Atlantic salmon are anadromous, the Secretaries (and thus the Services) share responsibility for managing the protection of these fish under the ESA.

19. In 2000, the Services issued a rule listing the Gulf of Maine Distinct Population Segment ("GOM DPS") of Atlantic salmon as "endangered" because it is in danger of becoming extinct. At that time, the Services included the salmon populations of seven rivers in Down East Maine in the description of the endangered GOM DPS, but did not include the Kennebec River salmon population in this listing.

20. In 2005, Plaintiff Friends of Merrymeeting Bay, Douglas Watts (a member of Plaintiff FOMB) and others filed a petition with the Services asking them to include Kennebec salmon in the GOM DPS. Although a federal "biological review team" found that the Kennebec salmon population should be included in the GOM DPS, along with the Androscoggin and Penobscot River salmon populations, and published this finding in the "2006 Status Review for Anadromous Atlantic Salmon in the United States," by mid-2008 the Services still had not ruled on the petition. On May 12, 2008, Mr. Watts, FOMB, and other conservation groups sued the Services to obtain a ruling on the petition. On September 3, 2008, the Services did rule on the petition, proposing to include the Kennebec, Androscoggin, and Penobscot River salmon populations in the GOM DPS. 73 Fed. Reg. 51,415 (September 3, 2008). On June 19, 2009, the Services issued a final rule including the salmon populations of all three rivers in the listed GOM DPS, thereby

formally designating these populations as endangered under the ESA. 74 Fed. Reg. 29,344 (June 19, 2009).

21. On that same day, NMFS issued a final rule designating "critical habitat" for the Kennebec, Androscoggin, and Penobscot salmon – *i.e.*, habitat "essential to the conservation of the species" and "which may require special management considerations or protection." 16 U.S.C. § 1532(5)(A)(i). The portion of the Kennebec River where Hydro Kennebec dam is located and those portions affected by the dam are part of that critical habitat. 74 Fed. Reg. 29,300 (June 19, 2009).

"Take" Of An Endangered Species Is Prohibited
By The Endangered Species Act.

22. Section 9 of the ESA makes it unlawful for any person to "take" an endangered species unless authorized to do so by the federal government. 16 U.S.C. § 1538(a)(1)(b).

23. Under the ESA, the term "take" means "to harass, harm, pursue, hunt, shoot, kill, trap, or collect, or to attempt to engage in any such conduct." 16 U.S.C. § 1532(19). By USFWS regulation:

> Harass in the definition of "take" in the Act means an intentional or negligent act or omission which creates the likelihood of injury to wildlife by annoying it to such an extent as to significantly disrupt normal behavioral patterns which include, but are not limited to, breeding, feeding, or sheltering. [and]
>
> Harm in the definition of "take" in the Act means an act which actually kills or injures wildlife by significantly impairing essential behavioral patterns, including breeding, feeding, or sheltering.

50 C.F.R. § 17.3.

24. A NMFS regulation further defines "harm" as including habitat modification where a causal link is established between such modification and injury or death of a

listed species. 40 C.F.R. § 222.102. In publishing that rule, NMFS listed the following among its examples of activities that may modify habitat and thus cause a take:

> 1. Constructing or maintaining barriers that eliminate or impede a listed species' access to habitat or ability to migrate;
>
> * * *
>
> 4. Removing or altering rocks, soil, gravel, vegetation or other physical structures that are essential to the integrity and function of a listed species' habitat;
>
> * * *
>
> 5. Removing water or otherwise altering streamflow when it significantly impairs spawning, migration, feeding or other essential behavior patterns; [and]
>
> * * *
>
> 7. Constructing or operating dams or water diversion structures with inadequate fish screens or fish passage facilities in a listed species' habitat…

64 Fed. Reg. 60,727, 60,730 (Nov. 8, 1999).

25. When a federally licensed activity – such as operating a hydroelectric dam – causes a take, the licensee may receive authorization under the ESA to continue the activity in one of two ways. One is to apply for and obtain an "incidental take permit" ("ITP") pursuant to Section 10 of the ESA, 16 U.S.C § 1539. The other is to obtain an "incidental take statement" ("ITS") pursuant to Section 7 of the ESA, 16 U.S.C. §1536; *see* 50 C.F.R. § 402.14. A take is considered "incidental" when the purpose of the activity is not to take an endangered species, but rather to conduct some otherwise lawful activity that incidentally results in a take. 16 U.S.C. § 1539(a)(1)(B); 50 C.F.R. § 402.02. An ITP can require that the holder of the ITP "minimize and mitigate the impacts of" the taking "to the maximum extent practicable." 16 U.S.C. § 1539(a)(2) (B)(2). Similarly, an ITS can require that "reasonable and prudent measures" be taken to "minimize" the impact of a take. 16 U.S.C. § 1536(b)(4)(ii). An ITP is not authorized unless certain

specified conditions are met. Among these is that the take "will not appreciably reduce the likelihood of survival and recovery of the species in the wild." 16 U.S.C. § 1539(a)(2)(B)(4). Similarly, an ITS is not authorized if the licensed activity is "likely to jeopardize the continued existence of any endangered species…or result in the destruction or adverse modification of habitat [critical to the species]…" 16 U.S.C. § 1536(a)(2) and (b)(4)(B).

26. The citizen suit provision of the ESA grants jurisdiction to United States District Courts to issue orders enjoining violations of the Act (such as the unauthorized taking of an endangered species) and authorizes an award of costs of litigation (including reasonable attorney and expert witness fees). 16 U.S.C. § 1540(g)(1) and (4).

Defendants Are Taking Atlantic Salmon
In Violation Of Section 9 Of The ESA.

27. Defendants' Hydro Kennebec dam harasses, harms, and kills – and thus "takes" – Atlantic salmon in a number of ways. Among these are the following:

a. The dam's turbines kill and injure out-migrating salmon when the salmon attempt to pass through them.

b. The dam severely limits upstream passage of salmon, preventing access to significant amounts of spawning and rearing habitat.

c. Facilities meant to allow the salmon to pass around or through the dam cause delays in passage, resulting in incremental losses of salmon smolts, pre-spawn adults, and adults.

d. The dam is a barrier to the migration of other fish whose presence is necessary for the salmon to complete their life cycle.

e. The dam adversely alters predator-prey assemblages, such as the ability of the salmon to detect and avoid predators.

f. The dam creates slow-moving impoundments in formerly free-flowing reaches. These altered habitats are less suitable for spawning and rearing of salmon and contribute to the dam's significant impairment of essential behavior patterns of the salmon. In addition, these conditions may favor non-native competitors at the expense of the native salmon.

g. The dam results in adverse hydrological changes, adverse changes to stream and river beds, interruption of natural sediment and debris transport, and changes in water temperature, all of which contribute to the dam's significant impairment of essential behavior patterns.

28. Defendants have neither an incidental take permit nor an incidental take statement authorizing their take of Atlantic salmon at Hydro Kennebec dam. Defendants' take of Atlantic salmon therefore violates Section 9(a)(1)(B) of the ESA, 16 U.S.C. § 1538(a)(1)(B). Defendants have been violating the Section 9 take prohibition since the day Kennebec salmon were included in the GOM DPS and thus designated as endangered under the ESA.

29. In their decision to include the Kennebec River population of Atlantic salmon on the Endangered Species List, the Services found dams on that river play a major role in imperiling the salmon. The Services stated: "The National Research Council stated in 2004 that the greatest impediment to self-sustaining Atlantic salmon populations in Maine is obstructed fish passage and degraded habitat caused by dams … Dams are known to typically kill or injure between 10 and 30 percent of all fish entrained at

turbines [cite omitted]. With rivers containing multiple hydropower dams, these cumulative losses could compromise entire year classes of Atlantic salmon … Thus, cumulative losses at passage facilities can be significant … Dams remain a direct and significant threat to Atlantic salmon." 74 Fed. Reg. at 29362. Similarly, the Services stated: "Dams are among the leading causes of both historical declines and contemporary low abundance of the GOM DPS of Atlantic salmon [cite omitted]." The Services also stated that the "effects [of dams] have led to a situation where salmon abundance and distribution has been greatly reduced, and thus the species is more vulnerable to extinction … Therefore, dams represent a significant threat to the survival and recovery of the GOM DPS." 74 Fed. Reg. at 29366-29367.

COUNT II
DEFENDANTS ARE VIOLATING
THE CLEAN WATER ACT WATER QUALITY CERTIFICATION

30. Plaintiffs reallege and incorporate by reference paragraphs 1 through 29.

Clean Water Act Water Quality Certifications Are Designed To Maintain Compliance With Water Quality Standards.

31. Congress declared the objective of the Clean Water Act "is to restore and maintain the chemical, physical, and biological integrity of the Nation's waters." 33 U.S.C. § 1251(a).

32. Under Section 401 of the CWA, 33 U.S.C. § 1341, hydroelectric dams must obtain a state "water quality certification" before they may obtain a license to operate from the Federal Energy Regulatory Commission. This water quality certification becomes a condition of the FERC license. 33 U.S.C. § 1341(d).

33. A water quality certification must contain conditions that ensure the licensed activity will not violate or prevent attainment of state water quality standards or other

state water quality requirements. 33 U.S.C. § 1341(d). Water quality standards define the minimum water quality that must be maintained within a waterbody. Water quality standards designate the uses to be sustained within the waterbody (such as habitat for fish or other aquatic life) and establish criteria to protect those uses. 33 U.S.C. § 1313; 40 C.F.R. § 131.2.

34. The citizen suit provision of the CWA authorizes citizens to enforce water quality certifications in United States District Court. 33 U.S.C. § 1365(a) and (f)(5). The Court is authorized to award costs of litigation (including reasonable attorney and expert witness fees). 33 U.S.C. § 1365(d).

Defendants Are Violating The Water Quality
Certification Issued For Hydro Kennebec Dam.

35. Defendants are violating the water quality certification issued for Hydro Kennebec dam. Specifically, Defendants are violating the following provision:

> INTERIM DOWNSTREAM FISH PASSAGE: The applicant [dam owner] shall continue and where needed improve existing operational measures to diminish entrainment, allow downstream passage, and eliminate significant injury to out-migrating anadromous fish in accordance with the terms of the KHDG [Kennebec Hydro Developers Group] Settlement Agreement.

The KHDG Settlement Agreement, in turn, provides:

> In the event that adult shad and/or adult Atlantic salmon begin to inhabit the impoundment above the [dam], and to the extent that [the dam owner] desires to achieve interim downstream passage of out-migrating adult Atlantic salmon and/or adult shad by means of passage through turbine(s), [the dam owner] must first demonstrate through site-specific quantitative studies designed and conducted in consultation with the resource agencies [which include the National Marine Fisheries Service and the U.S. Fish and Wildlife Service], that passage through turbine(s) will not result in significant injury and/or mortality (immediate or delayed).

36. In every year from 2006 forward, and in previous years, adult salmon returning from the ocean have been trapped below the Lockwood dam (the most

downstream dam on the Kennebec River) and transported in trucks upstream to the Sandy River, a tributary that joins the Kennebec River upstream of Weston dam, which is located two dams above Hydro Kennebec dam. After spawning, these salmon attempt to "out-migrate" down the Kennebec toward the sea. During this out-migration, the adult salmon inhabit the impoundments above Hydro Kennebec dam.

37. Defendants have not demonstrated, through site-specific quantitative studies designed and conducted in consultation with the resource agencies, that passage through turbines at Hydro Kennebec dam will not cause "significant injury and/or mortality (immediate or delayed)" to adult salmon. In fact, neither of the Defendants has conducted any site-specific quantitative studies on the effects of turbine passage on adult salmon at Hydro Kennebec dam.

38. However, Defendants achieve (or attempt to achieve) downstream passage of adult salmon through Hydro Kennebec dam's turbines.

39. The shad population in the Kennebec River is low. Starting in 2010, adult shad have been trapped below Lockwood dam and transported in trucks to a point in the Kennebec River below Shawmut dam, which is the dam immediately upstream of Hydro Kennebec dam. Like salmon, shad out-migrate down the Kennebec after spawning. Defendants have likewise chosen to pass (or attempt to pass) these adult shad through the Hydro Kennebec dam turbines without first demonstrating, through site-specific quantitative studies designed and conducted in consultation with the resource agencies, that turbine passage will not cause "significant injury and/or mortality (immediate or delayed)" to adult shad. Neither of the Defendants has conducted a site-specific

quantitative study on the effects of turbine passage on adult shad at Hydro Kennebec dam.

40. Defendants have thus far refused to either (a) install devices to assure that adult salmon and shad will not swim through turbines or (b) shut down their turbines during salmon and shad migration seasons. Defendants have installed a diversionary device at Hydro Kennebec dam, but that device is not effective at preventing salmon and shad from swimming through turbines at that dam.

PLAINTIFFS HAVE STANDING TO BRING THIS SUIT

42. Paragraphs 43 through 46 apply to both Counts I and II.

43. Plaintiffs have members who have been very active in efforts to preserve Atlantic salmon in the Kennebec River. For example, Plaintiffs' members have successfully petitioned and sued the Services to include the salmon population of the Kennebec in the GOM DPS, have for years advocated before federal and state agencies for better salmon passage at Hydro Kennebec and other dams, and regularly monitor the water quality of the Kennebec River. Plaintiffs have members who have also advocated for better shad passage at Hydro Kennebec.

44. Plaintiffs have members who are interested in maintaining the natural biodiversity of the Kennebec River and its environs. Plaintiffs have members who live near, own property near, and recreate on and near the Kennebec River and Merrymeeting Bay. Plaintiffs have members who, among other activities, kayak on, canoe on, fish in, walk and hike along, lead guided trips on, and enjoy observing and photographing aquatic life and wildlife in and around the Kennebec River and Merrymeeting Bay. Their

enjoyment of these activities is impaired by the diminution of the size and health of the Atlantic salmon and shad population in the Kennebec River.

45. Plaintiffs' members enjoy and in many ways receive great value from the presence of wild Atlantic salmon and shad and want the numbers of wild salmon in the Kennebec River to be as plentiful as possible. They also want the Kennebec River population of salmon to eventually recover to the point of no longer being endangered. The dearth of Atlantic salmon and shad in the river diminishes Plaintiffs' members' use and enjoyment of the river. If Atlantic salmon were populous enough in the Kennebec River, Plaintiffs' members would fish for and eat that salmon. They cannot do so now because the fish are endangered. Recovery of Atlantic salmon and shad in the rivers would increase economic opportunities for Plaintiffs' members because there would be a greater demand for guided trips that they could lead for paddling, fishing, fish-spotting, or photography, and for other purposes.

46. Defendants' dam operations are directly responsible for depressing Atlantic salmon populations in the Kennebec River. Defendants' dam is a leading cause of the near extinction of Atlantic salmon in the Kennebec River and of the fish's presence on the Endangered Species List. If Defendants complied with the Endangered Species Act, and with the water quality certification for Hydro Kennebec dam, there would be more Atlantic salmon in the Kennebec River and the chance of the river's salmon population recovering would be improved. Moreover, preservation and restoration of the salmon's critical habitat in and along the Kennebec River would improve the health, biodiversity, and sustainability of these natural areas in which Plaintiffs' members have recreational, aesthetic, and economic interests. In addition, if Defendants complied with the water

quality certification for their dam, there would be more shad in the Kennebec River and the chance of the river's shad population recovering would be improved.

DEFENDANTS CAN ACHIEVE COMPLIANCE WITH THE ESA AND THEIR CWA WATER QUALITY CERTIFICATION IN A MANNER THAT IS CONSISTENT WITH THE TERMS OF THE FERC LICENSE

47. Paragraphs 48 through 53 apply to both Counts I and II.

48. Relief in this case can be fashioned in a manner that is consistent with the FERC license issued for the operation of Hydro Kennebec dam.

49. Since the CWA water quality certification is part of the FERC license for Hydro Kennebec dam, compliance with the certification's ban on the passage of adult salmon and shad through the dam's turbines is *required* by the FERC license.

50. Moreover, there are a number of ways for Defendants to comply with the water quality certification and reduce their unlawful "take" of salmon in a manner consistent with the continued operation of their dam under the provisions of the FERC license. For example, Defendants can stop the turbines during salmon migration season to prevent the fish from swimming into the spinning turbine blades. This can be done without having to modify the FERC license. In fact, other dam owners stop their turbines in order to provide safe passage for migrating fish.

51. Defendants have indicated they do not intend to apply for an incidental take permit, but, rather, intend to obtain an incidental take statement pursuant to Section 7 of the ESA, 16 U.S.C. § 1536(b)(4). The ESA directs all federal agencies to work to conserve endangered species and to use their authorities to further the purposes of the ESA. Section 7 of the ESA, entitled "Interagency Cooperation," is the mechanism

designed to ensure the actions taken by federal agencies, including those they fund or authorize, do not jeopardize the existence of any listed species.

52. Under Section 7, federal agencies must consult with the Services when any action the agency intends to carry out, fund, or authorize (such as through a federal license) may affect a listed endangered species. One of the first steps in consultation is the preparation of a "biological assessment" ("BA"). 16 U.S.C. § 1536(c). One of the purposes of a BA is to help make the determination whether a proposed activity "is likely to adversely affect" listed species or their critical habitat. Id. The federal licensee may be designated to prepare the BA, though ultimate responsibility for the BA lies with the agency issuing the license. If the agency determines through a BA that its action is likely to adversely affect a listed species, the agency is required to submit to the Services a request for consultation. 16 U.S.C. § 1536(a) and (b). This process can result in the issuance of an incidental take statement, so long as the activity to be authorized is not "likely to jeopardize the continued existence of any endangered species…or result in the destruction or adverse modification of habitat [critical to the species]…" 16 U.S.C. § 1536(a)(2) and (b)(4)(B). An ITS, if issued, "specifies those reasonable and prudent measures that the Secretary considers necessary or appropriate to minimize" the impact of an activity on endangered species, and "sets forth the terms and conditions…that must be complied with by…the applicant [for a federal license]…to implement" those measures. 16 U.S.C. § 1536(b)(4)(ii) and (iv).

53. Defendants have indicated that they will attempt to obtain an ITS by applying to amend the FERC license for Hydro Kennebec dam, which would trigger the Section 7 consultation process. Defendants have asked FERC that they be designated to prepare the

biological assessment. Given, among other things, (a) Defendants' ongoing unlawful take of endangered Kennebec River salmon, (b) the dire condition of the Atlantic salmon population and the risk that the fish will soon become extinct, and (c) Defendants' failure to take meaningful steps to protect salmon, despite years of warning that the ESA listing was forthcoming, Plaintiffs believe Defendants must be put on an enforceable schedule for preparing the BA in the event they are designated to be the parties to prepare it. Such an order would have no effect on Defendants' ability to operate in a manner consistent with their FERC license.

RELIEF REQUESTED

Plaintiffs request that this Court:

a. Declare Defendants to be violating the take prohibition of the Endangered Species Act at Hydro Kennebec dam;

b. Declare Defendants to be violating their Clean Water Act water quality certification for Hydro Kennebec dam;

c. Order Defendants to comply with the water quality certification provisions that prohibit passing adult Atlantic salmon and adult shad through turbines without first demonstrating through site-specific quantitative studies, designed and conducted in consultation with resource agencies, that turbine passage will not result in significant injury and/or mortality (immediate or delayed);

d. Order Defendants to prepare a BA according to a specified schedule, and to (1) prevent Atlantic salmon from swimming into operating turbines at Hydro Kennebec dam unless authorized by an ITP or ITS and (2) implement other appropriate measures to comply with the ESA's take prohibition pending the issuance of any ITP or ITS;

e. Award costs of litigation (including reasonable attorney and expert witness fees), as provided for in 33 U.S.C. § 1365(d);

f. Order such other relief as the Court deems appropriate.

Dated: January 31, 2011

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UNITED STATES DISTRICT COURT
DISTRICT OF MAINE

FRIENDS OF MERRYMEETING BAY and
ENVIRONMENT MAINE,

Plaintiffs,

v.

BROOKFIELD RENEWABLE POWER, INC.
and HYDRO KENNEBEC, LLC,

Defendants.

Civil Action No.

COMPLAINT

INTRODUCTION

1. Defendants Brookfield Renewable Power, Inc. and Hydro Kennebec LLC are violating the federal Endangered Species Act ("ESA"), 16 U.S.C. § 1531 *et seq.*, by killing, harming, and harassing endangered Atlantic salmon at their Hydro Kennebec hydroelectric dam on the Kennebec River. Defendants are, in ESA parlance, illegally "taking" this endangered species. More specifically, Defendants' dam: kills and injures salmon with its rotating turbine blades when the fish try to pass through them; impedes upstream and downstream salmon passage, which prevents salmon from gaining access to significant amounts of spawning and rearing habitat; alters the natural habitat to such a degree that the essential behavior patterns of the fish are significantly impaired; and has other deleterious effects on the salmon.

2. The ESA allows the National Marine Fisheries Service ("NMFS") and United States Fish and Wildlife Service ("USFWS") (collectively, the "Services"), under certain

circumstances, to authorize an otherwise prohibited taking of an endangered species if such taking is "incidental" to, and not the purpose of, the carrying out of an otherwise lawful activity. 16 U.S.C. § 1539(a)(1)(B). Defendants do not have authorization from the Services to commit an "incidental take" of salmon at Hydro Kennebec dam.

3. Defendants are also violating the federal Clean Water Act ("CWA") water quality certification issued for their Kennebec River dam. This certification prohibits Defendants from allowing downstream-migrating adult salmon and adult shad to pass through the turbines of the dam unless Defendants have conducted a studies proving that such passage does not result in significant injury or mortality. Although Defendants are allowing adult salmon and adult shad to pass through their turbines, they have not conducted the requisite study. Plaintiffs believe such a study would show that turbine passage results in significant injury and mortality, as other studies have shown.

4. Neither the federal nor state government has taken enforcement action against Defendants to redress these violations. However, Congress authorized citizens to bring "citizen suits" in United States District Courts to enforce the ESA and CWA directly against violators. 16 U.S.C. § 1540(g) (ESA citizen suit provision); 33 U.S.C. § 1365 (CWA citizen suit provision).

5. Defendants' dam is a major reason the Kennebec population of salmon has declined to perilously low levels. Although they have long been aware of this fact, Defendants have not taken a number of basic, feasible steps, such as keeping fish from swimming into their spinning turbine blades, that would reduce the detrimental effects of their dam on this endangered population. Without a court order directing them to so,

Defendants will not comply expeditiously with the ESA and with their CWA water quality certification.

PARTIES

6. Plaintiff Friends of Merrymeeting Bay ("FOMB") is a non-profit Maine corporation with over 400 members. FOMB is dedicated to preserving the ecological, aesthetic, historical, recreational, and commercial values of Maine's Merrymeeting Bay and its watershed, which includes the Kennebec River. FOMB accomplishes its mission through research, advocacy, land conservation, education, and litigation.

7. Plaintiff Environment Maine is a non-profit Maine corporation. It is a statewide environmental organization that advocates for clean air, clean water, and preservation of Maine's natural resources on behalf of approximately 3,460 citizen members from across the state of Maine. Among other activities, Environment Maine researches and distributes analytical reports on environmental issues, advocates before legislative and administrative bodies, engages in litigation when necessary, and conducts public education.

8. Defendant Brookfield Renewable Power, Inc. ("Brookfield"), either in its own name or through a subsidiary, owns and operates Hydro Kennebec dam on the Kennebec River. Brookfield operates, and exercises fundamental control over, this dam. www.brookfieldpower.com/_Global/5/documents/relatedlinks/1699.pdf. Brookfield is itself a wholly-owned subsidiary of Brookfield Asset Management, a Toronto-based conglomerate.

9. The Federal Energy Regulatory Commission ("FERC") license for Hydro Kennebec dam is in the name of defendant Hydro Kennebec LLC. Hydro Kennebec LLC operates Hydro Kennebec dam.

JURISDICTION AND VENUE

10. Subject matter jurisdiction is conferred upon this Court by 16 U.S.C. § 1540(g)(1) (ESA citizen suit provision), 33 U.S.C. § 1365(a) (CWA citizen suit provision), and 28 U.S.C. § 1331 (federal question jurisdiction). Venue lies within this District pursuant to 16 U.S.C. § 1540(g)(3)(A) (ESA venue provision), 33 U.S.C. 1365(c)(1) (CWA venue provision), and 28 U.S.C. § 1391(e) (federal venue provision).

11. Plaintiffs gave Defendants notice of the violations alleged in this Complaint more than 60 days prior to commencement of this lawsuit by a letter addressed and mailed to: Brookfield's Chief Operating Office for U.S. Operations, Kim Osmars, and the Managers of Brookfield New England and Hydro Kennebec LLC, Craig Laurie and Mark Brown. A copy of this letter is attached as Exhibit 1 and incorporated by reference herein. Copies of the notice letter were mailed to (a) Defendants' registered agents, (b) the Secretaries of Commerce and Interior, (c) the Administrator of the U.S. Environmental Protection Agency ("EPA") and the Regional Administrator of the EPA for New England, (d) the Acting Commissioner of the Maine Department of Environmental Protection, and (e) Brian Stetson of Brookfield. The notice letters satisfy the pre-suit notice requirements of 16 U.S.C. 1540 § (g)(2)(A)(i) (ESA) and 33 U.S.C. § 1365(b)(1)(A) (CWA).

FACTUAL BACKGROUND

The Life Cycle Of Atlantic Salmon.

12. Atlantic salmon are anadromous, meaning they are born in fresh water, migrate to the ocean, and then return to fresh water to spawn.

13. In late autumn, female Atlantic salmon deposit eggs in a series of nests (called "redds") in a stream or river bed. Once the eggs are fertilized by spawning adult male salmon, the female salmon uses her tail to cover those eggs with gravel. After spawning, adult salmon, called "kelts," return to the ocean in early winter or the following spring. Eggs hatch in March or April; at this point the newborn fish are referred to as "alevin" or "sac fry." Three to six weeks after hatching, alevins emerge from their redds seeking food, and are at that point called "fry." Fry quickly develop into "parr," with camouflaging vertical stripes. They feed and grow for one to three years in their native streams or rivers before becoming "smolts." Smolts are silver colored and approximately six inches long. In the spring, the body chemistry of smolts change and they are able to enter salt water. Smolts migrate to the ocean where they develop over two to three years into mature salmon weighing 8 to 25 pounds. Mature adult salmon begin returning in the spring to their native streams to repeat the spawning cycle. Atlantic salmon are capable of spawning and completing this cycle several times.

There Are Almost No Atlantic Salmon Returning To The Kennebec River.

14. The Maine Atlantic Salmon Commission ("MASC") monitors the abundance and status of Atlantic salmon in many Maine rivers. On the Kennebec River, MASC traps and counts returning adult salmon at the lower-most dam, Lockwood dam. This trapping and counting is conducted annually, typically between May and November.

15. Historically, the Kennebec and Androscoggin Rivers, which share a common estuary, Merrymeeting Bay, had the largest Atlantic salmon runs in the United States, estimated at more than 100,000 adults each year. Now, according to the recent annual surveys done by MASC, the number of adult Atlantic salmon returning to the Kennebec River each year is dangerously low. In 2010, 5 adult salmon returned to the Kennebec River; in 2009, 29 returned; in 2008, 22 returned; in 2007, 16 returned; in 2006, 15 returned.

COUNT I
DEFENDANTS ARE VIOLATING
THE ENDANGERED SPECIES ACT

16. Plaintiffs reallege and incorporate by reference paragraphs 1 through 15.

The Kennebec Population Of Atlantic Salmon
Is On The Endangered Species List.

17. In enacting the Endangered Species Act, Congress expressly found that species of fish, wildlife, and plants in danger of or threatened with extinction are of "esthetic, ecological, educational, historical, recreational, and scientific value to the Nation and its people." 16 U.S.C. § 1531(a)(3). Congress stated that the purposes of the ESA "are to provide a means whereby the ecosystems upon which endangered species and threatened species depend may be conserved [and] to provide a program for the conservation of such endangered and threatened species…" 16 U.S.C. § 1531(b). By enacting the Endangered Species Act, Congress intended protection of endangered species to be afforded the highest of priorities. Under the ESA, an "endangered species" is a species of animal or plant (other than certain dangerous insect pests) which is in danger of extinction throughout all or a significant portion of its range. 16 U.S.C. § 1532(6).

18. The Secretary of Commerce (for endangered species in the ocean) and the Secretary of the Interior (for all other species) are responsible for administering and implementing the ESA, with the Services acting on their behalf. Because Atlantic salmon are anadromous, the Secretaries (and thus the Services) share responsibility for managing the protection of these fish under the ESA.

19. In 2000, the Services issued a rule listing the Gulf of Maine Distinct Population Segment ("GOM DPS") of Atlantic salmon as "endangered" because it is in danger of becoming extinct. At that time, the Services included the salmon populations of seven rivers in Down East Maine in the description of the endangered GOM DPS, but did not include the Kennebec River salmon population in this listing.

20. In 2005, Plaintiff Friends of Merrymeeting Bay, Douglas Watts (a member of Plaintiff FOMB) and others filed a petition with the Services asking them to include Kennebec salmon in the GOM DPS. Although a federal "biological review team" found that the Kennebec salmon population should be included in the GOM DPS, along with the Androscoggin and Penobscot River salmon populations, and published this finding in the "2006 Status Review for Anadromous Atlantic Salmon in the United States," by mid-2008 the Services still had not ruled on the petition. On May 12, 2008, Mr. Watts, FOMB, and other conservation groups sued the Services to obtain a ruling on the petition. On September 3, 2008, the Services did rule on the petition, proposing to include the Kennebec, Androscoggin, and Penobscot River salmon populations in the GOM DPS. 73 Fed. Reg. 51,415 (September 3, 2008). On June 19, 2009, the Services issued a final rule including the salmon populations of all three rivers in the listed GOM DPS, thereby

formally designating these populations as endangered under the ESA. 74 Fed. Reg. 29,344 (June 19, 2009).

21. On that same day, NMFS issued a final rule designating "critical habitat" for the Kennebec, Androscoggin, and Penobscot salmon – *i.e.*, habitat "essential to the conservation of the species" and "which may require special management considerations or protection." 16 U.S.C. § 1532(5)(A)(i). The portion of the Kennebec River where Hydro Kennebec dam is located and those portions affected by the dam are part of that critical habitat. 74 Fed. Reg. 29,300 (June 19, 2009).

"Take" Of An Endangered Species Is Prohibited
By The Endangered Species Act.

22. Section 9 of the ESA makes it unlawful for any person to "take" an endangered species unless authorized to do so by the federal government. 16 U.S.C. § 1538(a)(1)(b).

23. Under the ESA, the term "take" means "to harass, harm, pursue, hunt, shoot, kill, trap, or collect, or to attempt to engage in any such conduct." 16 U.S.C. § 1532(19). By USFWS regulation:

> Harass in the definition of "take" in the Act means an intentional or negligent act or omission which creates the likelihood of injury to wildlife by annoying it to such an extent as to significantly disrupt normal behavioral patterns which include, but are not limited to, breeding, feeding, or sheltering. [and]
>
> Harm in the definition of "take" in the Act means an act which actually kills or injures wildlife by significantly impairing essential behavioral patterns, including breeding, feeding, or sheltering.

50 C.F.R. § 17.3.

24. A NMFS regulation further defines "harm" as including habitat modification where a causal link is established between such modification and injury or death of a

listed species. 40 C.F.R. § 222.102. In publishing that rule, NMFS listed the following among its examples of activities that may modify habitat and thus cause a take:

> 1. Constructing or maintaining barriers that eliminate or impede a listed species' access to habitat or ability to migrate;
>
> * * *
>
> 4. Removing or altering rocks, soil, gravel, vegetation or other physical structures that are essential to the integrity and function of a listed species' habitat;
>
> * * *
>
> 5. Removing water or otherwise altering streamflow when it significantly impairs spawning, migration, feeding or other essential behavior patterns; [and]
>
> * * *
>
> 7. Constructing or operating dams or water diversion structures with inadequate fish screens or fish passage facilities in a listed species' habitat…

64 Fed. Reg. 60,727, 60,730 (Nov. 8, 1999).

25. When a federally licensed activity – such as operating a hydroelectric dam – causes a take, the licensee may receive authorization under the ESA to continue the activity in one of two ways. One is to apply for and obtain an "incidental take permit" ("ITP") pursuant to Section 10 of the ESA, 16 U.S.C § 1539. The other is to obtain an "incidental take statement" ("ITS") pursuant to Section 7 of the ESA, 16 U.S.C. §1536; *see* 50 C.F.R. § 402.14. A take is considered "incidental" when the purpose of the activity is not to take an endangered species, but rather to conduct some otherwise lawful activity that incidentally results in a take. 16 U.S.C. § 1539(a)(1)(B); 50 C.F.R. § 402.02. An ITP can require that the holder of the ITP "minimize and mitigate the impacts of" the taking "to the maximum extent practicable." 16 U.S.C. § 1539(a)(2) (B)(2). Similarly, an ITS can require that "reasonable and prudent measures" be taken to "minimize" the impact of a take. 16 U.S.C. § 1536(b)(4)(ii). An ITP is not authorized unless certain

specified conditions are met. Among these is that the take "will not appreciably reduce the likelihood of survival and recovery of the species in the wild." 16 U.S.C. § 1539(a)(2)(B)(4). Similarly, an ITS is not authorized if the licensed activity is "likely to jeopardize the continued existence of any endangered species…or result in the destruction or adverse modification of habitat [critical to the species]…" 16 U.S.C. § 1536(a)(2) and (b)(4)(B).

26. The citizen suit provision of the ESA grants jurisdiction to United States District Courts to issue orders enjoining violations of the Act (such as the unauthorized taking of an endangered species) and authorizes an award of costs of litigation (including reasonable attorney and expert witness fees). 16 U.S.C. § 1540(g)(1) and (4).

Defendants Are Taking Atlantic Salmon
In Violation Of Section 9 Of The ESA.

27. Defendants' Hydro Kennebec dam harasses, harms, and kills – and thus "takes" – Atlantic salmon in a number of ways. Among these are the following:

a. The dam's turbines kill and injure out-migrating salmon when the salmon attempt to pass through them.

b. The dam severely limits upstream passage of salmon, preventing access to significant amounts of spawning and rearing habitat.

c. Facilities meant to allow the salmon to pass around or through the dam cause delays in passage, resulting in incremental losses of salmon smolts, pre-spawn adults, and adults.

d. The dam is a barrier to the migration of other fish whose presence is necessary for the salmon to complete their life cycle.

e. The dam adversely alters predator-prey assemblages, such as the ability of the salmon to detect and avoid predators.

f. The dam creates slow-moving impoundments in formerly free-flowing reaches. These altered habitats are less suitable for spawning and rearing of salmon and contribute to the dam's significant impairment of essential behavior patterns of the salmon. In addition, these conditions may favor non-native competitors at the expense of the native salmon.

g. The dam results in adverse hydrological changes, adverse changes to stream and river beds, interruption of natural sediment and debris transport, and changes in water temperature, all of which contribute to the dam's significant impairment of essential behavior patterns.

28. Defendants have neither an incidental take permit nor an incidental take statement authorizing their take of Atlantic salmon at Hydro Kennebec dam. Defendants' take of Atlantic salmon therefore violates Section 9(a)(1)(B) of the ESA, 16 U.S.C. § 1538(a)(1)(B). Defendants have been violating the Section 9 take prohibition since the day Kennebec salmon were included in the GOM DPS and thus designated as endangered under the ESA.

29. In their decision to include the Kennebec River population of Atlantic salmon on the Endangered Species List, the Services found dams on that river play a major role in imperiling the salmon. The Services stated: "The National Research Council stated in 2004 that the greatest impediment to self-sustaining Atlantic salmon populations in Maine is obstructed fish passage and degraded habitat caused by dams … Dams are known to typically kill or injure between 10 and 30 percent of all fish entrained at

turbines [cite omitted]. With rivers containing multiple hydropower dams, these cumulative losses could compromise entire year classes of Atlantic salmon … Thus, cumulative losses at passage facilities can be significant … Dams remain a direct and significant threat to Atlantic salmon." 74 Fed. Reg. at 29362. Similarly, the Services stated: "Dams are among the leading causes of both historical declines and contemporary low abundance of the GOM DPS of Atlantic salmon [cite omitted]." The Services also stated that the "effects [of dams] have led to a situation where salmon abundance and distribution has been greatly reduced, and thus the species is more vulnerable to extinction … Therefore, dams represent a significant threat to the survival and recovery of the GOM DPS." 74 Fed. Reg. at 29366-29367.

COUNT II
DEFENDANTS ARE VIOLATING
THE CLEAN WATER ACT WATER QUALITY CERTIFICATION

30. Plaintiffs reallege and incorporate by reference paragraphs 1 through 29.

Clean Water Act Water Quality Certifications Are Designed To Maintain Compliance With Water Quality Standards.

31. Congress declared the objective of the Clean Water Act "is to restore and maintain the chemical, physical, and biological integrity of the Nation's waters." 33 U.S.C. § 1251(a).

32. Under Section 401 of the CWA, 33 U.S.C. § 1341, hydroelectric dams must obtain a state "water quality certification" before they may obtain a license to operate from the Federal Energy Regulatory Commission. This water quality certification becomes a condition of the FERC license. 33 U.S.C. § 1341(d).

33. A water quality certification must contain conditions that ensure the licensed activity will not violate or prevent attainment of state water quality standards or other

state water quality requirements. 33 U.S.C. § 1341(d). Water quality standards define the minimum water quality that must be maintained within a waterbody. Water quality standards designate the uses to be sustained within the waterbody (such as habitat for fish or other aquatic life) and establish criteria to protect those uses. 33 U.S.C. § 1313; 40 C.F.R. § 131.2.

34. The citizen suit provision of the CWA authorizes citizens to enforce water quality certifications in United States District Court. 33 U.S.C. § 1365(a) and (f)(5). The Court is authorized to award costs of litigation (including reasonable attorney and expert witness fees). 33 U.S.C. § 1365(d).

Defendants Are Violating The Water Quality
<u>Certification Issued For Hydro Kennebec Dam.</u>

35. Defendants are violating the water quality certification issued for Hydro Kennebec dam. Specifically, Defendants are violating the following provision:

> INTERIM DOWNSTREAM FISH PASSAGE: The applicant [dam owner] shall continue and where needed improve existing operational measures to diminish entrainment, allow downstream passage, and eliminate significant injury to out-migrating anadromous fish in accordance with the terms of the KHDG [Kennebec Hydro Developers Group] Settlement Agreement.

The KHDG Settlement Agreement, in turn, provides:

> In the event that adult shad and/or adult Atlantic salmon begin to inhabit the impoundment above the [dam], and to the extent that [the dam owner] desires to achieve interim downstream passage of out-migrating adult Atlantic salmon and/or adult shad by means of passage through turbine(s), [the dam owner] must first demonstrate through site-specific quantitative studies designed and conducted in consultation with the resource agencies [which include the National Marine Fisheries Service and the U.S. Fish and Wildlife Service], that passage through turbine(s) will not result in significant injury and/or mortality (immediate or delayed).

36. In every year from 2006 forward, and in previous years, adult salmon returning from the ocean have been trapped below the Lockwood dam (the most

downstream dam on the Kennebec River) and transported in trucks upstream to the Sandy River, a tributary that joins the Kennebec River upstream of Weston dam, which is located two dams above Hydro Kennebec dam. After spawning, these salmon attempt to "out-migrate" down the Kennebec toward the sea. During this out-migration, the adult salmon inhabit the impoundments above Hydro Kennebec dam.

37. Defendants have not demonstrated, through site-specific quantitative studies designed and conducted in consultation with the resource agencies, that passage through turbines at Hydro Kennebec dam will not cause "significant injury and/or mortality (immediate or delayed)" to adult salmon. In fact, neither of the Defendants has conducted any site-specific quantitative studies on the effects of turbine passage on adult salmon at Hydro Kennebec dam.

38. However, Defendants achieve (or attempt to achieve) downstream passage of adult salmon through Hydro Kennebec dam's turbines.

39. The shad population in the Kennebec River is low. Starting in 2010, adult shad have been trapped below Lockwood dam and transported in trucks to a point in the Kennebec River below Shawmut dam, which is the dam immediately upstream of Hydro Kennebec dam. Like salmon, shad out-migrate down the Kennebec after spawning. Defendants have likewise chosen to pass (or attempt to pass) these adult shad through the Hydro Kennebec dam turbines without first demonstrating, through site-specific quantitative studies designed and conducted in consultation with the resource agencies, that turbine passage will not cause "significant injury and/or mortality (immediate or delayed)" to adult shad. Neither of the Defendants has conducted a site-specific

quantitative study on the effects of turbine passage on adult shad at Hydro Kennebec dam.

40. Defendants have thus far refused to either (a) install devices to assure that adult salmon and shad will not swim through turbines or (b) shut down their turbines during salmon and shad migration seasons. Defendants have installed a diversionary device at Hydro Kennebec dam, but that device is not effective at preventing salmon and shad from swimming through turbines at that dam.

PLAINTIFFS HAVE STANDING TO BRING THIS SUIT

42. Paragraphs 43 through 46 apply to both Counts I and II.

43. Plaintiffs have members who have been very active in efforts to preserve Atlantic salmon in the Kennebec River. For example, Plaintiffs' members have successfully petitioned and sued the Services to include the salmon population of the Kennebec in the GOM DPS, have for years advocated before federal and state agencies for better salmon passage at Hydro Kennebec and other dams, and regularly monitor the water quality of the Kennebec River. Plaintiffs have members who have also advocated for better shad passage at Hydro Kennebec.

44. Plaintiffs have members who are interested in maintaining the natural biodiversity of the Kennebec River and its environs. Plaintiffs have members who live near, own property near, and recreate on and near the Kennebec River and Merrymeeting Bay. Plaintiffs have members who, among other activities, kayak on, canoe on, fish in, walk and hike along, lead guided trips on, and enjoy observing and photographing aquatic life and wildlife in and around the Kennebec River and Merrymeeting Bay. Their

enjoyment of these activities is impaired by the diminution of the size and health of the Atlantic salmon and shad population in the Kennebec River.

45. Plaintiffs' members enjoy and in many ways receive great value from the presence of wild Atlantic salmon and shad and want the numbers of wild salmon in the Kennebec River to be as plentiful as possible. They also want the Kennebec River population of salmon to eventually recover to the point of no longer being endangered. The dearth of Atlantic salmon and shad in the river diminishes Plaintiffs' members' use and enjoyment of the river. If Atlantic salmon were populous enough in the Kennebec River, Plaintiffs' members would fish for and eat that salmon. They cannot do so now because the fish are endangered. Recovery of Atlantic salmon and shad in the rivers would increase economic opportunities for Plaintiffs' members because there would be a greater demand for guided trips that they could lead for paddling, fishing, fish-spotting, or photography, and for other purposes.

46. Defendants' dam operations are directly responsible for depressing Atlantic salmon populations in the Kennebec River. Defendants' dam is a leading cause of the near extinction of Atlantic salmon in the Kennebec River and of the fish's presence on the Endangered Species List. If Defendants complied with the Endangered Species Act, and with the water quality certification for Hydro Kennebec dam, there would be more Atlantic salmon in the Kennebec River and the chance of the river's salmon population recovering would be improved. Moreover, preservation and restoration of the salmon's critical habitat in and along the Kennebec River would improve the health, biodiversity, and sustainability of these natural areas in which Plaintiffs' members have recreational, aesthetic, and economic interests. In addition, if Defendants complied with the water

quality certification for their dam, there would be more shad in the Kennebec River and the chance of the river's shad population recovering would be improved.

DEFENDANTS CAN ACHIEVE COMPLIANCE WITH THE ESA AND THEIR CWA WATER QUALITY CERTIFICATION IN A MANNER THAT IS CONSISTENT WITH THE TERMS OF THE FERC LICENSE

47. Paragraphs 48 through 53 apply to both Counts I and II.

48. Relief in this case can be fashioned in a manner that is consistent with the FERC license issued for the operation of Hydro Kennebec dam.

49. Since the CWA water quality certification is part of the FERC license for Hydro Kennebec dam, compliance with the certification's ban on the passage of adult salmon and shad through the dam's turbines is *required* by the FERC license.

50. Moreover, there are a number of ways for Defendants to comply with the water quality certification and reduce their unlawful "take" of salmon in a manner consistent with the continued operation of their dam under the provisions of the FERC license. For example, Defendants can stop the turbines during salmon migration season to prevent the fish from swimming into the spinning turbine blades. This can be done without having to modify the FERC license. In fact, other dam owners stop their turbines in order to provide safe passage for migrating fish.

51. Defendants have indicated they do not intend to apply for an incidental take permit, but, rather, intend to obtain an incidental take statement pursuant to Section 7 of the ESA, 16 U.S.C. § 1536(b)(4). The ESA directs all federal agencies to work to conserve endangered species and to use their authorities to further the purposes of the ESA. Section 7 of the ESA, entitled "Interagency Cooperation," is the mechanism

designed to ensure the actions taken by federal agencies, including those they fund or authorize, do not jeopardize the existence of any listed species.

52. Under Section 7, federal agencies must consult with the Services when any action the agency intends to carry out, fund, or authorize (such as through a federal license) may affect a listed endangered species. One of the first steps in consultation is the preparation of a "biological assessment" ("BA"). 16 U.S.C. § 1536(c). One of the purposes of a BA is to help make the determination whether a proposed activity "is likely to adversely affect" listed species or their critical habitat. Id. The federal licensee may be designated to prepare the BA, though ultimate responsibility for the BA lies with the agency issuing the license. If the agency determines through a BA that its action is likely to adversely affect a listed species, the agency is required to submit to the Services a request for consultation. 16 U.S.C. § 1536(a) and (b). This process can result in the issuance of an incidental take statement, so long as the activity to be authorized is not "likely to jeopardize the continued existence of any endangered species…or result in the destruction or adverse modification of habitat [critical to the species]…" 16 U.S.C. § 1536(a)(2) and (b)(4)(B). An ITS, if issued, "specifies those reasonable and prudent measures that the Secretary considers necessary or appropriate to minimize" the impact of an activity on endangered species, and "sets forth the terms and conditions…that must be complied with by…the applicant [for a federal license]…to implement" those measures. 16 U.S.C. § 1536(b)(4)(ii) and (iv).

53. Defendants have indicated that they will attempt to obtain an ITS by applying to amend the FERC license for Hydro Kennebec dam, which would trigger the Section 7 consultation process. Defendants have asked FERC that they be designated to prepare the

biological assessment. Given, among other things, (a) Defendants' ongoing unlawful take of endangered Kennebec River salmon, (b) the dire condition of the Atlantic salmon population and the risk that the fish will soon become extinct, and (c) Defendants' failure to take meaningful steps to protect salmon, despite years of warning that the ESA listing was forthcoming, Plaintiffs believe Defendants must be put on an enforceable schedule for preparing the BA in the event they are designated to be the parties to prepare it. Such an order would have no effect on Defendants' ability to operate in a manner consistent with their FERC license.

RELIEF REQUESTED

Plaintiffs request that this Court:

a. Declare Defendants to be violating the take prohibition of the Endangered Species Act at Hydro Kennebec dam;

b. Declare Defendants to be violating their Clean Water Act water quality certification for Hydro Kennebec dam;

c. Order Defendants to comply with the water quality certification provisions that prohibit passing adult Atlantic salmon and adult shad through turbines without first demonstrating through site-specific quantitative studies, designed and conducted in consultation with resource agencies, that turbine passage will not result in significant injury and/or mortality (immediate or delayed);

d. Order Defendants to prepare a BA according to a specified schedule, and to (1) prevent Atlantic salmon from swimming into operating turbines at Hydro Kennebec dam unless authorized by an ITP or ITS and (2) implement other appropriate measures to comply with the ESA's take prohibition pending the issuance of any ITP or ITS;

e. Award costs of litigation (including reasonable attorney and expert witness fees), as provided for in 33 U.S.C. § 1365(d);

f. Order such other relief as the Court deems appropriate.

Dated: January 31, 2011

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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 12^{th} of April in 2010 and median dates of capture for all smolts in 2002, 2006, and 2010 occurring near the 1^{st} 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 5^{th}, 10^{th}, 25^{th}, and 50^{th} 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:

  MDMR 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.'"

<u>FPL Energy Response:</u> "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.

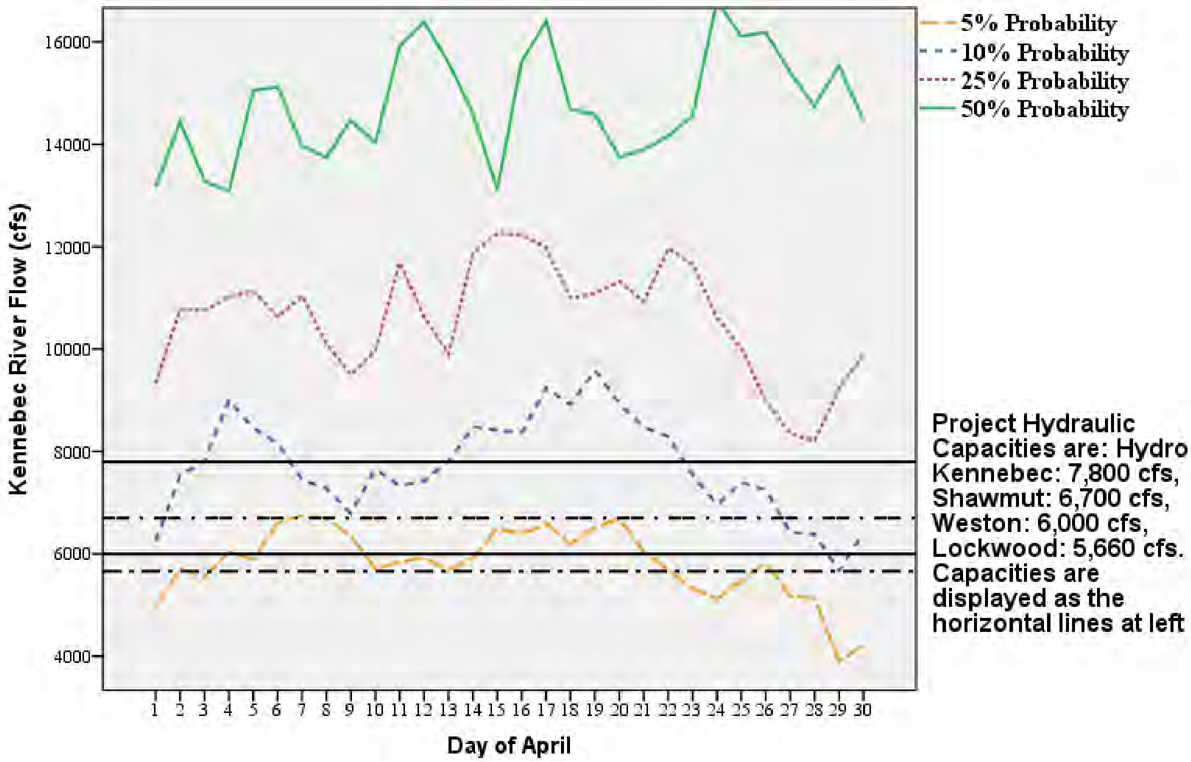


Figure 7.1.1. Relationship between Kennebec River mean daily flow in April and the hydraulic flow capacity of the Hydro Kennebec, Shawmut, Weston, and Lockwood projects. Flow curves represent the 5, 10, 25, and 50th mean daily flow percentiles. Flow volume is based on all days of record for the USGS 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.

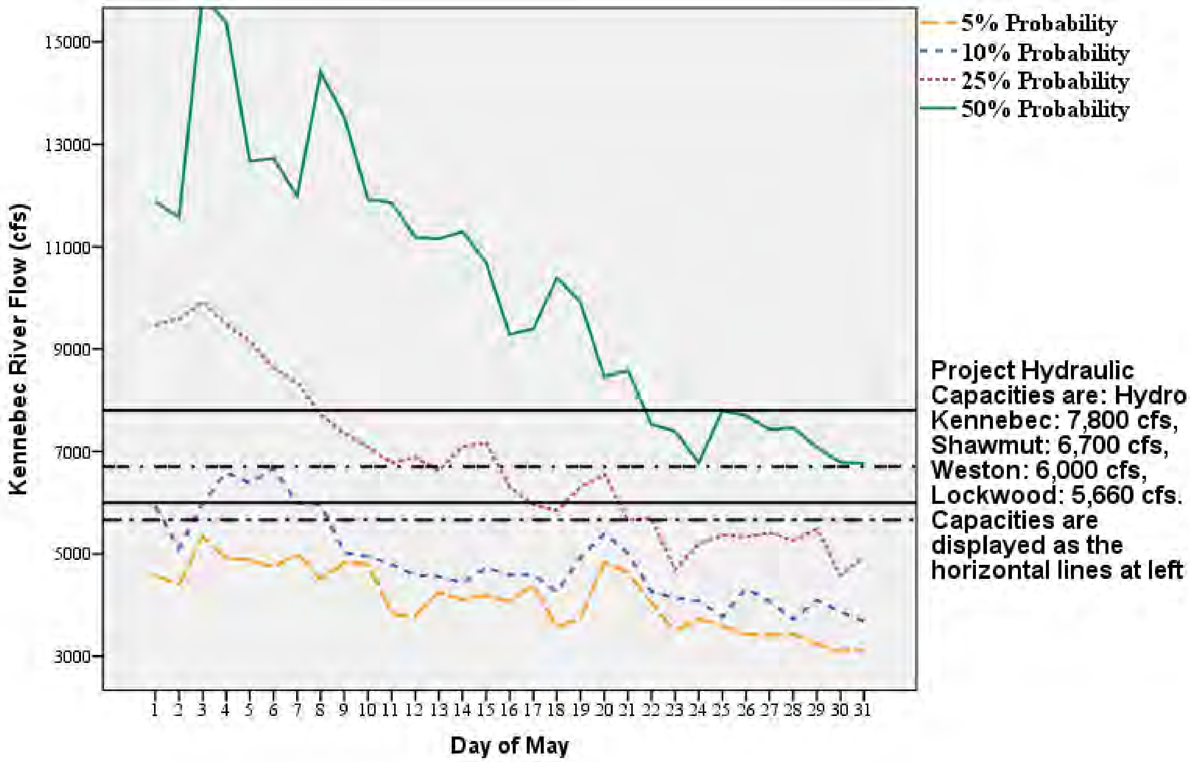


Figure 7.1.2. Relationship between Kennebec River mean daily flow in April and the hydraulic flow capacity of the Hydro Kennebec, Shawmut, Weston, and Lockwood projects. Flow curves represent the 5, 10, 25, and 50th mean daily flow percentiles. Flow volume is based on all days of record for the USGS 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.

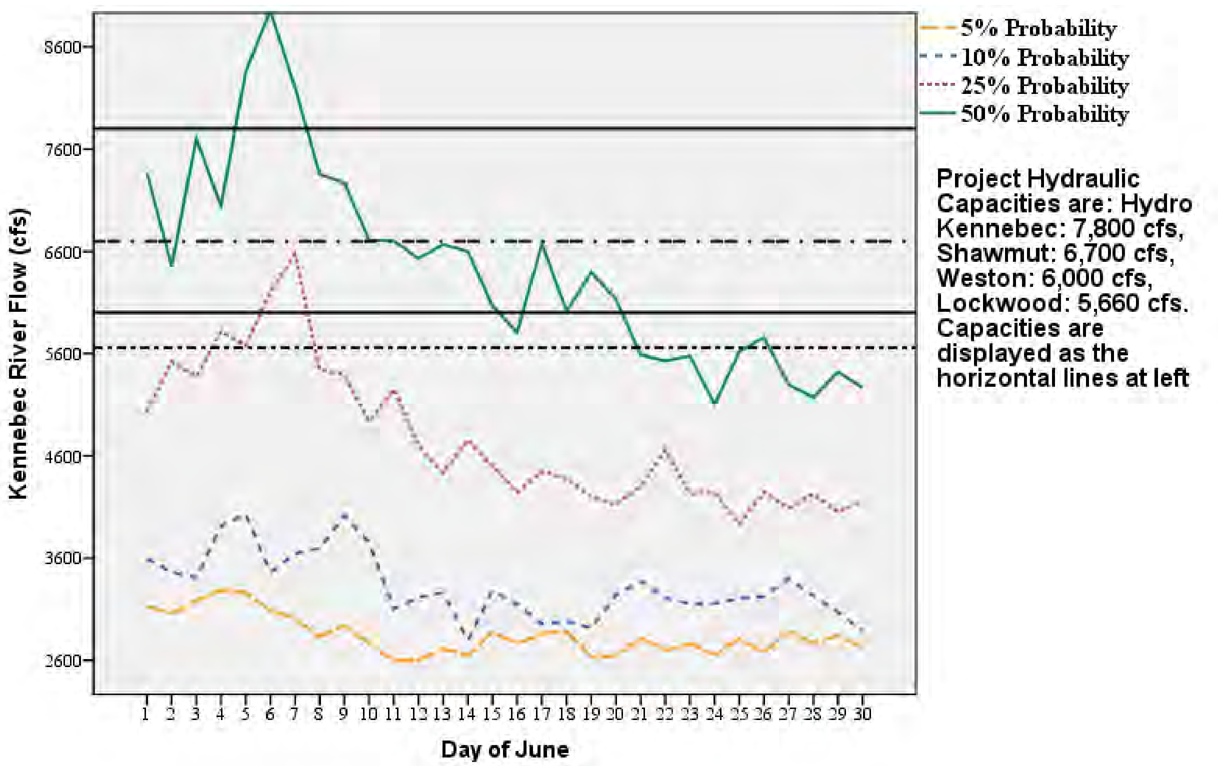


Figure 7.1.3. Relationship between Kennebec River mean daily flow in April and the hydraulic flow capacity of the Hydro Kennebec, Shawmut, Weston, and Lockwood projects. Flow curves represent the 5, 10, 25, and 50th mean daily flow percentiles. Flow volume is based on all days of record for the USGS 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.

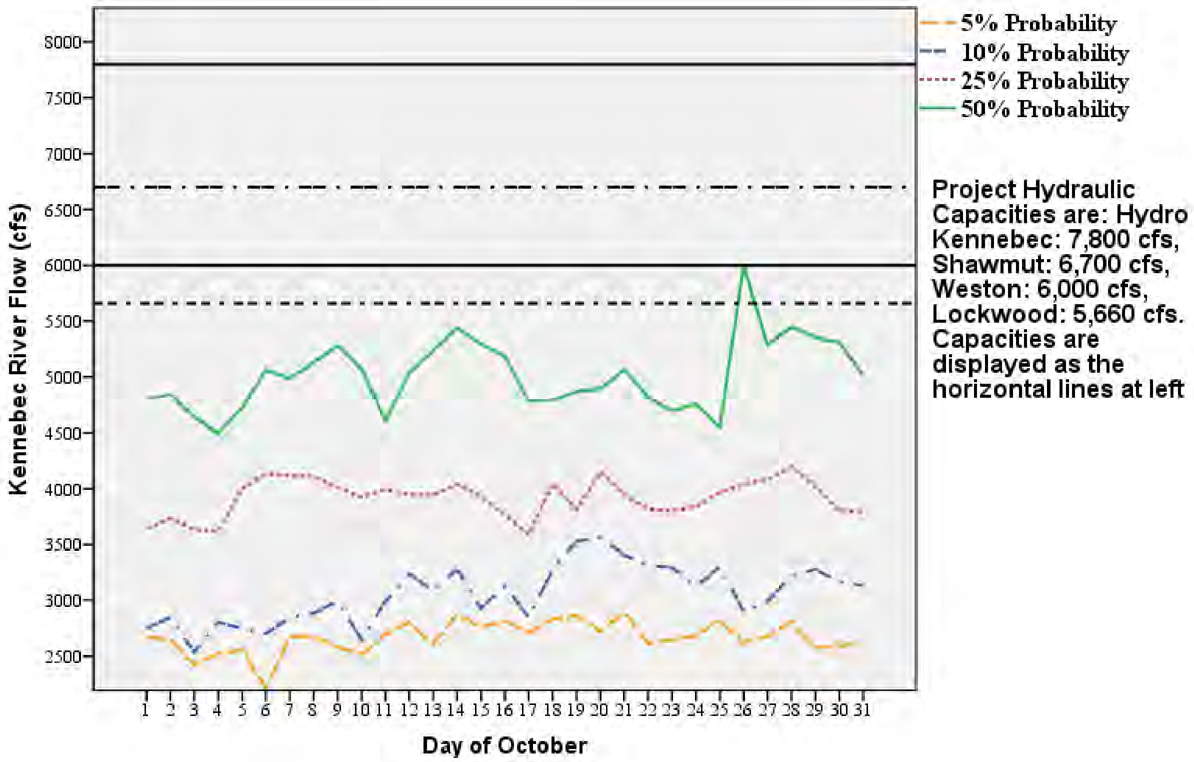


Figure 7.1.4. Relationship between Kennebec River mean daily flow in April and the hydraulic flow capacity of the Hydro Kennebec, Shawmut, Weston, and Lockwood projects. Flow curves represent the 5, 10, 25, and 50th mean daily flow percentiles. Flow volume is based on all days of record for the USGS 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.

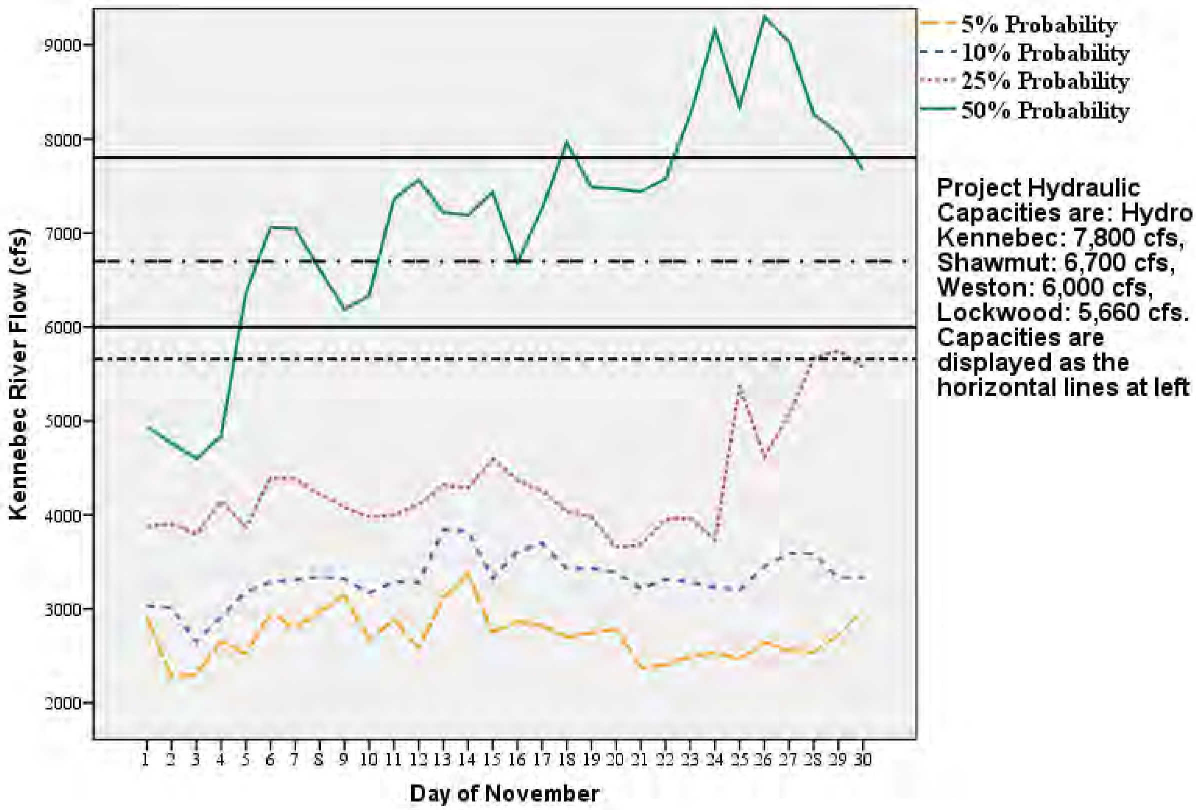


Figure 7.1.5. Relationship between Kennebec River mean daily flow in April and the hydraulic flow capacity of the Hydro Kennebec, Shawmut, Weston, and Lockwood projects. Flow curves represent the 5, 10, 25, and 50th mean daily flow percentiles. Flow volume is based on all days of record for the USGS 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 ≤ 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.

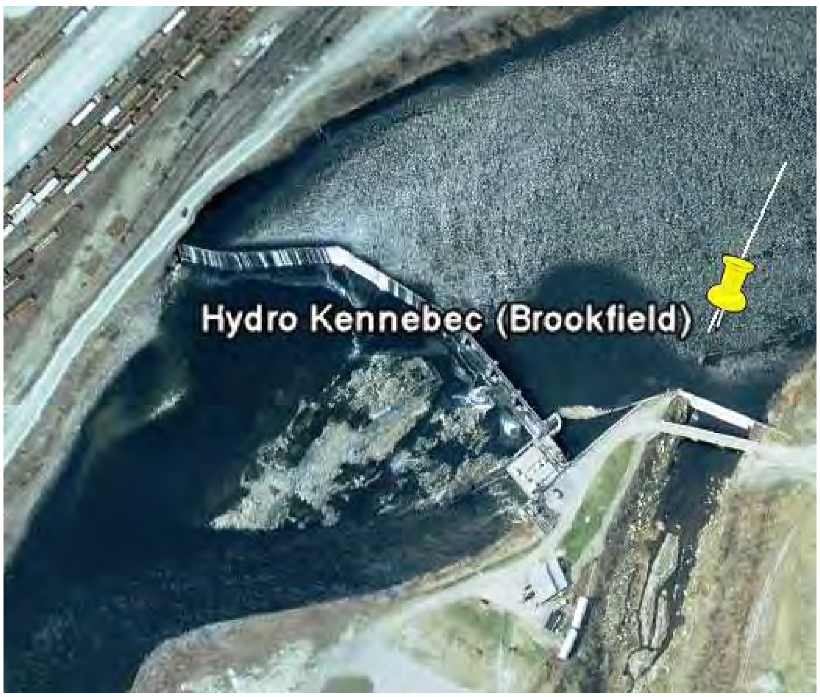
J. Fund the development and construction of a genetics conservation hatchery facility in both the Kennebec and Androscoggin River watersheds. Each facility would hatch and rear fish to approximately three inches in length for release into their respective rivers. The purpose of a conservation hatchery 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 $\leq$ 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 $\leq$ 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 $\leq$ 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 ≤ 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 ≤ 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 ≤ 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 ≤ 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.

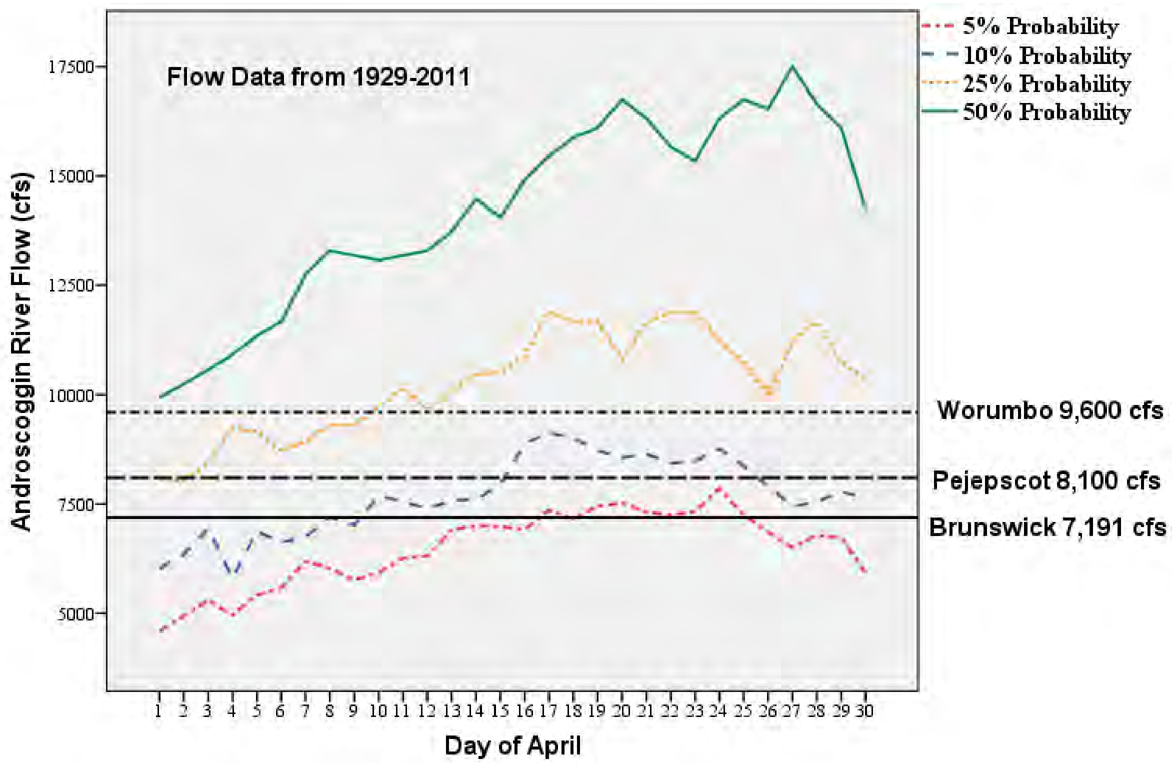


Figure 8.1.1 Relationship between Androscoggin River mean daily flow in April and the hydraulic flow capacity of the Brunswick, Pejepscot, and Worumbo projects. Flow curves represent the 5, 10, 25, 50, 75, and 90th mean daily flow percentiles. Flow volume is based on all days of record for the USGS gage 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.

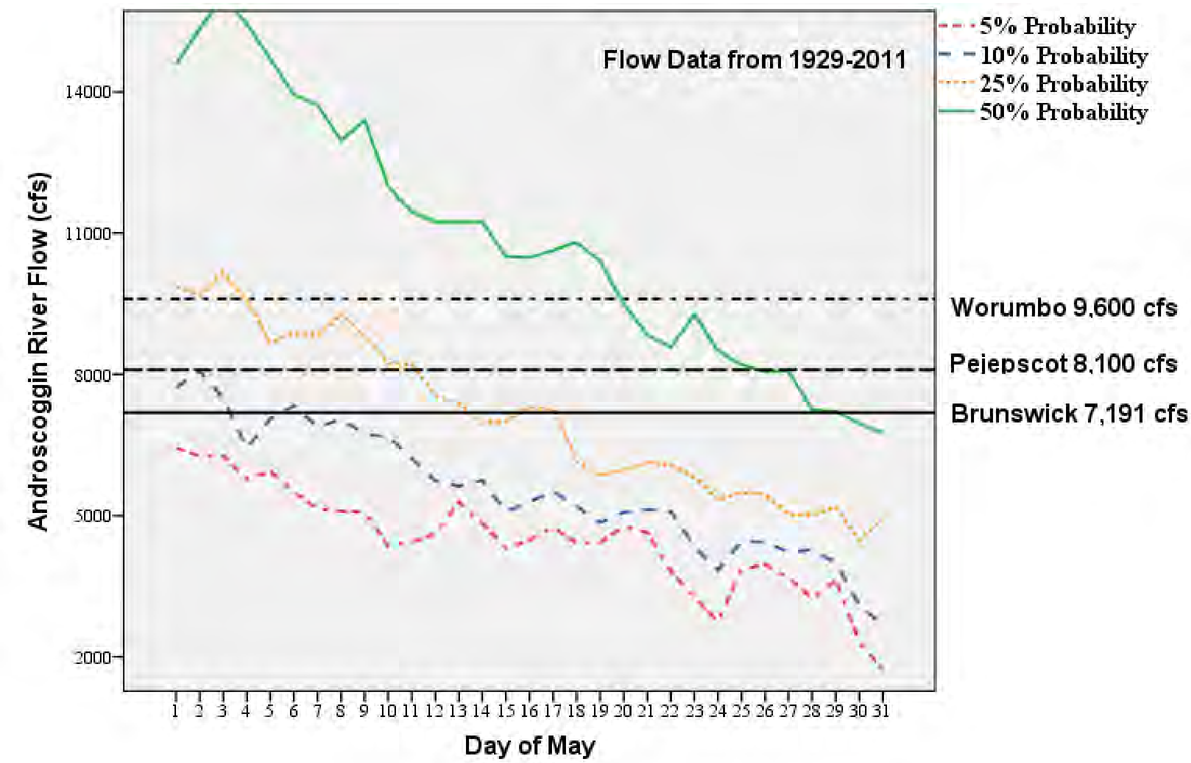


Figure 8.1.2 Relationship between Androscoggin River mean daily flow in May and the hydraulic flow capacity of the Brunswick, Pejepscot, and Worumbo projects. Flow curves represent the 5, 10, 25, 50, 75, and 90th mean daily flow percentiles. Flow volume is based on all days of record for the USGS gage 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 $\leq$ 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 $\leq$ 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 $\leq$ Project hydraulic capacity. The real probability is closer to 75% than it is to 50%.

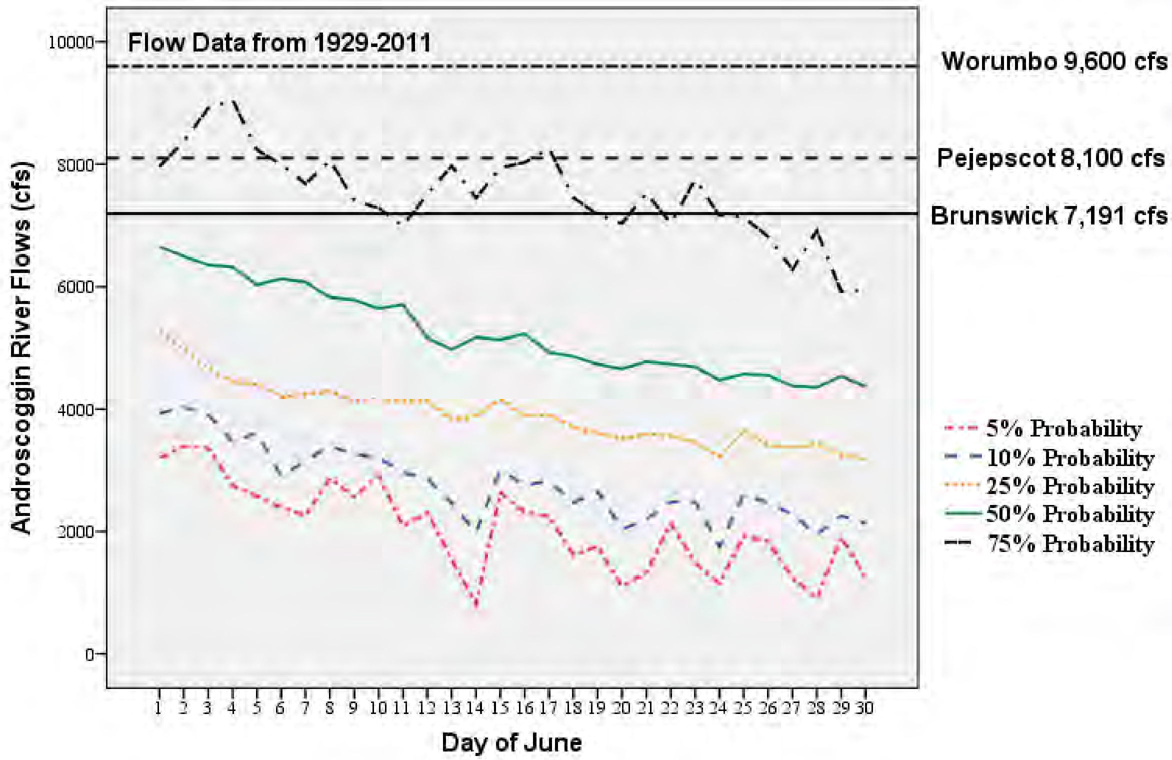


Figure 8.1.3 Relationship between Androscoggin River mean daily flow in June and the hydraulic flow capacity of the Brunswick, Pejepscot, and Worumbo projects. Flow curves represent the 5, 10, 25, 50, 75, and 90th mean daily flow percentiles. Flow volume is based on all days of record for the USGS gage 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.

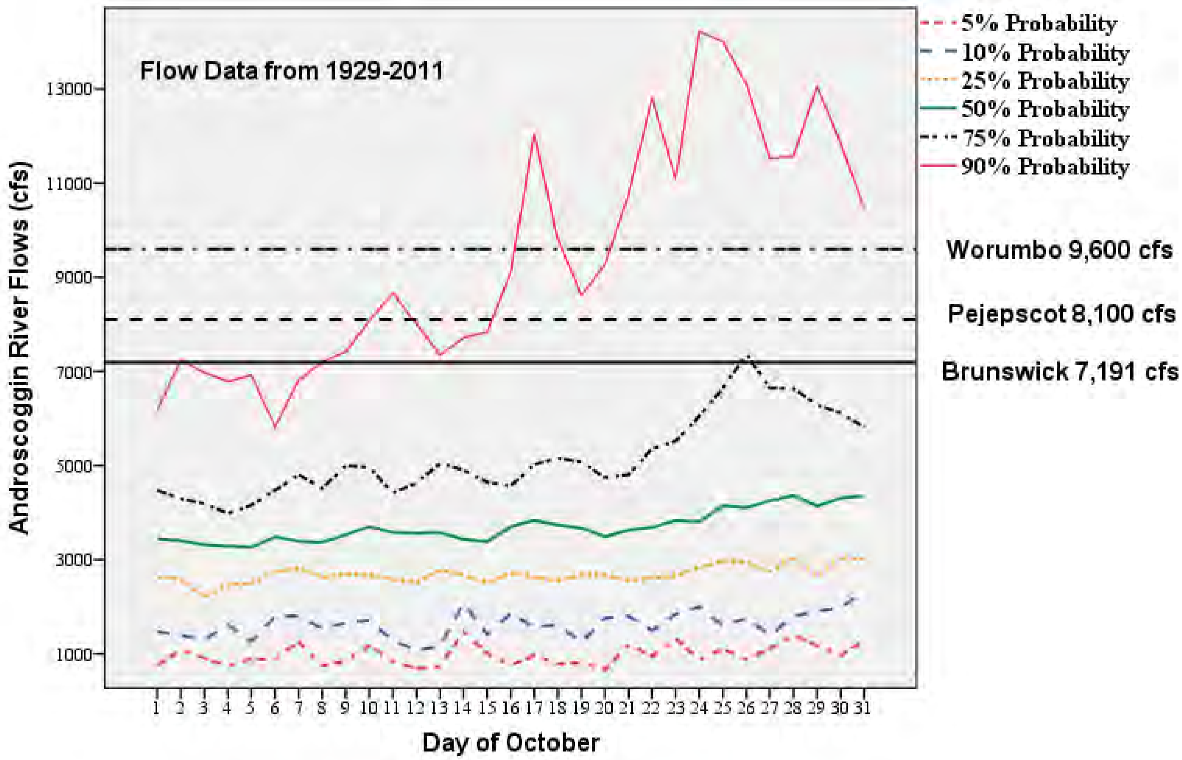


Figure 8.1.4 Relationship between Androscoggin River mean daily flow in October and the hydraulic flow capacity of the Brunswick, Pejepscot, and Worumbo projects. Flow curves represent the 5, 10, 25, 50, 75, and 90th mean daily flow percentiles. Flow volume is based on all days of record for the USGS 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.

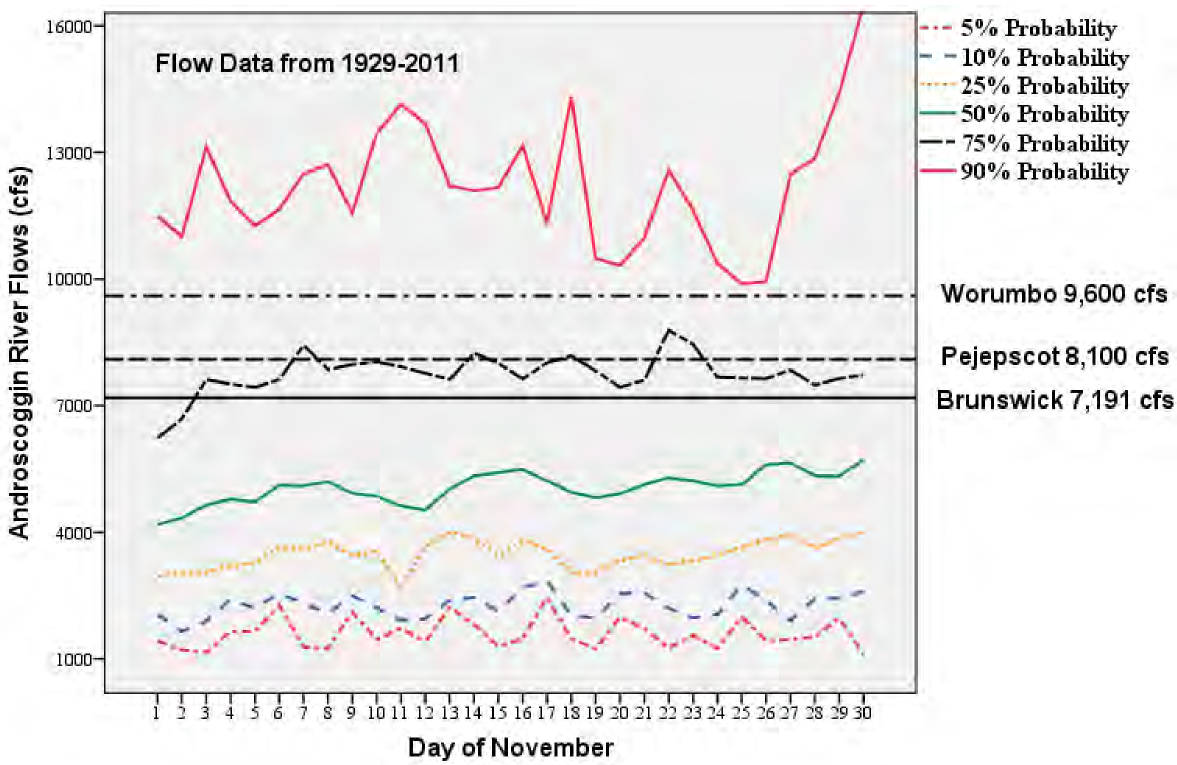


Figure 8.1.5 Relationship between Androscoggin River mean daily flow in November and the hydraulic flow capacity of the Brunswick, Pejepscot, and Worumbo projects. Flow curves represent the 5, 10, 25, 50, 75, and 90th mean daily flow percentiles. Flow volume is based on all days of record for the USGS 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 ≤ 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 $\leq$ 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

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Opinion of Dr. Jeffrey A. Hutchings

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Qualifications

After receiving my doctorate in Evolutionary Ecology from Memorial University of Newfoundland (Canada) in 1991, I undertook postdoctoral research at the University of Edinburgh (Scotland) and at the Department of Fisheries and Oceans, St. John's, Newfoundland. As Killam Professor of Biology at Dalhousie University in Canada and as Adjunct Professor at the University of Oslo in Norway, my research focuses on life history evolution, population ecology, genetics, and conservation biology of fishes. I have published more than 150 research papers in the peer-reviewed, primary scientific literature. Since 1999, I have served on the editorial boards of 6 national and international peer-reviewed scientific journals. From 2006-2010, I chaired Canada's national science advisory body responsible, by federal statute, for assessing the risk of extinction of Canadian species and population (www.cosewic.gc.ca). I am President of the 900-member Canadian Society for Ecology and Evolution (2012-2013). And, since 2009, I have chaired a Royal Society of Canada expert panel studying the effects of climate change, fisheries, and aquaculture on Canadian marine biodiversity, including Atlantic salmon.

Among others, I have had the following experience on scientific issues pertaining to the conservation biology of Atlantic salmon, a species that I started researching thirty years ago, in Newfoundland, in 1982. I was an invited speaker at the inaugural *International Conference on Interactions Between Wild and Cultured Atlantic Salmon* held in Loen, Norway, in April, 1990. Since 1995, I have been regularly invited by the Canadian Department of Fisheries & Oceans (DFO) to serve as a reviewer of stock assessments for Atlantic salmon in the Maritimes and Newfoundland. In 1996, I was a Canadian member of the Canada/U.S. Genetics Subgroup of the *Scientific Working Group on Salmonid Introductions and Transfers*, NASCO (North Atlantic Salmon Conservation Organization). In 1998, I served as a member of two DFO-sponsored, international review panels responsible for assessing the consequences of interactions between wild and cultured Atlantic salmon and striped bass in Atlantic Canada. In 1998 and 2000, I served on 2 separate review panels responsible for evaluating the reasons for the decline of Atlantic salmon returning to North American rivers in the 1990s. Throughout the 2000s, I served on the arms-length-from-government committee (www.cosewic.gc.ca) responsible for assessing the risk of extinction of hundreds of at-risk Canadian species, including Canada's 16 Designatable Units of Atlantic salmon (these are directly analogous to the Distinct Population Segments identified under the U.S. *Endangered Species Act*). Since 2009, I am have co-chaired an international working group at UC Santa Barbara's National Center for Ecological Analysis and

Synthesis on ‘red flags’ of species endangerment (www.nceas.ucsb.edu/projects/12559).

I am being compensated by the Plaintiffs at the rate of US$200 per hour. I have not testified as an expert in any legal matter within the past four years.

1 Introduction

The Gulf of Maine Distinct Population Segment (hereafter, GOM DPS) of Atlantic salmon comprises all sea-run Atlantic salmon whose freshwater range occurs in the watersheds of the Androscoggin River northward along coastal Maine to the Dennys River (including these fish wherever they occur in the estuarine and marine environments, and excluding sections of rivers above impassable falls in some rivers within the DPS) (Fay et al. 2006). The decision by the Biological Review Team to include the Androscoggin and Kennebec Rivers in the DPS (their consideration for inclusion in the DPS in a 2000 final-rule listing decision had been deferred) was based on genetic, life-history, and zoogeographic information (Fay et al. 2006). The GOM DPS is recognized as comprising three Salmon Habitat Recovery Units, or SHRUs. ‘Recovery units’ are deemed necessary to both the survival and recovery of the DPS, according to the National Marine Fisheries Service Interim Recovery Plan Guidance documents. One of these SHRU’s — the Merrymeeting Bay SHRU — comprises salmon in the Androscoggin and Kennebec Rivers.

I have rendered several opinions in this document, which can be summarized as follows. It is my opinion that:

- Restoration of Atlantic salmon populations in both the Androscoggin and Kennebec Rivers of the Merrymeeting Bay SHRU is fundamentally important to the recovery of the GOM DPS of Atlantic salmon;
- Hatchery fish are necessary — but far from sufficient — for the recovery of the Atlantic salmon populations of the Androscoggin and Kennebec Rivers, Merrymeeting Bay SHRU, and, thus, the recovery of the GOM DPS;
- Partitioning of the GOM DPS into three SHRU’s is scientifically reasonable and representative of a responsible management strategy consistent with a precautionary approach to the conservation of biodiversity;
- An Atlantic salmon population that experienced the current levels of smolt-adult survival experienced by hatchery-origin smolts that pass by dams during their downstream migration in the GOM DPS would not increase in abundance and would never recover;
- The mortality experienced by downstream migrating smolts and kelts and by upstream migrating returning adults attributable to dam facilities in the Merrymeeting Bay SHRU will have an adverse impact on the survival and the prospects for recovery of the SHRU and, thus, of the GOM DPS as a whole;
- Given the exceedingly low numbers of returning adults to the SHRU, most notably of fish of wild origin, the loss of a single smolt, or of a single adult, to human-induced causes is significant.

2 Gulf of Maine Distinct Population Segment of Atlantic Salmon

2.1 Importance of the Androscoggin and Kennebec Rivers to the recovery and persistence of the DPS

For recovery purposes, the GOM DPS is partitioned into three Salmon Habitat Recovery Units, or SHRU's. In my opinion, the restoration of Atlantic salmon populations in the Androscoggin and Kennebec Rivers, which comprise the Merrymeeting Bay SHRU, are fundamentally important to the recovery of the Gulf of Maine DPS of Atlantic salmon.

The Androscoggin (266 km long) and Kennebec (373 km) Rivers are among the largest in the GOM DPS. The lengths of these rivers dwarf the lengths of the Downeast Maine rivers (16-107 km long) that are part of the GOM DPS. As a consequence, they are vital to the recovery and persistence of the DPS. It is well-established that large, complex river systems – such as the Androscoggin and Kennebec Rivers – are capable of supporting large salmon populations (Aas et al. 2011). It is also well established that, all else being equal, large populations are less vulnerable than small populations to extinction (*e.g.,* Shaffer 1981; Caughley 1994; Allendorf and Luikart 2007). The greater the number of individuals in a population, the less likely it is that the population will decrease (and the greater the chance that the population will persist) because of: (i) unpredictable environmental changes that similarly affect all individuals (termed 'environmental stochasticity'); (ii) unpredictable environmental changes that affect some but not all individuals (termed 'demographic stochasticity'); and (iii) unpredictable changes in genes and/or gene frequencies, which can lead to inbreeding and the fixation of harmful genes (termed 'genetic stochasticity') (Lande 1988, 1993).

Large populations are also less likely to experience a situation manifested by what is termed an 'Allee effect', which can lead to population decline. It is normally assumed that as populations decrease in abundance, their *rate of population growth* steadily increases (Gotelli 2010). Population growth rate is assumed to increase because as a population declines, conditions favorable to survival, growth, and reproduction should improve; lower population abundance is assumed to translate into reduced competition, meaning that each individual has better access to necessary resources, such as food, at low population abundance than at high population abundance. An Allee effect exists when population growth rate begins to decline, rather than increase, at a certain 'threshold' level of abundance (Courchamp et al. 2008). All else being equal, large populations are less likely than small populations to decline to this threshold level of abundance, at which the Allee effect is expressed.

Large populations are also of fundamental importance to the recovery of the GOM DPS because of the contributions that large populations make to the persistence of small populations, such as those that exist in the northern coastal part of the DPS. This is because of the 'straying' characteristic of salmon populations. (Based on historical documents, such as those written by Atkins and Foster (1867, 1868), it is highly probable that the Androscoggin, Kennebec, and Penobscot Rivers each once supported adult salmon populations comprising at least 100,000 spawning adults.)

That is, when adults return from the ocean to their natal rivers to spawn, errors in migration can occur, and some adults (albeit a small percentage, estimated to be 1% for the GOM DPS; Baum 1997) end up spawning in rivers in which they were not born. This straying can be extremely important to the persistence of small salmon populations (that are at greater risk of decline because of the three forms of stochasticity, or unpredictability, identified above) because of the additional spawners that large populations, produced by large rivers, can provide (Fraser et al. 2007). Put another way, the large salmon populations that can be produced by large rivers, such as the Androscoggin, Kennebec, and Penobscot Rivers of the GOM DPS, can provide a 'rescue effect' to small populations, thus increasing the chance that population groups, such as the GOM DPS, will persist through time.

In addition to their potential for producing large populations of salmon, the inclusion of the Androscoggin and Kennebec Rivers in the GOM DPS provides far greater potential for the ability of the DPS to adapt to future environmental change. This is because of the *increased diversity* that recovered salmon populations in the Merrymeeting Bay SHRU would provide to the DPS as a whole.

Diversity is directly related to persistence. The more variable systems are, the more likely they will persist over time. Stock market portfolios typically reflect breadth to reduce the overall risk to one's investment capital. Farmers typically grow a variety of crops to reduce the chance of failure of any one particular crop. From a biological perspective, high genetic diversity increases the likelihood of having or producing individuals with genes that will allow adaptation to environmental change, including alterations to habitat or biological community brought about by natural variation and human actions.

The greater the genetic variation and the phenotypic differentiation (*i.e.,* variation in observable characteristics such as body size, behavior, and growth) within and among salmon populations, the greater the likelihood that some salmon populations within the DPS will be better able to respond favorably to environmental change than others. Extremely strong evidence of the vital importance of population differentiation and diversity to the persistence of salmon meta-populations, or DPS's, has recently been provided in a study of sockeye salmon in the Gulf of Alaska (Schindler et al. 2010).

2.2 Importance of hatchery fish to the recovery of the Merrymeeting Bay SHRU

It is my opinion that hatchery fish are necessary — but far from sufficient — for the recovery of the Merrymeeting Bay SHRU of Atlantic salmon and, thus, the recovery of the GOM DPS. Hatchery fish are likely to be of greatest importance to recovery efforts during the initial years of the recovery program, when population numbers are very low, as they are now. At present, as Table 1 below indicates, fewer than 10 adult fish of wild origin have been returning to the SHRU annually in each of the past five years for which data are available (2006-2010). This is an exceedingly low number of returning adults and places the SHRU at heightened risk of extinction because of the SHRU's increased susceptibility to stochastic, unpredictable events — anything from droughts to disease to chemical spills — that increase the chance of extinction. *Any measure that increases the chances of survival to the returning-adult stage will reduce the SHRU's probability of extinction.*

Even though hatchery-origin fish have lower survival rates than wild-origin fish in the GOM DPS (Table 2), they are capable of increasing the number of spawning adults in the short term, providing a potentially important 'kick start' to the recovery process (Waples et al. 2007; Berejikian et al. 2008). The period of time that constitutes the 'short term' depends on many factors and cannot be articulated precisely for any given situation. Nonetheless, it has been noted that fitness losses in salmonids can potentially arise after only 1 or 2 generations of captive-breeding/rearing (Fraser 2008; Christie et al. 2011). And there is considerable evidence, both theoretical and empirical in nature, to suggest that the magnitude of fitness loss increases as the duration of hatchery populations in captivity increases. As concluded by Fraser (2008) in his exhaustive review of the ability of hatchery and captive breeding programs to conserve salmonid biodiversity, "No matter how good the intentions, it would appear that as yet, humans have not generated a group of captive-bred/reared fish that on average will perform equally to wild fish once they are released into the wild".

Notwithstanding their importance in the early stages of the recovery program, the use of hatchery fish does not present a medium- or long-term solution. One reason for this can be attributed to the genetic and phenotypic differences that exist between hatchery-spawned and/or reared fish and those that are spawned and reared in the wild (Fraser 2008; Christie et al. 2011). Such differences can exist even in the offspring of hatchery broodstock obtained directly from the wild because of inherited maladaptive phenotypic characteristics. A second reason, as discussed in greater detail below (section 3.2), is the observation that smolts of hatchery origin (documented for Penobscot River smolts that must pass dams during their downstream migration) within the GOM DPS are estimated to have less than 25% the rate of survival to the adult stage as smolts of wild origin (documented for Narraguagus River smolts that do not pass dams during their downstream migration) (USASAC 2011). It is my opinion that some part of the elevated mortality experienced by hatchery-origin smolts in the Penobscot River is caused by their hatchery origin and some part is caused by their passage by dams. A third reason, also discussed below (Section 3.3), is that an Atlantic salmon population that experiences the smolt-adult survival rates that have been documented for hatchery-origin smolts in the GOM DPS (and that pass by dams in the Penobscot River) will experience negative population growth, meaning that it will decline with time.

In short, while hatchery-bred fish and eggs can provide an essential supplement to wild salmon populations at the brink of extinction, such as those in the Merrymeeting Bay SHRU, they cannot by themselves bring such populations back to sustainable levels. That is, hatchery fish are necessary — but far from sufficient — for the recovery of the Atlantic salmon populations of the Androscoggin and Kennebec Rivers, Merrymeeting Bay SHRU, and, thus, the recovery of the GOM DPS.

2.3 Recovery of Salmon Habitat Recovery Units (SHRU's)

In my opinion, the partitioning of the GOM DPS of Atlantic salmon into three Salmon Habitat Recovery units, or SHRU's, is scientifically sound, theoretically and empirically defensible, and representative of a responsible management strategy consistent with a precautionary approach to resource management and the conservation of biodiversity.

As noted by the 2009 draft of the Gulf of Maine Distinct Population Segment Management Guidance for Recovery (NOAA 2009), "maintaining a population in all three SHRU's is necessary in order to preserve the genetic variability of the DPS, which in turn is necessary in ensuring that the population is capable of adapting to and surviving natural environmental and demographic variation that all populations are subjected to over time".

The responsible authorities have proposed a minimum census abundance of 500 spawners of non-hatchery origin for each SHRU to serve as a "benchmark to evaluate the population as either recovered or one that requires protection under the ESA [Endangered Species Act]" (NOAA 2009). That is, the census abundance of 500 spawners per SHRU is meant to provide a 'starting point' for establishing delisting criteria (NOAA 2009). As noted by NOAA (2009), this benchmark of 500 spawners is consistent with viability criteria established for endangered and threatened salmonid populations elsewhere in the U.S, such as those in the Interior Columbia Basin (Cooney et al. 2007) and in the Central Valley region of California for endangered winter-run Chinook salmon, threatened spring-run Chinook salmon, and threatened steelhead (NMFS 2009). It is worth noting, however, that this benchmark of 500 is less than 1% of the presumed historical spawning population sizes of at least 100,000 for *each* river within the SHRU.

It is also important that the benchmark of 500 spawners be distributed between the Androscoggin and Kennebec Rivers to ensure that the breadth of ecological and environmental conditions that each river's watershed contributes to the process of natural selection in salmon is maintained. It is necessary to maintain this breadth in order to generate the genetic and phenotypic variability within and among salmon populations that is necessary for the Merrymeeting Bay SHRU to contribute positively to the persistence of the GOM DPS.

3 Merrymeeting Bay SHRU

3.1 Current status: numbers of returning adults

Remnant populations of Atlantic salmon exist in the Merrymeeting Bay SHRU. As noted above and elsewhere (*e.g.,* Baum 1997), historical records indicate that several hundred thousand adults returned annually to the largest rivers in the GOM DPS. Atkins and Foster (1867) estimated that between 68,000 and 216,000 adults were harvested in Kennebec River in 1820, and that the average annual yield of salmon in Penobscot River, before the construction of dams in the river, could not have been less than 150,000 adult salmon (Atkins and Foster 1868).

The historical numbers of salmon returning annually to the largest rivers in the GOM DPS were more than ten thousand times greater than the annual counts of adults of wild origin in the Androscoggin and Kennebec Rivers in the past 3 to 4 decades (Table 1; USASAC 2011). Several observations can be drawn from these census count data:

- Since 2006, fewer than 50 adults have returned annually to the Androscoggin River; in 4 of the past 6 years, the numbers of returning adults have numbered 20 or less;
- Since 2006, fewer than 65 adults have returned annually to the Kennebec River; in 4 of the past 6 years, the numbers of returning adults have numbered 21 or less;
- Since 2006, the number of adults returning to the Merrymeeting Bay SHRU has fluctuated considerably, reaching a low of 14 adults in 2010 and a high of 110 adults in 2011;
- Based on the most recent 5 years for which data are available (2006-2010), 77% of adults returning to the Merrymeeting Bay SHRU have been of hatchery origin;
- Based on the most recent 5 years for which data are available (2006-2010), 71% of adults returning to the Merrymeeting Bay SHRU that were spawning for the first time were two-sea-winter (2SW) fish (meaning they spent 2 winters at sea before returning to the river to spawn);
- Based on the most recent 5 years for which data are available (2006-2010), 4% of adults returning to the Merrymeeting Bay SHRU have been 3SW fish or Previous Spawners (PS) (*i.e.*, adults who spawned, returned to the sea, and are back to spawn again).

The proportion of 1SW, 2SW, 3SW, and PS salmon varies considerably among Atlantic salmon populations throughout the species' range. In the GOM DPS, the incidence of 2SW adults is quite high; much higher than the incidence in many rivers in Nova Scotia and New Brunswick and far greater than those in Newfoundland (where most salmon spawn as 1SW adults) (Hutchings and Jones 1998). These differences in sea-age at maturity are adaptive, meaning that, in the GOM DPS, adults that return to spawn as 2SW fish have greater reproductive success (are better 'adapted' to local environments) than salmon returning to spawn at other ages. However, it is certainly possible that the recent predominance of 2SW adults represents an adaptive response to recent (*e.g.,* past century) human-induced changes to the environment, meaning that 2SW adults might not have been as dominant historically when 3SW (and possibly 4SW) adults might have been more common. It is also reasonable to hypothesize that PS fish, which migrate downstream to the sea as 'kelts', represent genotypes that are well-adapted to current local conditions, given that they survived to potentially spawn more than once – further emphasizing the importance of safe downstream passage for kelts.

3.2 Survival rates

In general, the life cycle of Atlantic salmon can be thought of as comprising three stages: (i) egg-to-smolt stage; (ii) smolt-to-spawning-adult stage; (iii) post-spawning stage. The first stage represents the period from the time at which the eggs are released by the female until the time at which the salmon begin their downstream migration to the ocean as smolts. The second stage represents the period from the beginning of the smolt migration until the time at which the returning adults are spawning. The third stage represents the 'kelt' or 'previous spawner' stage and extends from the time of initial spawning until the time at which the same individual spawns again.

Table 1. *Atlantic salmon of wild and hatchery origin returning to Androscoggin and Kennebec Rivers (USASAC 2011). Abbreviations: 1SW, 2SW, 3SW refer to salmon that spent 1, 2, and 3 winters at sea, respectively, before returning to a river to spawn for their first time; PS refers to Previously Spawned adult; NA= data not yet available.*

		Hatchery Origin				**Wild Origin**				**Total**
River	**Years(s)**	**1SW**	**2SW**	**3SW**	**PS**	**1SW**	**2SW**	**3SW**	**PS**	
Androscoggin	1983-2000	26	507	6	2	6	83	0	1	631
	2001	1	4	0	0	0	0	0	0	5
	2002	0	2	0	0	0	0	0	0	2
	2003	0	3	0	0	0	0	0	0	3
	2004	3	7	0	0	0	1	0	0	11
	2005	2	8	0	0	0	0	0	0	10
	2006	5	1	0	0	0	0	0	0	6
	2007	6	11	0	0	1	2	0	0	20
	2008	8	5	0	0	2	1	0	0	16
	2009	2	19	0	0	0	3	0	0	24
	2010	2	5	0	0	0	2	0	0	9
	2011									47
Annual average	**2006-2010**	**4.6**	**8.2**	**0**	**0**	**0.6**	**1.6**	**0**	**0**	**15**
Annual average	**2007-2011**	NA	NA	NA	NA	NA	NA	NA	NA	**23.2**
Kennebec	1975-	12	189	5	1	0	9	0	0	216

	2000									
	2006	4	6	0	0	3	2	0	0	15
	2007	2	5	1	0	2	6	0	0	16
	2008	6	15	0	0	0	0	0	0	21
	2009	0	16	0	6	1	10	0	0	33
	2010	0	2	0	0	1	2	0	0	5
	2011									63
Annual average	**2006-2010**	**2.4**	**8.8**	**0.2**	**1.2**	**1.4**	**4.0**	**0**	**0**	**18**
Annual average	**2007-2011**	NA	NA	NA	NA	NA	NA	NA	NA	**27.6**

Estimates of survival between the egg and smolt stages are rare for populations within the GOM DPS, based on the reviews undertaken by Bley and Moring (1988) and by Hutchings and Jones (1998). The only study cited by either review for GOM DPS Atlantic salmon is the work of Meister (1962) who provided an estimate of 1.1% for salmon in Cove Brook, Maine (part of the GOM DPS). Based on egg-smolt survival data compiled for 12 rivers worldwide, Hutchings and Jones (1998) reported a median probability of surviving between the egg and smolt stages of 0.0137 (*i.e.,* 1.37%). Restricting the smolt-adult survival data to those populations (located in New Brunswick and Québec) nearest to the GOM DPS (Big Salmon River: 0.0017; Miramichi: 0.0047; Pollett: 0.0198; Bec-Scie: 0.0156; Saint-Jean: 0.303; and Trinité: 0.0324), the median egg-smolt survival is 0.0177. For the model simulations used here, the value of 0.0177 was used. (Note that this value of almost 1.8% exceeds the value estimated by Meister (1962) for a GOM DPS salmon population.)

Estimates of survival between the smolt and returning-adult stages are not available for the Merrymeeting Bay SHRU populations. However, there are smolt-adult survival estimates available for salmon in two other rivers in the GOM DPS (USASAC 2011). These survival data distinguish Penobscot River smolts of hatchery origin that pass by one or more dams during their downstream migration and Narraguagus River smolts of wild origin for which their downstream passage is unimpeded by dams. Smolt-adult survival data are available from: (i) 1969 to 2009 for hatchery-origin smolts returning as 1SW adults to Penobscot River; (ii) 1969 to 2008 for hatchery-origin smolts returning as 2SW adults to Penobscot River; and (iii) 1997 to 2008 for wild-origin smolts returning as 2SW adults to Narraguagus River (Table 2).

Estimates of survival during the kelt stage in the scientific literature are rare. In a Newfoundland population where all of the fish spawn as 1SW adults, Chadwick et al. (1978) estimated a mean overwinter survival of post-spawning 1SW fish to the kelt stage to be 63%. Given the absence of data for other rivers, that is the estimate used here. (Although there are reports that 20% of kelts migrate downstream before winter in the Merrymeeting Bay SHRU (NextEra 2011), it is assumed here that all kelts spend the winter in the river before returning to the ocean the following spring. This assumption has little effect on the final model results.) During their downstream migration, kelts are assumed to experience a survival rate of 82% as they pass each dam (based on the average of 4 whole-station kelt survival estimates for dams in the Kennebec and Androscoggin Rivers; NextEra 2011). Once kelts have entered the ocean, they are assumed to experience an 80% survival rate prior to their return to the river in the same year to spawn.

3.3. Population growth rate

It is my opinion that an Atlantic salmon population that experienced the current levels of smolt-adult survival realized by hatchery-origin smolts that pass by dams during their downstream migration in the GOM DPS (Table 2) would not increase in abundance and would never recover.

A standard measure of density-independent population growth is provided by r, a parameter often referred to as the intrinsic rate of population growth (*e.g.,* Gotelli 2010). Using life-history data (*i.e.,* information on a survival rates and estimates of the number of eggs a female produces), population growth rate (r) can be estimated from what is commonly known as the Euler-Lotka equation (Roff 2002; Gotelli 2010):

$$1 = l_x\, m_x \exp(-rx)$$

where l_x is the probability of surviving from birth until age x and m_x is the number of eggs produced by an individual breeding at age x (Roff 2002). In estimating r for the Merrymeeting Bay SHRU, the number of eggs per female was assumed to be 8,500 eggs for each adult spawning for the first time and 10,000 eggs for each Previously Spawned adult (or kelt), based on eggs-per-female data provided by USASAC (2011). By estimating population growth rate, one can then determine whether a population is likely to increase or decrease under a range of potential survival conditions. When a population is increasing, the population growth rate (r) is positive and it is greater than zero; when a population is declining, r is negative and it is less than zero.

Table 2. *Estimates of the survival of fish, expressed as a proportion, between the smolt and returning-adult stage over the most recent ten-year period for which data are available (USASAC 2011). If survival is sufficient to result in population growth (meaning that the number of returning adults would increase over time), a positive sign is indicated in parentheses. If survival is not sufficient to produce population growth (meaning that the number of returning adults would decline over time), a negative sign is indicated. 'Year of Smolt Cohort' is the year in which smolts migrated downstream to the ocean. Abbreviations: SW=sea winter; H=hatchery-origin smolts that pass dams in Penobscot River; W=wild-origin smolts that pass no dams in Narraguagus River.*

Year of Smolt Cohort	**2SW (W)**	**2SW (H)**	**1SW (H)**
2009	--------	--------	0.0009 (−)
2008	0.0063 (+)	0.0020 (−)	0.0006 (−)
2007	0.0200 (+)	0.0036 (−)	0.0018 (−)
2006	0.0076 (+)	0.0030 (−)	0.0006 (−)
2005	0.0073 (+)	0.0014 (−)	0.0008 (−)
2004	0.0097 (+)	0.0015 (−)	0.0007 (−)
2003	0.0104 (+)	0.0016 (−)	0.0007 (−)
2002	0.0060 (+)	0.0021 (−)	0.0006 (−)
2001	0.0084 (+)	0.0019 (−)	0.0008 (−)
2000	0.0017 (−)	0.0010 (−)	0.0006 (−)
1999	0.0052 (+)	0.0011 (−)	--------

10-year average	0.0083 (+)	0.0019 (−)	0.0008 (−)

Three important conclusions can be drawn from the data in Table 2, which represent prevailing smolt-adult survival rates for two rivers in the GOM DPS:

- During the past ten years, the survival to the 2SW adult stage has, on average, been *4 times greater* for smolts of wild origin that pass *no* dams during downstream migration (0.83%) than it has been for smolts of hatchery origin that *do* pass dams during downstream migration (0.19%);
- An Atlantic salmon population that experienced the smolt-adult survival rates reported for wild-origin 2SW adults that do not migrate past dams would increase with time ($r > 0$ in 9 of the past 10 years);
- An Atlantic salmon population that experienced the smolt-adult survival rates reported for hatchery-origin 2SW adults that must migrate past dams would decrease with time ($r < 0$ every year in the past 10 years).

Another, and perhaps more intuitive, way to think of the survival data in Table 2 is to determine the number of smolts required to produce a single returning adult. (This is simply 1 divided by the survival proportions given in Table 2.) These estimates are given in Table 3. They show that, on average, and over the past ten years:

- In the absence of dams, 120 wild-origin smolts are required to produce a single returning 2SW adult;
- In the presence of dams, 526 hatchery-origin smolts are required to produce a single returning 2SW adult;
- In the presence of dams,1250 hatchery-origin smolts are required to produce a single returning 1SW adult.

Table 3. *Smolt-to-adult survival data from Table 2 expressed as the number of smolts required to produce a single returning adult. For example, if smolt-adult survival was 0.001, the number of smolts required to produce 1 returning adult is 1/0.001 = 1,000. Abbreviations are the same as those in the caption for Table 2.*

Year of Smolt Cohort	**2SW (W)**	**2SW (H)**	**1SW (H)**
2009	--------	--------	1111
2008	159	500	1667
2007	50	278	556
2006	132	333	1667
2005	137	714	1250
2004	103	667	1429
2003	96	625	1429
2002	167	476	1667
2001	119	526	1250
2000	588	1000	1667
1999	192	909	--------
10-year average	**120**	**526**	**1250**

4 Effect of Dams on the Merrymeeting Bay SHRU

4.1 Effect of dams on survival

For the Merrymeeting Bay SHRU of Atlantic salmon, there are potentially several periods of life during which survival is negatively affected by the presence of dams. One occurs during the smolt migration; a second occurs during the upstream migration of returning adults to the spawning grounds. Additional periods would include the downstream and subsequent upstream migrations of post-spawning kelts. And the prevention of upstream migration by spawning adults to suitable spawning habitat would represent another example of how the presence of dams can affect population viability and persistence.

There are estimates of smolt survival as they pass by dam facilities. Based on the four estimates of whole-station smolt survival available for the Kennebec and Androscoggin Rivers (NextEra 2011), the average whole-station survival rate per dam, using the initial injury rate model estimates (the most defensible estimates among those available), is 87%. (These 'initial' injuries include scale loss, gill damage, severed body/backbone, and bruised head or body (NextEra 2011), all of which can be expected to result in significantly increased likelihood of death. However, the injury-rate mortality estimates do not account for delayed mortality, *i.e.*, the mortality that occurs after a smolt has passed a dam but that can be attributed to dam passage.) Although estimates of the survival probabilities for upstream migrating adults could be estimated from available data (potentially between 67 and 76%; Bailey 2011), these estimates will not be considered further in this opinion for the purpose of predicting recovery times and population growth rate. In other words, the assumption here is that *all* returning adults survive the upstream migration to the spawning grounds. This assumption will have the effect of *under*-estimating recovery times and *over*-estimating population growth in the forecasts presented below. The forecasts presented here are thus conservative estimates that understate the effects that dams have on Atlantic salmon mortality. Put another way, the forecasts demonstrate that even if existing dams were modified to provide 100% effective upstream passage, the downstream impacts alone will have significant effects.

As mentioned previously, survival data are not available for salmon in the Merrymeeting Bay SHRU, necessitating the use of survival data for the only two rivers in the GOM DPS for which such data are available: the Penobscot and Narraguagus Rivers. Given that there are dams on the Penobscot River, it is not unreasonable to consider the prevailing smolt-adult survival rates experienced by hatchery-origin smolts, recorded from the Penobscot River (Table 2), to be representative of prevailing smolt-adult survival in the presence of dams for salmon in the Androscoggin and Kennebec Rivers. Similarly, it is not unreasonable to consider the prevailing smolt-adult survival rates experienced by wild-origin smolts, recorded from the Narraguagus River (Table 2), to be representative of prevailing smolt-adult survival in the absence of dams for salmon in the Androscoggin and Kennebec Rivers.

The smolt-adult survival data in Table 2 allow for two different analyses to be undertaken to explore the effects of dams on salmon population growth rate and recovery. The first method involves *removing* the effects of dam-related mortality on kelt survival and from the smolt-adult survival rates reported for hatchery-origin smolts in the Penobscot River. The second method involves *including* the effects of dam-related mortality on kelt survival and on the smolt-adult survival rates reported for wild-origin smolts in the Narraguagus River. The use of *both* approaches should yield an empirically defensible range of estimates of the consequences of dams to the population growth rate and recovery of the Merrymeeting Bay SHRU.

To *remove* the influence that each dam has on smolt-adult survival (using the Penobscot River data), one simply needs to *divide* the prevailing survival rate (*i.e.*, those for *hatchery*-origin smolts presented in Table 2, which factor in mortality related to passing multiple dams) by 0.87^n, where *n* represents the number of dams through which smolts must pass during their downstream migration and for which one is now assuming 100% safe downstream passage. To *include* the influence that each dam has on smolt-adult survival (using the Narraguagus River data), one *multiplies* the prevailing survival rate (*i.e.*, those for *wild*-origin smolts that do not pass dams; Table 2) by 0.87^x, where *x* represents the number of dams through which smolts must pass during their downstream migration.

Based on hatchery-origin smolt survival rate data from the Penobscot River, even if smolt and kelt survival were to be improved when passing 3 dams now presumed 100% safe or 4 dams now presumed 100% safe, the population growth rate (*r*) would be negative (Table 4).

Based on wild-origin smolt survival rate data from the Narraguagus River (in which dams do not affect salmon passage), if smolt and kelt survival declined when passing 3 or 4 dams, the population growth rate (*r*) would be negative for 6 of the past 10 years in the presence of 3 dams and negative for 7 of the past 10 years in the presence of 4 dams (Table 4).

4.2 Effects of dams on recovery time

The population growth rate (*r*) can be used to predict the times required for the Merrymeeting Bay SHRU to reach 500 returning adults of wild origin. The estimates provided here represent scenarios for which there is no future input of hatchery-origin fish into the SHRU, *i.e.*, all of the production will be assumed to originate from fish spawning in the wild. Of course, additional inputs of hatchery-origin fish into the Kennebec River are anticipated. What this means for the forecasts presented here is that the predicted recovery times may be over-estimated. However, the *qualitative* differences in recovery times under different survival-rate scenarios will not be affected. For example, if the time to achieve 500 adults is estimated to be 60 years if smolts and kelts experience 100% survival through each of 3 dams, as opposed to 120 years under survival rates of smolt and kelt involving passage through dams, the 60- and 120-year time frames might represent over-estimates, but the predicted *doubling* of recovery time is a robust estimate of the effects of dams on recovery time.

Table 4. *Estimates of the survival of fish, expressed as a proportion, between the smolt and returning-adult stage over the most recent ten-year period for which data are available (a) if the smolt survival consequences of migrating past 3 and 4 dams are included in the smolt-adult survival rates of 2SW wild-origin smolts (see* '2SW (W)' *in the table) or (b) if the smolt survival consequences of migrating past 3 and 4 dams are excluded from the smolt-adult survival rates of 2SW and 1SW hatchery-origin smolts (see* '2SW (H) and 1SW (H)' *in the table.*

Year of Smolt Cohort	**2SW (W)**		**2SW (H)**		**1SW (H)**	
	3 dams' impacts included	4 dams' impacts included	3 dams' impacts removed	4 dams' impacts removed	3 dams' impacts removed	4 dams' impacts removed
2009	--------	--------	--------	--------	0.0014 (−)	0.0016 (−)
2008	0.0042 (−)	0.0036 (−)	0.0030 (−)	0.0035 (−)	0.0009 (−)	0.0010 (−)
2007	0.0132 (+)	0.0115 (+)	0.0055 (−)	0.0063 (+)	0.0027 (−)	0.0031 (−)
2006	0.0050 (−)	0.0044 (−)	0.0046 (−)	0.0052 (−)	0.0009 (−)	0.0010 (−)
2005	0.0048 (−)	0.0042 (−)	0.0021 (−)	0.0024 (−)	0.0012 (−)	0.0014 (−)
2004	0.0064 (+)	0.0056 (+)	0.0023 (−)	0.0026 (−)	0.0011 (−)	0.0012 (−)
2003	0.0068 (+)	0.0060 (+)	0.0024 (−)	0.0028 (−)	0.0011 (−)	0.0012 (−)
2002	0.0040 (−)	0.0034 (−)	0.0032 (−)	0.0037 (−)	0.0009 (−)	0.0010 (−)
2001	0.0055 (+)	0.0048 (−)	0.0029 (−)	0.0033 (−)	0.0012 (−)	0.0014 (−)
2000	0.0011 (−)	0.0010 (−)	0.0015 (−)	0.0017 (−)	0.0009 (−)	0.0010 (−)
1999	0.0034 (−)	0.0030 (−)	0.0017 (−)	0.0019 (−)	--------	--------
10-year average	**0.0054 (+)**	**0.0047** (−)	**0.0029 (−)**	**0.0034 (−)**	**0.0012 (−)**	**0.0014 (−)**

To estimate recovery times for the Merrymeeting Bay SHRU under different smolt-adult survival scenarios, one can use the following equation (Gotelli 2010) to estimate how the abundance of returning adults (N) will change with generation time (t) for different rates of population growth (r) for any particular starting population size (N_0):

$$N_t = N_0 (\exp(rt)) \quad .$$

For the present purposes, the starting population size (N_0) was set to two numbers. The first (N_0 = 50) represents the average number of adults returning to the Merrymeeting Bay SHRU in the past 5 years (2007-2011; Table 1). The second (N_0 = 110) represents the maximum number of adults returning to the SHRU in the past 5 years (in 2011; Table 1). The time required to achieve 500 2SW adults is equal to the number of generations (t) multiplied by 5 years (Table 5).

The results of this analysis indicate that the presence of dams very significantly increases the time required to achieve the benchmark of 500 wild spawners in the Merrymeeting Bay SHRU.

The first analysis uses the smolt-adult survival data for wild-origin 2SW

Narraguagus River salmon as the baseline and incorporates the survival consequences of dam passage for smolts and kelts. The results indicate that the presence of 3 dams, when compared to the no-dam scenario, reduces population growth rate to such a large extent (*r* declines from 0.130 to 0.015) that the recovery time is increased by a factor almost ten. The same analysis indicates that population growth rate (*r*) would be negative (−0.02) in the presence of 4 dams, meaning that the population would never recover.

The risk of such greatly extended recovery times — and the reason one would want to reduce recovery time — is that the longer a population exists near the brink of extinction, the more likely it is that one or more stochastic, unpredictable events will occur which might significantly increase the chance of extinction of the SHRU.

The second analysis uses the smolt-adult survival data for hatchery-origin 2SW and 1SW Penobscot River salmon as the baseline and removes the survival consequences of dam passage for smolts and kelts. The results suggest that 100% safe passage by both smolts and kelts by either 3 or 4 dams would not be sufficient to result in positive population growth, meaning that the population would never recover.

Table 5. *Estimated effects of dams on smolt-adult survival, population growth rate (r), and the estimated time, in years, for a population size of 500 adults to be attained, under two different starting population sizes (N_0 = 50 and 110). For 2SW wild-origin smolts* ('2SW (W)')*, the current conditions reflect survival in the absence of dams; by including the effects of dams on survival, the smolt-adult survival rates are reduced. For 2SW and 1SW hatchery-origin smolts* ('2SW (H)' *and* '1SW (H)')*, the current conditions reflect survival in the presence of dams; by excluding the effects of dams on survival, the smolt-adult survival rates are increased.*

	2SW (W)			**2SW (H)**			**1SW (H)**		
	Current smolt survival	Lowered smolt and kelt survival through 3 dams	Lowered smolt and kelt survival through 4 dams	Current smolt survival	100% smolt and kelt survival through 3 dams	100% smolt and kelt survival through 4 dams	Current smolt survival	100% smolt and kelt survival through 3 dams	100% smolt and kelt survival through 4 dams
10-year average smolt-adult survival	0.0083	0.0054	0.0047	0.0019	0.0029	0.0034	0.0008	0.0012	0.0014
Population growth rate (*r*)	0.130	0.015	-0.02	−0.16	−0.07	−0.04	−0.39	−0.28	−0.25
Time (yr) to achieve 500 2SW adults when N_0=50	90	770	never	never	never	never	never	never	never

Time (yr) to achieve 500 2SW adults when N_0=110	60	505	never	never	never	never	never	never	never

5 Summary

Atlantic salmon in the Merrymeeting Bay SHRU are at historically low levels of abundance. The very low abundance of returning adults (Table 1) renders the SHRU extremely vulnerable to *any* anthropogenic or natural factor that threatens the survival of Atlantic salmon, particularly those of wild origin. The total number of adult salmon of wild origin returning annually to Androscoggin and Kennebec Rivers in the past 5 years (2006-2010) for which the smolt origin (wild vs hatchery) is known has been less than 10. The 2011 count of all fish returning to the Merrymeeting Bay SHRU, irrespective of smolt origin, was 110. By comparison, most salmon populations in Canada number in the hundreds, thousands, and tens of thousands of spawning Atlantic salmon (COSEWIC 2011).

Measured against the number of returning adults of wild origin, the Merrymeeting Bay SHRU is on the brink of extinction. As a consequence of this fragility, it is my opinion that the mortality experienced by downstream migrating smolts and kelts, and by upstream migrating returning adults, attributable to dam facilities in the SHRU will have an adverse impact on the survival and the prospects for recovery of the Merrymeeting Bay SHRU and, thus, of the GOM DPS as a whole. Given the exceedingly low numbers of returning adults, most notably of fish of wild origin, the loss of a single smolt, or of a single adult, is significant.

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11 January 2012

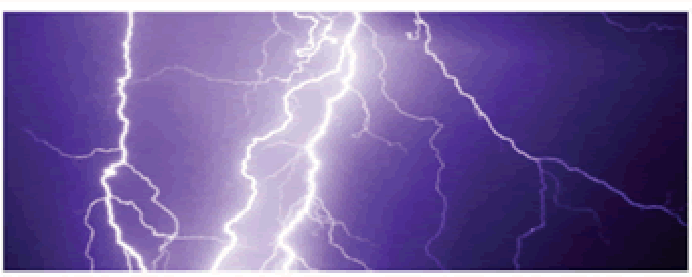
Jeffrey A. Hutchings   Date

Synapse
Energy Economics, Inc.

Analysis of selected Maine hydro plants on the Androscoggin and Kennebec Rivers and their importance to the New England electricity system

Opinion of Maximilian Chang

January 12, 2012



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1. Introduction

I have been asked by the Plaintiffs to evaluate the contribution of seven Maine dams to the New England electric grid. Four of the dams are located on the Kennebec River: Lockwood (owned by NextEra and Merimil Limited Partnership), Shawmut, Weston, and Hydro-Kennebec (owned by Brookfield Power US Asset Management). The other three dams are located on the Androscoggin River: Brunswick (owned by NextEra), Pejepscot (owned by Topsham Hydro Partners), and Worumbo (owned by Miller Hydro Group). Maine has classified these seven dams as "run-of-the-river," meaning that they have limited or no storage reservoirs that would regulate water flow across the turbines (Maine 2010).

My opinion, expressed herein, is based on my professional experience and is informed by (a) a review of documents and statistics prepared by the Department of Energy's Energy Information Agency and the New England Independent System Operator, (b) relevant industry analyses, and (c) information provided by the Defendants through interrogatories. Where appropriate to support my opinion, I have cited these documents, and they are listed in the Bibliography at the end of this opinion.

My analysis evaluates the impact on the New England electric grid if the seven dams individually or collectively were to shut down seasonally to accommodate migrating anadromous fish.

In preparing my opinion, I have been asked by the Plaintiffs to consider the following questions:

1. What is the energy and capacity contribution of the seven dams to the New England electric grid?
2. What would be the impact upon the New England electric grid if the seven dams shut down seasonally?
3. What would be the impact upon the dam owners of seasonally shutting down the seven dams?

To answer these questions, I have organized my opinion in the following manner. First, I provide a brief overview of the New England electric grid, including historical supply and demand for the six New England states and Maine alone; the markets for electric energy and capacity that operate in the region; and the role that run-of-the-river hydropower plays in the regional market. Next, I look specifically at the seven dams in question to identify the percentage of energy and capacity they provide in New England and within Maine, alone. I then evaluate whether these contributions are necessary in order to meet average and peak demand in New England or within Maine, alone. Finally, I discuss possible impacts on dam owners' revenues if these dams were to shut down seasonally to accommodate migrating anadromous fish.

In summary, it is my opinion that neither the New England's electric power grid nor the local electric system within Maine would be adversely impacted by a seasonal shut-down of the dams. The seven hydro dams contribute to the electric grid; however, the seasonal shut-down of these units would not result in a significant impact on the region or the state. Both Maine and New England have adequate supply capacity to offset the loss of these dams.

Based on historical energy prices, lost revenue to dam owners would be in the range of roughly $1.5 – $2 million in aggregate for the seven dams for each month that turbines are fully shut down from April through June, and roughly $1.5 – $1.75 million in aggregate for each month that turbines of the seven dams are fully shut down from October to November. Monthly energy revenue losses for each dam would range roughly from $100,000 to $360,000 depending on the individual dam and time of year.

Based on regional capacity prices, the lost capacity revenue to dam owners would be in the range of roughly $130,000 in aggregate for the seven dams for each month that turbines are fully shut down from April through June, and roughly $210,000 in aggregate for each month that turbines of the seven dams are fully shut down from October to November. Monthly capacity revenue losses for each dam would range roughly from $7,000 to $43,000 depending on the individual dam and time of year.

2. Qualifications and Experience

I hold a Bachelor of Arts degree in Biology and Classical Civilization from Cornell University, and a Master of Science degree in Environmental Health from the Harvard School of Public Health. In my current position at Synapse Energy Economics, I conduct analyses on issues relating to electricity markets, avoided costs, energy efficiency, capacity markets, and the economics of energy supply resources. Synapse works for a wide range of clients throughout the United States, including environmental groups, public utility commissions and their staff, governmental associations, public interest groups, attorneys general, offices of consumer advocates, foundations, and federal governmental organizations such as the Environmental Protection Agency and the Department of Energy.

As part of my work at Synapse, I co-authored the two most recent *Avoided Energy Supply Costs in New England* reports (2009 and 2011), which are used by the New England energy efficiency program administrators to quantify the value of energy efficiency programs. I have also co-authored a recent report investigating the economics of proposed nuclear power plants and alternatives in the Southeast United States. Additionally, I have testified in front of the Massachusetts Department of Public Utilities on behalf of the Cape Light Compact in support of its three-year energy efficiency programs.

The Plaintiffs are compensating me for my work on this case at a rate of $140 per hour. I have been engaged in this case on their behalf since December 2011.

In preparing this report, I supervised the work of a Senior Consultant who assisted me in preforming the analysis consistent with Synapse Energy Economics' in carrying out such practices.

A copy of my resume is included as Attachment One.

3. General Explanation the New England Electric Grid

A. Brief Overview of New England's Electric Power System

The New England electrical power system spans the six states of New England, and serves the 14 million people living therein. This system includes: more than 300 generating units, representing approximately 32,000 megawatts (MW) of generating capacity; more than 5,000 demand assets, representing 2,500 MW of demand resources; and more than 8,000 miles of high-voltage transmission lines. These resources work together to meet the New England regional load, regardless of state boundaries (ISO-NE 2011c).[1]

The New England Independent System Operator (ISO-NE) is the non-profit entity that manages and coordinates the generation and transmission of power across New England to meet demand. ISO-NE has operational, market, and planning responsibilities to balance supply (capacity) and demand (load) of electricity across New England (Giaimo 2011). ISO-NE's operational responsibilities include ensuring minute-to-minute reliable operation of the New England power grid, ensuring the dispatch of lowest-priced resources, and coordinating operations with neighboring power systems. ISO-NE's market responsibilities include the administration and monitoring of wholesale electricity markets, which include energy and capacity. ISO-NE's planning responsibilities include administering requests to interconnect generation and transmission resources, and conducting transmission needs assessments to meet current and future power needs in New England.

Measuring Electrical Output

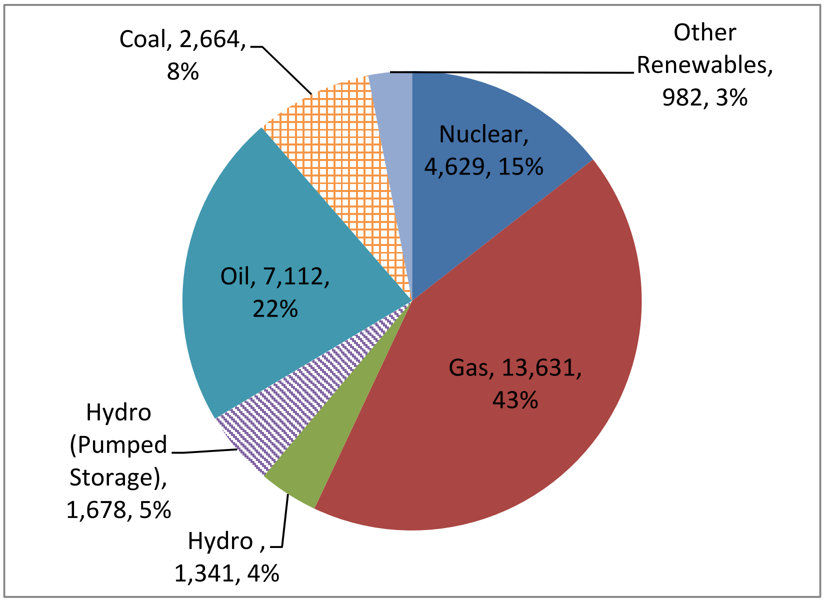
All electric generating units measure their electrical output in two different but related ways. Amounts of electric energy used or produced (e.g., in a year) are measured in megawatt-hours (MWh). When discussing an amount of electric energy produced (e.g., the number of MWh produced in a given year), the terms "generation," "generated," or "electric output" will be used. The amount of electric power produced or consumed at a given moment will be referred to as "load" or "demand," respectively, while the amount that *can be* produced at a given moment will be referred to as "capacity." Capacity is measured in kilowatts (kW) or megawatts (MW). The amount of energy that *is* produced by a generator in a given period is often compared to the amount it *could* have produced if running at full capacity 100 percent of the time. That ratio, expressed as a percent or as a number between zero and one, is called the plant's capacity factor (CF) (Steinhurst 2008).

B. Overview of New England Supply and Demand

The approximately 32,000 MW of generating capacity in New England can be broken out by fuel type, as shown in Exhibit 1 (ISO-NE 2011a).

[1] One megawatt is the equivalent of one million watts.

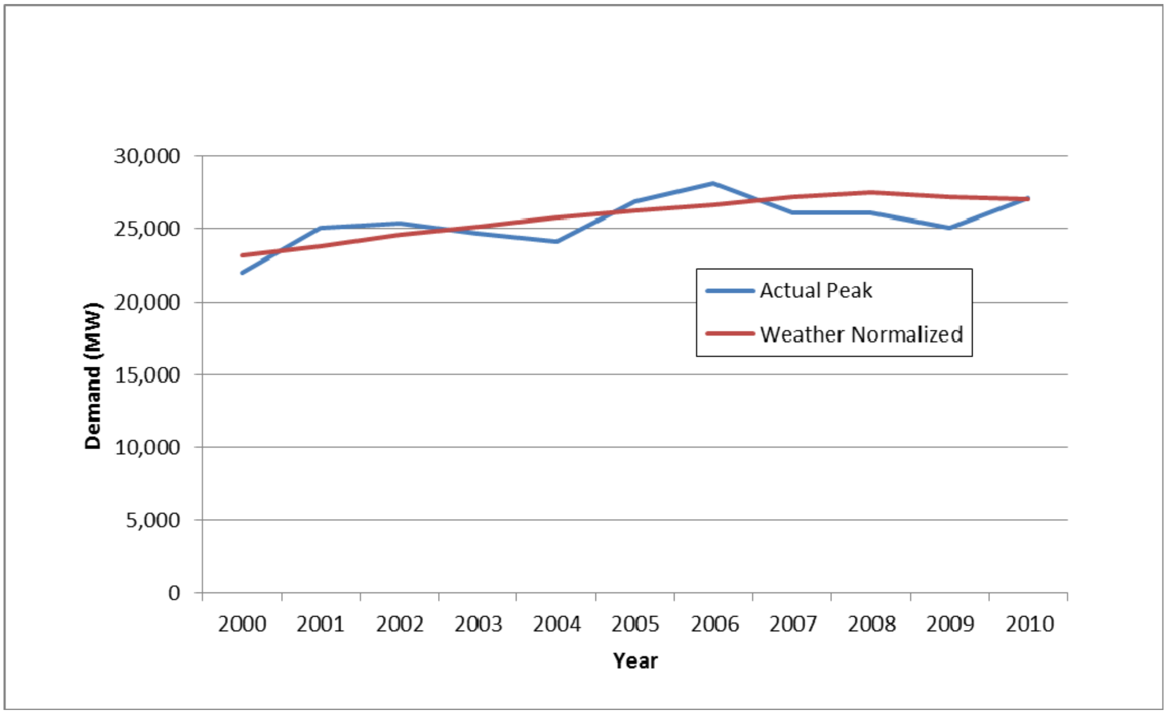
Exhibit 1. 2011 Expected Summer New England Capacity by Energy Source (MW)



By far the most dominant form of generating capacity in New England is natural gas combustion units, which represent 43 percent (13,631 MW) of New England's total generating capacity. Oil combustion generating capacity follows at 22 percent (7,112 MW), nuclear units provide 15 percent (4,629 MW), and hydro resources represent 4 percent (1,341 MW) (ISO NE 2011a). Pumped storage facilities (which represent 5 percent, or 1,678 MW, of New England's capacity in Exhibit 1) pump water into storage ponds during periods of low demand and then pass the water through turbines to generate electricity during periods of high demand.

The New England region is a summer-peaking region, meaning that the demand for power is greatest in the summer. According to ISO-NE, actual peak load in 2010 was 27,102 MW. The historical trend in peak load is shown in the following exhibit for both actual and weather-normalized peaks.

Exhibit 2. 2000-2010 New England Actual and Weather-Normalized Summer Peaks (MW)



The 2010 peak load of 27,102 MW was balanced against a resource capacity of 32,431 MW, which included non-generation demand resources (e.g. energy efficiency and demand response) and imports from outside New England. The excess capacity of 5,329 MW represents a reserve margin of approximately 20 percent (ISO-NE 2011a). Each year, ISO-NE projects the future installed capacity requirement (ICR) for the New England region (ISO-NE 2011b). The ICR represents the capacity plus reserves needed to meet New England's future capacity needs. ISO-NE projects reserve margins in future years through 2020 at a range of 12.6 to 14.6 percent (ISO-NE 2011c).

Data for 2003-2010 indicate that New England has added 4,382 MW of new capacity, as shown in the following exhibit.

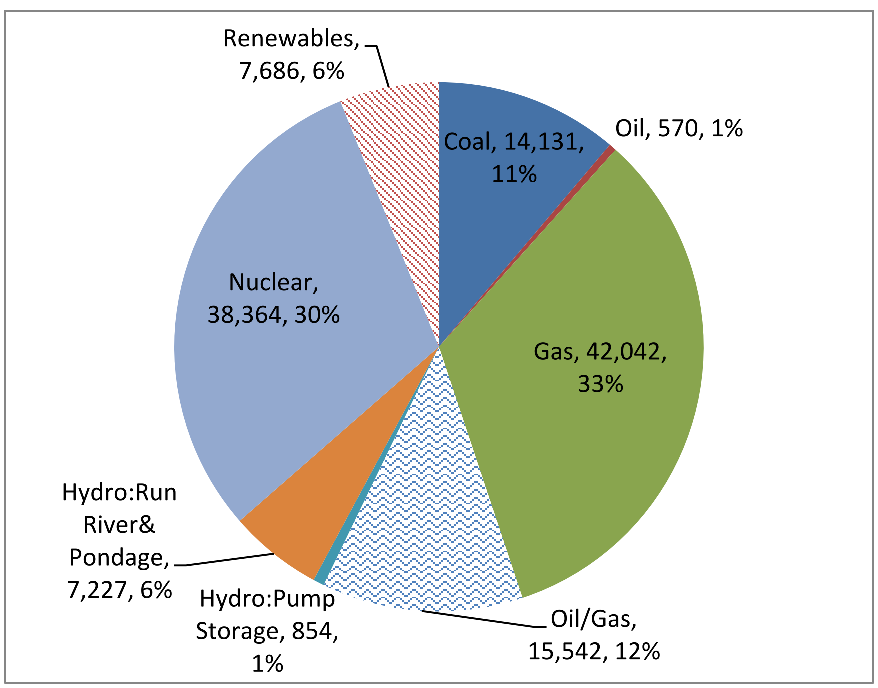
Exhibit 3. New England New Capacity Additions (Summer Capacity in MW)

Year	Summer Capacity (MW)
2003	2,757
2004	578
2005	6
2006	31
2007	142
2008	142
2009	367
2010	359
Total	4,382
Notes	
Data from EIA Form 860	

These data show that New England continues to add additional capacity to meet future load. According to ISO-NE, an additional 11,816 MW of new capacity is currently in the interconnection queue (ISO-NE 2011c). However, it is important to note that not all of the projects in the interconnection queue will actually be built. The ISO-NE historical attrition rate is 69% (ISO-NE 2011c). Using this attrition rate suggests that 3,663 MW of the 11,816 MW of new capacity in queue may actually be added.

Total annual energy requirements in 2010, the most recent full year of available data, were 130,771 gigawatt-hours (GWh) (ISO-NE 2010). The following exhibit shows the distribution of energy production by generating source for New England.

Exhibit 4. 2010 New England Generation by Energy Source (GWh)



On an energy basis (i.e., the amount of electric output of New England generation for 2010), 33 percent (42,042 GWh) of New England's electricity generation was from natural gas combustion units. Nuclear units provided 30 percent (38,364 GWh) of electricity generation in New England, and hydro resources represented 5.5 percent (7,227 GWh).

C. Overview of Maine Supply and Demand

Although New England's electric grid operates at a regional level, it is useful to view the electric system through the context of Maine. Maine represents approximately 9 percent of population and 8.9 percent of electricity consumption in New England (ISO-NE 2011d). In terms of capacity for the 2011 – 2012 period, Maine has 3,244 MW of in-state generation and 287 MW of in-state non-generation resources, for a total capacity of 3,531 MW. According to ISO-NE, Maine's 2011 actual peak demand was 1,964 MW. Maine currently exports electricity to other New England states, since Maine's capacity exceeds demand.

ISO-NE reports that, within Maine, 1,300 MW of new supply capacity are in the process of connecting to the regional transmission grid. While it is likely that not all of these projects will be completed, the number suggests proposed projects are in place that could meet the shortfall of generation resulting from the seasonal shut-down of the dams (see Section 4 for quantification of the dams' contributions to the grid).

While the grid operates on a regional basis, there are situations where local generation is required to meet specific reliability needs of the transmission system. In western Maine, ISO-NE had identified the need to maintain local generation in order to maintain voltages across transmission lines (ISO-NE 2011c). However, the dams in question have not been specifically identified by ISO-NE to maintain voltages in western Maine, as other local generation options are adequate to fulfill this requirement.

Additionally, ISO-NE has indicated that two current transmission projects (the Maine Power Reliability Project and the Rumford-Woodstock-Kimball Road) will alleviate this reliability constraint in western Maine once they are operational (ISO-NE 2011c).

D. Energy and Capacity Markets

Energy Markets

ISO-NE manages and coordinates the wholesale energy markets through two primary markets: (1) the Day-Ahead Market, where the majority of the transactions occur; and (2) the Real-Time Market, where the remaining energy supplies and demands are balanced. These two markets represent the bulk of electricity transactions, and their prices on average are very close to each other. However, there is greater volatility in the Real-Time Market, since it reflects real-time requirements.

The Forward Capacity Market

ISO-New England's Forward Capacity Market (FCM) is a market-driven approach designed to ensure that there is enough generation on the electrical grid to meet the peak demands each summer and winter. Under the FCM, ISO-NE acquires sufficient capacity to satisfy the installed capacity requirement (ICR) that it has set for a given power-year; this is accomplished by way of a forward-capacity auction (FCA) for that power-year, which sets the price for capacity. The FCA for each power-year is conducted roughly three calendar years in advance of the start of that power-year. ISO-NE has held five FCAs to date; FCA 1 was held in 2008 for the power-year starting June 2010, and, most recently, FCA 5 was held in 2011 for the power year starting June 2014.

At the most basic level, there are four steps to the forward capacity market:

1) The ISO-NE forecasts the peak demand that will need to be met three years ahead of time, hence a forward market.
2) ISO-NE then asks for a show of interest from owners of new or existing generation units, energy efficiency programs, or distributed generation projects who may be interested in providing capacity during this future year.
3) Next, ISO-NE puts those potential market participants through a qualification process to ensure each is a viable source of providing energy or reducing demand during peak load hours.
4) Finally, ISO-NE runs a descending clock auction for all qualified participants. Those who own the most cost-effective resources are given a capacity obligation, and are guaranteed revenue for the capacity they provide.

E. Role of Hydro in New England Energy and Capacity Markets

Like wind and solar energy resources, run-of-the-river hydropower is to some extent dependent on uncontrollable conditions, in this case river flow. As a result, ISO-NE categorizes wind, solar, and run-of-the-river hydro as “intermittent” resources. This affects the role that run-of-the-river hydropower plays in both the energy and capacity markets.

As noted earlier, ISO-NE works to ensure that capacity is available to meet New England’s peak demand, which occurs during the summer months. ISO-NE rates the summer and winter capacities for intermittent resources based on historical output (ISO-NE). For the summer rating of an existing run-of-the-river hydro resource, ISO-NE uses a formula based on the resource’s median output from 1 p.m. to 6 p.m., from June through September, for the last five years. The winter rating is the median output from 5 p.m. to 7 p.m., from October through May, for the last five years. Thus, ISO-NE’s summer and winter ratings for a hydro resource may differ, depending on historical river flow conditions. This means that the hydro resource’s value in the capacity market may also differ from season to season.

4. Power Produced from the Identified Dams

Exhibit 5, below, summarizes the energy and capacity characteristics of the seven hydro plants analyzed in this study. The generating capacity is represented both by nameplate values (the technical rating) from Energy Information Administration (EIA) and by the seasonal load-carrying capacity as determined by ISO-NE. Note that the summer capacity is much less than both the nameplate and winter capacities, due to summer river flow conditions that impact each dam’s summer rating for capacity revenues. These are all run-of-river facilities with minimal reservoir storage. Exhibit 5 also presents the 2010 generation for each facility as reported to the EIA, and an equivalent capacity factor (representing how much the plant runs) based on the nameplate capacity.

Exhibit 5. Hydro Plant Capacity and Generation Summary

Facility	Owner	Nameplate Capacity (MW)	Summer Capacity (MW)	Winter Capacity (MW)	2010 Electric Generation (MWh)	Capacity Factor
		1	2	3	4	5=4÷(1*8760)
Hydro Kennebec Project	Brookfield	15.0	3.8	7.9	50,337	38%
Worumbo Hydro Station	Miller Hydro	19.4	4.7	10.2	90,947	54%
Brunswick	NextEra	20.0	5.9	14.7	98,844	56%
Lockwood Hydroelectric Facility	NextEra, Mermil	7.2	2.5	4.8	32,371	51%
Shawmut	NextEra	9.2	9.5	9.5	52,001	65%
Weston	NextEra	13.2	13.2	13.2	65,685	57%
Pejepscot Hydroelectric Project	Topsham	13.7	4.3	10.7	74,823	62%
Total		97.7	44.0	71.0	465,008	54%

Notes

1 Nameplate capacity based on EIA Form-860 data for 2010

2,3 Summer and winter capacity based on ISO-NE 2011 CELT data

4 2010 electric generation based on EIA Form-923 data for 2010

A. The Seven Dams as a Percent of 2010 New England Energy and Capacity

As reported by ISO-NE, the 2010 total net energy requirement for New England was 130,767,000 MWh (ISO-NE 2011a). The electric generation at the seven Maine dams, presented in Exhibit 5, represents 0.36 percent or a small fraction of one percent of that total. The New England summer claimed capability for generators in 2010 was 31,435 MW, of which the above generators, at 44 MW, represent 0.14 percent or a small fraction of one percent of New England's summer claimed capability.

Based on EIA data for 2010, the seven dams generated approximately 465,000 MWh of electricity (EIA 860 Data). I have been asked to evaluate the effects of seasonal shutdowns of the dams' turbines during the spring Atlantic salmon smolt and kelt downstream migration period (which I have been told to assume lasts from April through June) and the fall kelt downstream migration period (which I have been told to assume lasts from October through November).

One simple approach to examine how New England could make up the shortfall of generation resulting from a seasonal shut down of the dams in the spring and/or fall months is to identify other, existing units that could be operated more often. While this analysis ignores specific generating unit limitations or transmission limitations, it provides a high-level indication of whether or not there is existing under-utilized electric generation capability. Using an EPA database generation sources in Maine, we analyzes generation from Rumford Power Associates, a 270 MW gas combined cycle plant located in Rumford, Maine (EPA). In 2010, this plant generated approximately 520,000 MWh, which translates into a capacity factor of 22 percent. Increasing the capacity factor of the plant to 40 percent would result in an increase in electricity generation of 425,000 MWh, nearly the equivalent electricity generation of the seven dams for the entire year.

Another approach of viewing the dam's role in the New England capacity market is to compare the nameplate capacity of the seven dams, which is 97.7 MW as shown in Exhibit 5, against ISO-NE's excess capacity, which for 2010 was 5,239 MW. The nameplate capacity of the seven dams that would be replaced represents less than 2 percent of the 2010 excess capacity. The summer capacity of the seven dams, which would be a more appropriate comparison to the summer excess capacity, are less than one percent of the 2010 excess capacity.

B. The Seven Dams as a Percent of Maine Energy and Capacity

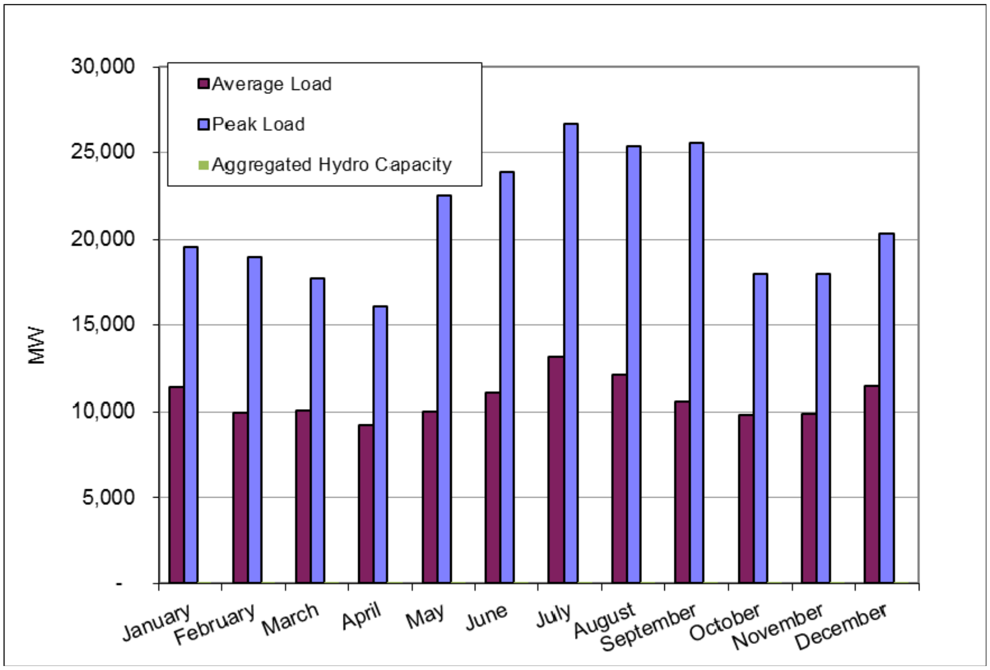
Although ISO-NE does not report a specific net energy requirement for Maine, electricity consumption in Maine in 2010 represented 8.9 percent of the New England total. Thus, electric generation of these hydro plants represented approximately 5.5 percent of Maine's total generation in 2010 based on ISO-NE and EIA data. Similarly, these hydro plants represented 2.3 percent of Maine's 2010 summer generating capability, which totaled 3,071 MW (ISO-NE 2011d).

5. New England and Maine Monthly Loads

A. Overview of New England Loads

Exhibit 6, below, shows the monthly average and peak loads in 2010, with the summer capacity (44 MW) and winter capacity (71 MW) associated with the seven dams. The highest loads in New England occur during the summer period. However, as noted above, ISO-NE rates the summer capacity of the seven dams as 44 MW, based on historical output during peak summer periods. The capacity of the seven dams is barely visible on the graph below.

Exhibit 6. New England 2010 Average and Peak Load by Month with Summer and Winter Capacity of the Seven Dams (MW)

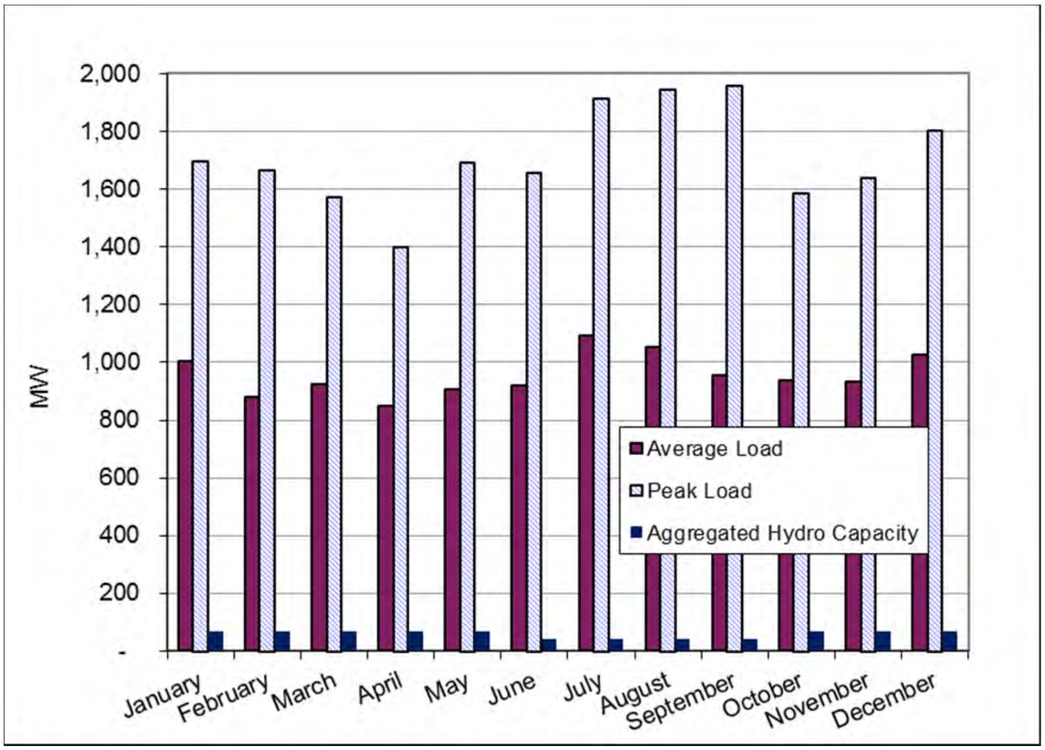


This exhibit shows that the seven dams meet an imperceptibly small fraction of New England's total load.

B. Overview of Maine Loads

Even though the New England electric system operates on a regional basis, looking at Maine's load provides a useful examination. As indicated earlier, Maine represents about 8.9 percent of total New England loads. Exhibit 7, below, shows the monthly average and peak loads in 2010 for Maine from ISO-NE data. Like the rest of New England, the highest loads in Maine occurred during the summer period. The aggregated summer and winter capacities of the seven dams are also included, in order to show their contribution to meeting Maine's load throughout the year.

Exhibit 7. 2010 Monthly Loads in Maine (MW)



This exhibit shows that the seven dams meet only a small fraction of Maine's load.

C. Monthly Hydro Generation

Exhibit 8, below, shows the monthly generation from the studied hydro plants, as well as Maine's monthly and total electricity demand in 2010. Hydro generation is greatest in April, both in absolute terms and as a percentage of load, but this is also one of the lowest load months, as shown in Exhibit 7. For the five-month period of April through June plus October and November, these hydro plants represent an average of 6.1 percent of Maine's electricity demand. As noted earlier, other available resources are more than sufficient both in New England and within Maine to make up this generation if the dam turbines do not operate in April, May, June, October, and November.

Exhibit 8. 2010 Monthly Hydro Generation from Seven Dams and Maine Electricity Consumption

Month	Hydro Generation (MWh)	Maine Electricity Consumption (MWh)	Hydro Percentage of Maine Electricity Consumption
	1	2	3=1÷2
January	45,375	748,464	6.1%
February	40,607	590,688	6.9%
March	46,451	686,712	6.8%
April	51,002	610,560	8.4%
May	40,087	675,552	5.9%
June	32,366	663,840	4.9%
July	31,055	813,936	3.8%
August	29,196	784,920	3.7%
September	29,112	688,320	4.2%
October	39,727	698,616	5.7%
November	40,087	672,480	6.0%
December	39,941	764,832	5.2%
Year	465,008	8,398,920	5.5%

Notes
1 Hydro generation from EIA-923 data
2 Maine load from ISO-NE data

D. Impact of the Loss of Capacity and Generation

In aggregate, the capacity from these hydro plants represents 1.43 percent of Maine's summer capacity and 2.12 percent of its winter capacity. Available capacity in Maine exceeds the state's peak load by a significantly larger amount than these dams' aggregate capacity.

These dams represent a larger fraction of the total capacity in the April to June period, when their generation is greatest and the loads are the lowest. However, partial or full loss of their output could easily be covered by other available resources at all times of the year.

Maine currently has a renewable portfolio standard (RPS) that requires 30 percent of electricity sales to come from eligible renewable resources, and hydropower is one of the eligible resources to help meet this goal. While electricity generation from hydropower will vary year-by-year, 2010 data from EIA indicates that Maine hydropower plants generated 45.4 percent of Maine's electricity demand. Reducing the generation from the seven dams even by the **full** year would reduce the Maine's hydro generation percentage to 39.9 percent, still well above the 30 percent threshold, even before the inclusion of other eligible resources in Maine. Reducing the generation from the seven dams for only April through June and October through November, would only reduce Maine's hydro generation from 45.4 to 42.9 percent.

6. Possible Impacts on Dam Owners

A. Loss of Revenues

Although I do not have access to actual revenue or operating cost data from the dam operators, it is possible to estimate a reasonable range of annual gross revenues based on publically available data. This data includes the monthly generation for each plant from the U.S. Energy Information Administration (EIA), monthly energy prices by period from ISO-NE (ISO-NE 2012), and capacity prices from ISO-NE.

Energy Revenues

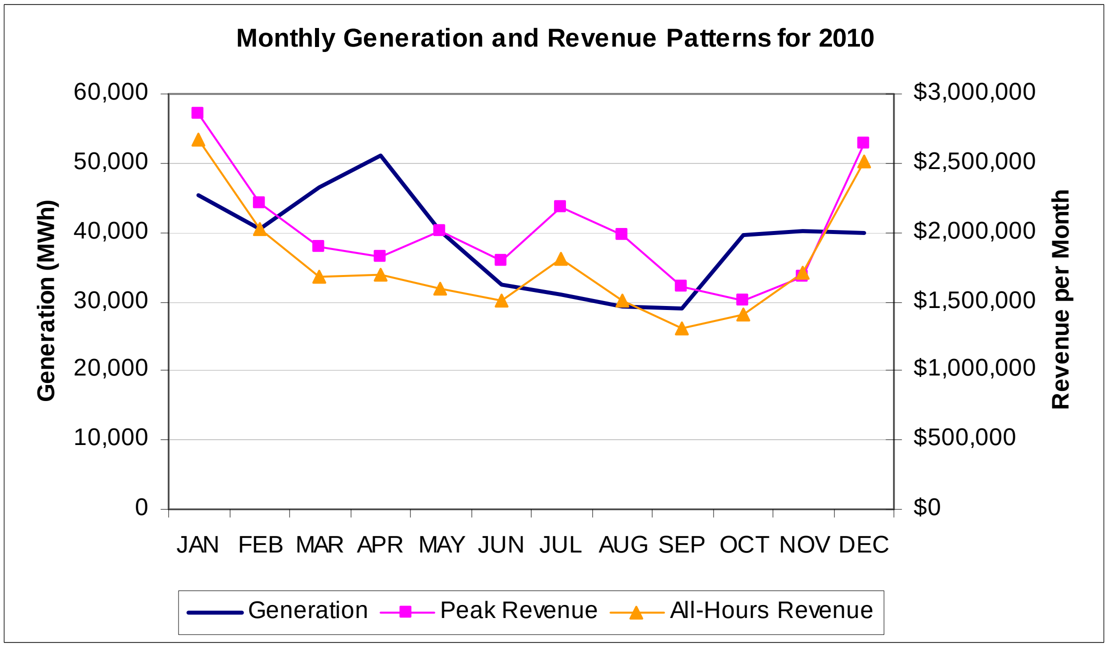
For energy revenues, I estimate a range of possible revenues based on the peak period prices for the upper bound, and the all-hours prices for the lower bound. Although these plants are run-of-the-river, they are identified by ISO-NE as “daily cycling,” given that there is likely some flexibility in scheduling generation to match daily peak hours.

The following exhibit summarizes the 2010 generation and my estimates of gross energy revenues based on wholesale market prices. The energy revenues for the seven dams aggregated together run a little below $2 million per month, and are greatest in the winter. Summer revenues are a little above the average, even though generation is lower in those months, because energy prices are higher.

Partial or full shutdown of these hydro units would have energy revenue impacts proportional to the monthly loss of generation. Monthly revenues for all seven dams together in 2010 were in the $1.5 to $2 million range from April through June, and in the $1.5 to $1.75 million range for October and November. For each individual dam, the revenues from April through June range from approximately $100,000 to $350,000 and from October and November range from approximately $97,000 to $360,000, depending on the individual dam and month.

Electric energy wholesale prices (and revenues) may be a little higher in future years. But the primary determinant of electric wholesale prices in New England is natural gas prices, which are forecast to be relatively stable (Hornby 2011).

Exhibit 9. Monthly Generation and Energy Revenues for all Seven Dams



Capacity Revenues

ISO-NE provides and pays for capacity through the Forward Capacity Market (FCM) and annual auctions for capacity three years in the future. As mentioned earlier, five Forward Capacity Auctions (FCA) have been held to date to provide capacity up through May 31, 2015. In recent FCAs, there has been a capacity surplus and the auctions have cleared at their floor prices.

There are big differences between winter and summer capacities for these hydro plants. New England's peak load period is summer. Capacity prices have dropped considerably in New England and stopped at the floor level because of capacity surpluses. Capacity payments for these hydro plants will be at their winter capacity values for eight months (October through May) and at summer capacity values for four months (June through September). Total capacity revenue for the seven dams for the next several years may be over $2 million per year. If they do not run or have their capacity reduced in a given month, their monthly payments will be proportionally reduced. For example, if all of the studied hydro plants were totally shut down during the month of June in 2013, the capacity revenue loss would be about $130,000 in aggregate for the seven dams. For each individual dam, the loss of capacity revenue will vary by the capacity obligation of each dam. For the June 2013 example, this range is approximately $7,300 for the Lockwood dam to $39,000 for the Weston dam. Exhibit 10, below, shows the total expected capacity revenue for the seven dams based on each of the five Forward Capacity Auctions.

Exhibit 10. Expected Capacity Revenues for All Seven Dams

Capacity Auction	Period (June 1 start)	Capacity Price ($/kW-month)	Summer Capacity (MW)	Winter Capacity (MW)	Summer Capacity Revenue	Winter Capacity Revenue	Annual Capacity Revenue
		1	2	3	4=1*2*(4)*(1,000)	5=1*3*(8)*(1,000)	6=4+5
FCA-1	2010-2011	$4.500			$792,000	$2,557,000	$3,349,000
FCA-2	2011-2012	$3.600			$633,000	$2,046,000	$2,679,000
FCA-3	2012-2013	$2.951	43.99	71.30	$519,000	$1,677,000	$2,196,000
FCA-4	2013-2014	$2.951			$519,000	$1,677,000	$2,196,000
FCA-5	2014-2015	$3.209			$565,000	$1,823,000	$2,388,000

Notes
Values may not sum due to rounding
Summer: June through September
Winter: October through May
Capacity prices based on ISO-NE data for Forward Capacity Auction (FCA)
Capacity values based on CELT 2011

7. Summary

Based on the analysis provided above, it is my opinion that neither the New England electric power grid nor the local electric system within Maine would be adversely impacted by a seasonal shut-down of the seven dams. The seven hydro dams contribute to the electric grid; however, the seasonal shut-down of these units would not result in a significant impact on the region or the state. Both Maine and New England have more than adequate supply capacity to offset the seasonal loss of these dams.

I estimate that the lost energy revenues to the dam owners would be in the range of roughly $1.5 – $2 million in aggregate for the seven dams for each month that turbines are fully shut down from April through June, and roughly $1.5 – $1.75 million in aggregate for each month that turbines of the seven dams are fully shut down from October to November. I estimate that the lost capacity revenues to the dam owners would be roughly $130,000 in aggregate for the seven dams for the month of June, and roughly $210,000 in aggregate for each month that turbines of the seven dams are fully shut down during the months of April, May, October, and November.

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January 12, 2012

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