February 16, 2022

From: The Kennebec Coalition (Atlantic Salmon Federation U.S.; Maine Rivers; Natural Resources Council of Maine; Trout Unlimited and Kennebec Valley Chapter of Trout Unlimited) and Conservation Law Foundation

To: Kathy Howatt
Hydropower Coordinator
Maine Department of Environmental Protection
17 State House Station
Augusta, ME 04333-0017

(*via email only*)

Re: Revised Brookfield Application for Water Quality Certification (WQC) at the Shawmut Dam

Dear Ms. Howatt:

We are writing on behalf of the Kennebec Coalition and the Conservation Law Foundation (the NGOs) on Brookfield's revised application for water quality certification (WQC) at the Shawmut Dam. The Department should deny certification. Brookfield's application contains nothing new of substance, and the Department should reach the same conclusion on this revised application as it did on the original - that relicensing the dam as proposed would violate state water quality standards.

The NGOs have submitted extensive comments on the Federal Energy Regulatory Commission's (FERC) Shawmut relicensing application (FERC Accession Number 20200831-5332), draft Shawmut Environmental Assessment (FERC Accession Number 20210816-5050), the Species Protection Plan (SPP) for the Lockwood, Weston, and Hydro-Kennebec dams (FERC Accession Number 20210825-5088), and the Interim SPP for the Shawmut Dam (FERC Accession Number 20210920-5080). We also submitted scoping comments on FERC's proposed EIS (FERC Accession Number 20211223-5172) and on the Department's draft denial of Brookfield's initial application for Shawmut WQC. We incorporate all of these comments by reference. The NGOs also have the following specific comments concerning Brookfield's revised application for WQC.

1. The Department has the legal authority, and the obligation, to deny Brookfield's WQC application due to inadequate fish passage proposals that fail to meet the state's water quality standards

More than 15 years ago, the requirement under the Clean Water Act that owners and operators of hydroelectric projects obtain a water quality certification from the state where they operate the project when seeking to license or relicense that project under the Federal Power Act was unanimously upheld by the U.S. Supreme Court. S.D. Warren Co. v. Maine Board of Environmental Protection, 547 U.S. 370 (2006). In S.D. Warren, the Supreme Court upheld the conclusions reached previously by the Department, the Board of Environmental Protection, the Maine Superior Court and the Maine Supreme Judicial Court that the operation of S.D. Warren's hydroelectric project on the Presumpscot River resulted in a discharge. That conclusion triggered the requirement under Section 401 of the Clean Water Act

Section, 33. U.S.C. § 1341 that before S.D. Warren's project could be relicensed by the Federal Energy Regulatory Commission, it needed to receive a certification from the state that the discharge would not violate the applicable water quality standards for the Presumpscot River. In analyzing the purpose and reach of Section 401, the Court observed that "Section 401 recast pre-existing law and was meant to 'continu[e] the authority of the State … to act to deny a permit and thereby prevent a Federal license or permit from issuing to a discharge source within such State.' S. Rep. No. 92–414, p. 69 (1971). Its terms have a broad reach, requiring state approval any time a federally licensed activity 'may' result in a discharge ('discharge' of course being without any qualifiers here), 33 U. S. C. §1341(a)(1), and its object comprehends maintaining state water quality standards, see n. 1, *supra.*" 547 U.S. at 380.

Accordingly, it is well established that the Department has the legal authority to approve, approve with conditions or to deny an application for water quality certification based on an analysis of if and how a federally licensed activity resulting in a "discharge" can meet Maine's water quality standards. Nothing in Brookfield's revised application changes the substance of the proposed measures for the Shawmut Dam from its previous application. Therefore, the Department should deny the application.

2. The Shawmut Impoundment does not comply with state water quality standards for aquatic life

Above Brookfield's Shawmut Dam, the Kennebec River is fully impounded and, according to DEP's most recent Integrated Water Quality Monitoring Report Appendices, the waters of the Shawmut impoundment do not meet applicable water quality standards for aquatic life. Specifically, that 12-mile long section of the Kennebec impounded by the Shawmut Dam is listed under "Category 3: Rivers and Streams with Insufficient Data or Information to Determine if Designated Uses are Attained (One or More Uses may be Impaired)" in those appendices.[1] The Appendices further characterize the Shawmut Dam segment as "Category 3 for potential aquatic life use impairment; insufficient data to delist: macroinvertebrate community attained Class C in 2004 but did not attain in 2002."[2] The Department should deny certification on these grounds.

3. The Shawmut Dam does not operate as a "run-of-river" facility

Brookfield characterizes the Shawmut Dam as a "run-of-river" facility (where inflow is equal to outflow on a near-instantaneous basis), but the reality is that its operation more closely resembles a peaking system that has fluctuating flows that do not track inflow for a variety of reasons. These reasons are identified clearly in an October 13, 2021 memo from Jennifer Jones (Kleinschmidt Associates) to Randy Dorman (Brookfield Renewable) included as part of Appendix 19 to the revised application. The memo describes three situations where the project routinely deviates from run-of-river operation:[3]

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[1] Maine DEP. 2018. 2016 Integrated Water Quality Monitoring Report. Appendices. P. 60. Accessed at https://www.maine.gov/dep/water/monitoring/305b/2016/28-Feb-2018_2016-ME-IntegratedRptLIST.pdf#page=63

[2] *Ibid.*, accessed at https://www.maine.gov/dep/water/monitoring/305b/2016/28-Feb-2018_2016-ME-IntegratedRptLIST.pdf#page=63

[3] Brookfield 2021. Application for Water Quality Certification, Shawmut Dam. Appendix 19, page 74. Accessed at https://www.maine.gov/dep/ftp/HYDRO/WaterQualityCertifications/Shawmut2021/Application-materials/ApplicationAppendices/Appendix%2019%20Brookfield%20Responses%20to%20Comments%20on%20FERC%20DEA.pdf#page=74

- *Units are turned on or off to accommodate changes in inflow and/or pond level. Units 1-6 typically operate in the approximate range of 650 cfs each, units 7-8 typically operate in the approximate range of 1,300 cfs each.*
- *Night time shutdown for eel passage. Since the fall of 2009, Units 7 and 8 have been shut down for 8 hours each night for a six week period between September 15 and November 15 to provide for the safe passage of downstream migrating eels. Depending on available inflow and pond level (spillage or not), these shutdowns and morning startups can change outflows by up to 2,600 cfs.*
- *The rubber dam (inflatable bladder) sections are deflated to accommodate changes in inflow and/or pond level. Since completion of the rubber dam sections in the fall of 2009, and depending on the current inflow compared to the total station hydraulic capacity, management of the pond level by short term operation of the bladder can change short term outflow by up to 7,000 cfs per bladder.*

In short, Brookfield's own consultants provide the information - and documentation - of HOW and WHY the Shawmut project deviates from run-of river operation. While the operational reasons are not unusual, the impact of those operations are significant on the flow of water into and out of the Shawmut Dam impoundment at several scales: (1) changes of 650-1300 cfs in station discharge as units cycle on and off; (2) changes of up 2,600 cfs for nighttime shut-downs for eel passage; and (3) changes of up to 7,000 cfs due to operation of the inflatable bladder.

Kleinschmidt also notes that the smallest of these three operational changes, in one instance we noted, resulted in head-pond fluctuations of up to 0.4 feet for short term operational changes in the range of +/- 600-1,000 cfs:

> *An example of the fluctuations noted are shown in the plot below between August and September 2018. The discharge values appear to rise and fall by 600-1,000 cfs for multiple days during this period. . .. These fluctuations in discharge are the result of unit operations, switching between different units to optimize Project operations and maintain a relatively constant headpond elevation. . .. In the case for the period shown below, the headpond averages 112.0 feet and fluctuates less than 0.4 feet for the period between 8/13 and 9/21, indicating that storage is not being used and run-of-river conditions are being met.* [4]

The Kleinschmidt memo does not provide any information on the amount of head pond fluctuation associated with operational changes that result in larger changes in station outflow. Nighttime shutdowns for eel passage would cause flow changes up to 2,600 cfs—2 to 4 times large than the 650-1300 cfs fluctuations from units cycling on and off. Operation of the inflatable bladder would cause flow changes up to 7,000 cfs—7-10 times larger. The Kleinschmidt memo does not identify what head pond fluctuations result from these changes, but they are likely to be larger than the +/- 4 inches observed during the series of smaller fluctuations in station discharge documented in the memo.

The concern with these fluctuations is not with the impacts of reservoir elevation changes, presuming these are within licensed limits, but with the impacts of changes in station discharge below Shawmut Dam, and as they pass through the Hydro-Kennebec and Lockwood projects. DEP's analysis should address the impacts of these kinds of short-term, but significant-in-magnitude, changes in flow. When

[4] Ibid., pages 74-75. Accessed at https://www.maine.gov/dep/ftp/HYDRO/WaterQualityCertifications/Shawmut2021/Application-materials/ApplicationAppendices/Appendix%2019%20Brookfield%20Responses%20to%20Comments%20on%20FERC%20DEA.pdf#page=74

these changes in flow occur, the Shawmut Dam is most certainly operating as a peaking project and not in fact a "run-of-river" one.

The potential impacts of that operation on aquatic habitat below the Shawmut Dam, attraction flow to the fishways at the project, or fish migration in the Kennebec River between the project and tidewater should be assessed accordingly. Specifically, DEP should assess how variable discharges from the Shawmut project may affect downstream resources and uses on the Kennebec River. Anecdotal information from river users suggests these changes can impact boat access to some river segments, particularly the tailrace of the Lockwood dam. Variations in flow might also affect upstream and downstream salmon and clupeid passage at the Shawmut, Hydro-Kennebec, and Lockwood dams and, if they occur during periods of extreme low flows or are of large magnitude, aquatic habitat – particularly spawning habitat for riverine spawners such as American shad, blueback herring and sea lamprey.

These fluctuations at the Shawmut Dam are especially worthy of further analysis as none of the other lower Kennebec dams' licenses allows so much freedom to alter flows. Indeed, all the other lower Kennebec River dams have specific terms under either the FERC license or the applicable Water Quality Certification, to minimize flow fluctuations, and in all cases are substantially more protective than the one foot of reservoir surface elevation proposed by the Licensee.

At the Weston Dam, upstream of Shawmut, the licensee is limited to the same 1-foot variation from a full head pond elevation proposed for Shawmut, but this is coupled with a requirement for a minimum flow of "1947 cfs of inflow, whichever is less."[5]

At the Hydro Kennebec project, "instantaneous run-of-river" is required:

> The licensee shall operate the Hydro-Kennebec Project in an instantaneous run-of-river mode for the protection of fish and wildlife resources. The licensee . . . shall at all times act to minimize the fluctuation of the reservoir surface elevation by maintaining a continuous discharge form the project that approximates the instantaneous sum of all the inflow to the reservoir.[6]

And at the Lockwood project, only a 6" deviation from full pond is allowed under normal operating conditions, and minimum flows are required into the bypass channel (50 cfs) and below the powerhouse during flashboard replacement (2114 cfs).[7] Deviations from run-of-river flow are substantially constrained by the 6" limit on reservoir fluctuation and the very limited surface area of the Lockwood impoundment.

Shawmut is most similar to Weston: both have impoundments that are approximately 12 miles long. Such a long reservoir, combined with the ability to make use of 12" of fluctuation in reservoir surface elevation, provide substantial opportunity for operational flexibility that could result in fluctuations in downstream flows. These deviations are constrained at the Weston project by the requirement for a 1947 cfs minimum flow. The applicant proposes—and the existing license provides—no similar constraint at Shawmut.

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[5] FERC, November 25, 1997. Order Issuing New License, P-2325, pages 24-25. FERC Accession Number 19971201-0190.

[6] FERC, October 15, 1986. Order Issuing New License, P-2611, page 6. FERC Accession Number. 19861022-0033.

[7] FERC, March 4, 2005. Order Issuing New License, pages 7-8. FERC Accession Number 20050304-3069.

Accordingly, and at a minimum, any water quality certification for the Shawmut Dam must include a condition or conditions to ensure that minimum flows and attraction flows to fishways are maintained, and that flow fluctuations are minimized to avoid impacts on fish passage and downstream habitat. The most protective condition would be to require instantaneous run-of-river with a condition like that applied at the Hydro-Kennebec Dam. If that is not achievable, restricting reservoir fluctuation to a narrower band AND including a minimum flow (or inflow) requirement would be appropriate. As documented in the Kleinschmidt memo, during periods of normal operations Shawmut can operate with less than 4" of reservoir fluctuation, and at minimum can pass the 1947 cfs minimum flow already required upstream at Weston.

4. Brookfield's proposed upstream fish passage facility will not work and is identical to that proposed in the previous application and determined to be inadequate by the Department.

The upstream fish passage facility proposed in its original water quality certification application was deemed inadequate by the Department. Brookfield's "revised" application proposes the same upstream fish passage facility, and it too remains inadequate. The evaluation and assessment by the experts at Maine's Department of Marine Resources (MDMR) makes clear why the proposed facility is inadequate:

> Despite claims to the contrary by Brookfield, MDMR has always maintained serious concerns about the fish lift and downstream designs at this complicated site. While efforts were made to provide comments reactively to proposals by Brookfield, many of the best options for passage have been dismissed by Brookfield that would be supported and may be required by the [state and federal] agencies.
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> As proof that the agencies were not satisfied with the direction of the currently proposed fish plans, the resource agencies all supported a delay in passage to complete the licensee commissioned study, *Energy Enhancements and Lower Kennebec Fish Passage Improvements Study* (Feasibility Study), filed for stakeholder review and comment on May 20, 2019 (FERC Accession #s 20190701-5155 and 20190701-5154). The Feasibility Study considered several fish passage options, including a Nature-Like Fishway (NLF) and dam decommissioning and removal at the Shawmut project. A NLF alternative was included in the Feasibility Study at the request of resource agencies, yet Brookfield failed to move the NLF alternative forward in the consultation process. MDMR worked with Interfluve and determined a NLF is feasible, practical and a reasonable addition, in concert with the proposed fishway, to improve the chances to meet agency goals and ESA requirements for passage efficiency and timing. A memo with conceptual details for the NLF is attached. An NLF has many benefits that would be additive to the proposed fishway and would improve both upstream and downstream passage and delays at the site. In addition, the Feasibility Study demonstrated that removal of the Shawmut dam was feasible and reasonably practical. MDMR does not agree that the current fishway design is "*reasonably certain to facilitate fish passage on an annual basis for the numbers of each species specified by NMFS and recommended by MDMR*" as we explain in our comments below.
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> To inform the location of the proposed fishway, the Licensee conducted a siting study from May 19-June 14, 2016 with radio-tagged alewife to quantify the preferential use of discrete tailwater regions to inform the placement of the proposed fishway and siting of the fishway entrance. MDMR noted in our comments on April 28,2020 that the study occurred during a low flow period, which was not representative of flows during the passage season, and that Alewife are not a good proxy for predicting the attraction of other species to a fishway entrance, as the Lockwood and Brunswick projects demonstrate.

MDMR is very concerned about the effectiveness of the proposed fishway in May, June, and July when the majority of anadromous species are migrating upstream (Table 3). To help inform the fish passage design, CFD modeling was conducted by the licensee at a limited number of flows that were not developed in consultation with the agencies and were not representative of flows during the passage season. The initial modeling was conducted at 2,540 cfs; 4,790 cfs; 10,750 cfs; and 20,270 cfs which represent the 95%, 50%, 15%, and 5% exceedance flows. One additional model run that included the location of the proposed fish lift and its attraction water was conducted at 4,790 cfs. The maximum station hydraulic capacity of the Shawmut project is 6,690 cfs, which is exceeded approximately 65% of the time in May, 35% of the time in June, and 20% of the time in July, the months when 91% of Atlantic Salmon and 100% of American Shad, Blueback herring, Alewife, and Sea lamprey migrate upstream. Water in excess of station capacity is spilled at the sluice gate in the middle of the dam, the hinged flashboards on the west side of the dam, or the rubber crest(s) on the eastern half of the dam. As a result, there will be false attraction to multiple locations at the project during the majority of the upstream migration season. These conditions, with false attraction to multiple locations at the project, were not including [sic] in the CFD modeling conducted by the licensee.

While it is hard to predict the exact passage efficiency and passage delays for the proposed fish passage facilities at the Shawmut Project, the results of studies conducted on Atlantic Salmon and American Shad migrating upstream at the Lockwood Project are illustrative. The Lockwood and Shawmut projects are similar in that they are complex, wide sites, that have multiple sources of spill that create false attraction for migrating fish. Two years of telemetry studies using adult Atlantic Salmon were conducted by Brookfield at the Lockwood project. In 2016, 16 of the 18 test fish (88.9%) which returned to the project area were recaptured in the fish lift, and the time from return to the project area to recapture was 0.7-111.2 days (mean=17 days). In 2017, 14 of the 20 test fish (70%) were recaptured in the fish lift, and the time from return to the project area to recapture was 3.3-123 days (mean=43.5). As part of a study of energy consumption (Rubenstein 2021 Thesis Defense), adult Atlantic Salmon were captured at the Lockwood fish lift, tagged with thermal radio tags and released downstream of the Project. In 2018, 66.7% of the tagged adults (4 of 6) were recaptured at the fish lift, and the time to recapture was 16-33 days (mean=21.8). The following year, 45.0% of tagged adults (9 of 20) were recaptured, and the time to recapture was 9-30 days (mean=18.7). A 2015 study found that 0% of American Shad captured in the fishway, radio tagged, and returned downstream were recaptured at the fishway.

The Lockwood fishway (fish lift) was designed consistent with standards for upstream passage of anadromous fish in 2004, but the complicated arrangement of the project has undermined the ability of the fishway to effectively attract and pass fish. MDMR would not be surprised to see similar results at the Shawmut Project, where false attraction is likely to occur during the migration season. MDMR believes that having only one non-volitional fishway at the Shawmut Project will result in a large percentage of fish not finding the fishway and/or experiencing substantial delays. Dam removal would address those issues or the completion of an NLF at the site in concert with the existing proposed fishway may address those issues.[8]

It is important to emphasize the work of Sarah Rubinstein, cited by MDMR above, on the impacts of fish passage delays on upstream migrating Atlantic salmon adults. In her University of Maine master's thesis[9],

[8] MDMR. 2021. MDMR Response Draft Environmental Assessment (DEA) for the Shawmut Project. August 13. Pp. 9-10. FERC Accession Number 20210816-5234.
[9] Rubenstein, Sarah R., "Energetic Impacts of Passage Delays in Migrating Adult Atlantic

Ms. Rubinstein documented weeks of delay for salmon attempting to pass the Lockwood Dam and demonstrated that these delays are preventing repeat spawning in salmon. The success of repeat spawners has an outsized role in contributing to population numbers, so this impact is severe. Delays at the Shawmut Dam piled on top of those at the dams above and below it would be disastrous.

In addition, the NGOs are unaware of any upstream fish lift that meets Brookfield's proposed standard of 96 percent passage for adults. In our comments to FERC, particularly those on the draft EA and the SPP for the Lockwood, Hydro-Kennebec and Weston dams, we provided an extensive review of the literature on the failures of fish lifts to pass salmonids, including one study that noted an average passage rate of only 61.7 percent.[10]

Again, the NGOs believe that the Department should deny Brookfield's application for Water Quality Certification on the basis of an inadequate proposal for upstream passage. If the Department chooses to issue a Water Quality Certification with conditions, it must require additional upstream fish passage measures to those Brookfield's proposed, such as the nature like fishway MDMR discussed in the comments cited above.

5. Brookfield's proposed "improvements" to the limited existing downstream fish passage measures at the Shawmut Dam are insufficient and will not allow its operations to meet downstream passage standards even close to 97 percent for Atlantic salmon smolts.

Based on Brookfield's own data, it is clear that less than 60% of Atlantic salmon smolts survive passage through the four lower Kennebec dams. On behalf of the NGOs, Don Pugh, a fish passage expert with decades of experience, including many years at the S.O. Conte Anadromous Fish Research Center,[11] evaluated Brookfield's downstream smolt passage data from 2012 to 2015[12] [13] [14] [15]and identified two key factors that inflated smolt survival percentages.

Salmon" (2021). *Electronic Theses and Dissertations*. 3468. https://digitalcommons.library.umaine.edu/etd/3468

[10] Noonan MJ, Grant JWA, Jackson CD. 2012. A quantitative assessment of fish passage efficiency: Effectiveness of fish passage facilities. Fish Fish (Oxf). 13(4):450–464.

[11] Mr. Pugh's curriculum vitae is attached to these comments as Attachment 3.

[12] Normandeau (Normandeau Associates, Inc.). 2013. Downstream passage effectiveness for the passage of Atlantic salmon smolts at the Weston, Shawmut and Lockwood projects, Kennebec River, Maine. Prepared for FPL Energy Maine Hydro LLC and The Merimil Limited Partnership.

[13]Normandeau (Normandeau Associates, Inc.). 2014. Evaluation of Atlantic salmon Passage at the Weston, Shawmut, Hydro Kennebec, and Lockwood Projects, Kennebec River and Brunswick Project, Androscoggin River, Maine, Spring 2013. Prepared for Brookfield White Pine Hydro LLC and The Merimil Limited Partnership.

[14] Normandeau (Normandeau Associates, Inc.). 2015. Evaluation of Atlantic salmon Passage at the Weston, Shawmut, Hydro Kennebec, and Lockwood Projects, Kennebec River and Brunswick Project, Androscoggin River, Maine, Spring 2014. Prepared for Brookfield White Pine Hydro LLC and The Merimil Limited Partnership.

[15] Normandeau (Normandeau Associates, Inc.). 2016. Evaluation of Atlantic salmon Passage at the Weston, Shawmut, and Lockwood Projects, Kennebec River and Pejepscot and Brunswick Projects, Androscoggin River, Maine, Spring 2015. Prepared for Brookfield White Pine Hydro LLC and The Merimil Limited Partnership.

First, Normandeau (Brookfield's consultant) inappropriately used paired release studies when analyzing the 2013 to 2015 data. Paired release studies should only be used when there are at least 1000 fish[16] but Brookfield used this methodology with much smaller numbers of Atlantic salmon smolt (approximately 100 each year released above each dam) in the Kennebec. In doing so, Brookfield's consultant actually "creates fish" statistically, with calculated survival rates exceeding the number of fish that actually survived.[17]

Second, Brookfield inappropriately calculated overall downstream survival rates as the product of survival rates at each individual dam, which leaves out the highly significant impacts of the impoundments between the dams. Mr. Pugh analyzed the actual survival of individual smolts from 200 meters above the Weston Dam to the lowermost telemetry station below the Lockwood Dam. Only an average of 56% of smolts survived this multi-dam passage over the course of the four years of the Normandeau studies (Table 1).[18] Even this low survival rate is likely an overestimate because Normandeau released smolts just above the Weston Dam, excluding the likely significant impacts on smolt survival of the 12-mile-long journey through the Weston impoundment to the dam itself. Based on Mr. Pugh's calculations, Brookfield's contention that it can meet an "end-of-pipe" downstream passage goal of 88.5% is wishful thinking that imperils the future of the endangered Atlantic salmon.

Similarly, Mr. Pugh's analysis shows that average survival at the Shawmut Dam between 2013 and 2015 was 78.3% as set forth in Table 2 below, not the 93% the Department appears to have accepted. Brookfield's claimed dam survival estimates for the Shawmut Dam of 96.3%, 93.6%, and 90.6%, for an average 93.5%,[19] is an overestimate of actual survival of fish that pass the Shawmut Dam. For fish released above Shawmut passing to the telemetry station above the Hydro-Kennebec Dam, survival was just 78.3%.

[16] Zydlewski, J., D. Stich and D. Sigourney. 2017. Hard choices in assessing survival past dams – a comparison of single- and paired-release strategies. Can. J. Fish. Aquat. Sci. 74(2): 178-190.

[17] Kennebec Coalition. 2020. MOTION TO INTERVENE, WITH PROTESTS AND COMMENTS OPPOSING THE ISSUANCE OF A NEW LICENSE FOR THE SHAWMUT PROJECT NUMBER 2322-069, WITH RECOMMENDATION FOR ORDER OF PLAN FOR DECOMMISSIONING AND REMOVAL. P. 41. FERC Accession Number 20200831-5332.

[18] Kennebec Coalition. 2020. MOTION TO INTERVENE, WITH PROTESTS AND COMMENTS OPPOSING THE ISSUANCE OF A NEW LICENSE FOR THE SHAWMUT PROJECT NUMBER 2322-069, WITH RECOMMENDATION FOR ORDER OF PLAN FOR DECOMMISSIONING AND REMOVAL. P. 38. FERC Accession Number 20200831-5332.

[19] 2020. Kleinschmidt Associates. Brookfield White Pine Hydro LLC. Application for New License for Major Water Power Project – Existing Dam. Shawmut Hydroelectric Project (FERC Number 2322). January 30. P. E-4-52.

The numbers of smolt arriving at the Weston Dam and detected at the telemetry stations below the dams are from the study reports prepared by Normandeau Associates, Inc.[20] [21] [22] [23] Tables 12-15 and Appendix A in the 2012 report and Appendices C in the 2013 to 2015 reports list the number of fish that arrived at the Shawmut and Weston Dams and that were detected below each of the dams, at the Hydro-Kennebec station, and at the lowermost telemetry station below the Lockwood Dam. Mr. Pugh calculated survival as the number of fish released above Weston that arrived at the dam detected at the lowermost telemetry station below Lockwood or at the Hydro-Kennebec Dam, divided by the number of smolts arriving at a dam (Weston or Shawmut), times one hundred (See Tables below). Fish that are released above Weston encounter the Weston Dam and the downstream dams like naturally outmigrating smolts. This estimate is conservative when compared to wild smolts as it does not include the impact of the Weston impoundment.

Table 1. Number of smolt arriving at the Weston project and detected at the lowermost telemetry station below the Lockwood project and annual and combined survival rates.

Year	Arrive Weston	Detected Lowest Station	%
2012	115	34	29.6
2013	100	70	70
2014	99	69	69.7
2015	98	59	60.2
All	412	232	56.3

[20] Normandeau (Normandeau Associates, Inc.). 2013. Downstream passage effectiveness for the passage of Atlantic salmon smolts at the Weston, Shawmut and Lockwood projects, Kennebec River, Maine. Prepared for FPL Energy Maine Hydro LLC and The Merimil Limited Partnership.

[21] Normandeau (Normandeau Associates, Inc.). 2014. Evaluation of Atlantic salmon Passage at the Weston, Shawmut, Hydro Kennebec, and Lockwood Projects, Kennebec River and Brunswick Project, Androscoggin River, Maine, Spring 2013. Prepared for Brookfield White Pine Hydro LLC and The Merimil Limited Partnership.

[22] Normandeau (Normandeau Associates, Inc.). 2015. Evaluation of Atlantic salmon Passage at the Weston, Shawmut, Hydro Kennebec, and Lockwood Projects, Kennebec River and Brunswick Project, Androscoggin River, Maine, Spring 2014. Prepared for Brookfield White Pine Hydro LLC and The Merimil Limited Partnership.

[23] Normandeau (Normandeau Associates, Inc.). 2016. Evaluation of Atlantic salmon Passage at the Weston, Shawmut, and Lockwood Projects, Kennebec River and Pejepscot and Brunswick Projects, Androscoggin River, Maine, Spring 2015. Prepared for Brookfield White Pine Hydro LLC and The Merimil Limited Partnership.

Table 2. Number of smolts arriving at the Shawmut project, number detected arriving at the Hydro-Kennebec station and the percent survival for each of three years and the combined survival.

Year	Arrive Shawmut	Detected Hydro-K	%
2013	**102**	**86**	**84.3**
2014	**100**	**82**	**82**
2015	**93**	**63**	**67.7**
All	**295**	**231**	**78.3**

Brookfield proposes the whole river (end-of-pipe) survival as a multiplication of the immediate dam survival estimates at each project. But a more accurate picture of smolt survival would be gained by analyzing the number of fish that pass all four projects, as it accounts for complete project impacts in addition to immediate dam passage. These impacts include increased water temperature in the impoundments[24] [25]; reduced migration speed through the impoundments[26] [27] [28] [29] [30] [31]; increased

[24] Marschall, E., M.Mather, D.Parish, G.Allison, and J. McMenemy. 2011. Migration delays caused by anthropogenic barriers: modeling dams, temperature, and success of migrating salmon smolts. Ecological Applications, 21(8), pp. 3014-3031.

[25] McCormick, S., D.Lerner, M.Monette, K.Nieves-Puigdoller, J.Kelly, and B.Bjornsson. 2009. Taking It with you when you go: how perturbations to the freshwater environment, including temperature, dams, and contaminants, affect marine survival of salmon. American Fisheries Society Symposium 69:195–214.

[26] Babin, A., M.Ndong, K.Haralampides, S.Peake, R.Jones, R.Curry, and T.Linnansarri. 2020. Migration of Atlantic salmon (*Salmo salar*) smolts in a large hydropower reservoir. Can. J. Fish. Aquat. Sci. https://doi.org/10.1139/cjfas-2019-0395

[27] Havn, T., E. Thorstad, M.Teichert, S.Saether, L.Heermann, R.Hedger, M.Tambets, O.Diserud, j.Borcherding, and F. Økland. 2018. Hydropower-related mortality and behaviour of Atlantic salmon smolts in the River Sieg, a German tributary to the Rhine. Hydrobiologia 805**,** 273–290.

[28] Holbrook, C., M.Kinnison, and J.Zydlewski. 2011. Survival of migrating Atlantic salmon smolts through the Penobscot River, Maine: a prerestoration assessment. Trans. Am. Fish. Soc. 140:1255–1268.

[29] Marschall, E., M.Mather, D.Parish, G.Allison, and J. McMenemy. 2011. Migration delays caused by anthropogenic barriers: modeling dams, temperature, and success of migrating salmon smolts. Ecological Applications, 21(8), pp. 3014-3031.

[30] Norrgard, J., L.Greenberg, J.Piccolo, and M.Schmitz. 2013. Multiplicative loss of landlocked Atlantic salmon *Salmo salar* L. smolts during downstream migration through multiple dams. Rivers Research and Applications, Vol.29, no 10, pp. 1306-1317.

[31] Stich, D. M. Kinnison, J.Kocki, and J.Zydlewski. 2015. Initiation of migration and movement rates of Atlantic salmon smolts in fresh water. Can. J. Fish. Aquat. Sci. 72: 1–13.

predation in the impoundment and tailraces[32] [33] [34] [35]; and the cumulative impacts of injury during dam passage[36] [37]. Each of these impacts can negatively affect survival and must be considered as project effects. Outmigration must be considered as a complete movement past all four projects, not as the subset of only passage from the lower end of the impoundment to the base of a single dam. A direct analysis of smolt survival from arrival at the Weston project to detection below the Lockwood project accounts for these factors—and shows survival rates much lower than Brookfield reports.

Brookfield's analysis is further undermined by inappropriately using "paired release" analysis to determine survival in 2013, 2014, and 2015. The paired release analysis is designed to determine the 'natural', no dam in place, mortality from immediately above the dam to below it and adjust dam passage survival at the project to account for this 'natural' mortality. Again, a paired release analysis is not appropriate for the Kennebec studies as the sample sizes were too low. Multiple tables in the reports from 2013 to 2015 show a paired survival estimate greater than either survival for S1 or S2 (test release and tailrace release survivals) for both group releases and all releases combined for a project (e.g., Normandeau,2013 - Tables 40, 41 & 46: Normandeau 2015 - Tables 4-11 & 4-15). In essence, the paired release calculation in these instances 'makes' fish. Table 4-15 (Weston 2015 whole station survival estimates) release survivals for S1 and S2 are 0.888 and 0.850. The calculated paired release survival is 100.0% (S1 ÷ S2 * 100). Similarly, the 2013 report estimated Lockwood survival is 100% when both S1 and S2 are 0.95. In neither release did all fish survive – the only thing that survived intact was Brookfield's estimate, divorced from any basis in fact.

The Kennebec River presents a particularly egregious example of the impact of impoundments – the still waters created by dams. Eighty-five percent of the stretch of the Kennebec River between the Lockwood Dam and the confluence of the Sandy River is impounded – nearly 30 river miles from the upper end of the Weston impoundment to the Lockwood Dam.

NMFS clearly states that impoundments constitute a serious risk to Atlantic salmon in its 2013 Biological Opinion:

> Impoundments created by these dams limit access to habitat, alter habitat, and degrade water quality through increased temperatures and lowered dissolved oxygen levels. Furthermore, because hydropower dams are typically constructed in reaches with moderate to high underlying gradients, significant areas of free-flowing habitat have been

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[32] Blackwell, B. and F.Juanes. 1998. Predation on Atlantic salmon smolts by striped bass after dam passage. North American Journal of Fisheries Management 18:936–939.

[33] Jepsen, N., K.Aarestrup, F Okland, and G. Rasmussen. 1998. Survival of radio-tagged Atlantic salmon (*Salmo salar* L.) and trout (*Salmo trutta* L.) smolts passing a reservoir during seaward migration. *Hydrobiologia* **371/372:** 347–353.

[34] Havn, T., E. Thorstad, M.Teichert, S.Saether, L.Heermann, R.Hedger, M.Tambets, O.Diserud, j.Borcherding, and F. Økland. 2018. Hydropower-related mortality and behaviour of Atlantic salmon smolts in the River Sieg, a German tributary to the Rhine. Hydrobiologia 805**,** 273–290.

[35] Økland, F., Teichert, M.A.K., Thorstad, E.B., Havn, T.B., Heermann, L., Sæther, S.A., Diserud, O.H., Tambets, M., Hedger, R.D. & Borcherding, J. 2016. Downstream migration of Atlantic salmon smolt at three German hydropower stations. NINA Report 1203: 1-47.

[36] Holbrook, C., M.Kinnison, and J.Zydlewski. 2011. Survival of migrating Atlantic salmon smolts through the Penobscot River, Maine: a prerestoration assessment. Trans. Am. Fish. Soc. 140:1255–1268.

[37] Zydlewski, J., G.Zydlewski, and G.Danner.2010. Descaling Injury Impairs the osmoregulatory ability of Atlantic salmon smolts entering seawater. Trans. Am. Fish. Soc. 138:129-136.

> converted to impounded habitats in the Kennebec and Androscoggin River watersheds Coincidently, these moderate to high gradient reaches, if free-flowing, would likely constitute the highest value as Atlantic salmon spawning, nursery, and adult resting habitat within the context of all potential salmon habitat within these reaches. [38]

Brookfield's analysis of downstream fish passage effectiveness for salmon for the years 2012 to 2015 does not consider any of the above effects. Rather it is designed to assess survival merely from arrival to below the dam. For the four projects combined, this is just over a half of a river mile, less than 2% of length of the four projects' impact on smolts. New research also from the University of Maine illustrates that impoundments substantially increase the impacts of predation on salmon smolts. On the Penobscot River, predation is 36 times higher in impoundments than in free-flowing river segments.[39]

Brookfield attempts to justify its inadequate downstream passage in Appendix 12 of its application with a model developed by Normandeau Associates that purports to support a conclusion that downstream passage will be 97%-98% for smoltsattah. The NGOs again contracted with Don Pugh to review this model and he concluded that this model is misleading as its conclusions are based on faulty assumptions. Mr. Pugh's analysis is attached as Attachment 3.

In sum, Brookfield has dramatically overstated the success of its existing downstream passage measures and greatly inflated the likelihood of the success of its limited proposed additional measures with an inaccurate and misleading model. Again, the NGOs believe that this is grounds for the Department to deny Brookfield's application for Water Quality Certification. Should it choose not to do so, the Department must require strict measures such as those MDMR recommended in its draft scoping comments on FERC's upcoming EIS. Specifically, MDMR stated:

> MDMR requests that FERC not rely on the proposed guidance booms as safe, timely, and effective downstream passage for all species. USFWS has summarized passage data on guidance booms in a recent filing. The data in their summary demonstrates that guidance booms do not provide safe, timely, and effective passage for salmon smolts or adult river herring and guidance booms do not meet current USFWS design criteria. MDMR recommends that all project passage measures comport with the USFWS Fish Passage Engineering Design Criteria (2019) and based on those criteria, we recommend screening all operating turbines with angled, full-depth bar racks with clear space less than or equal to 0.75 inches. The best available data indicate that racks with 0.5-inch clear space are most protective for multiple species and life stages.[40]

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[38] National Marine Fisheries Service (NMFS). 2013. Endangered Species Act Biological Opinion, Amendment of the Licenses for the Lockwood (2574), Shawmut (2322), Weston (2325), Brunswick (2284), and Lewiston Falls (2302) Projects. July 19, 2013. Page 46 [FERC Accession Number 20130723-0012].

[39] Mensinger, M. et al. Using acoustic predator tags to characterize predation on Atlantic Salmon smolts. Atlantic Slamon Ecosystems Forum; 2022 January 11-12. (abstract is attached to these comments as Attachment 2).

[40] MDMR. 2021. Comments on Notice Of Intent To Prepare An Environmental Impact Statement For The Proposed Project Relicense, Interim Species Protection Plan, And Final Species Protection Plan, Request For Comments On Environmental Issues, Schedule For Environmental Review, And Soliciting Scoping Comments on the Lockwood (FERC No. 2574), Hydro-Kennebec (FERC No. 2611), Shawmut (FERC No. 2322), and Weston (FERC No. 2325) Hydroelectric Projects. December 22.P. 3. FERC Accession Number 20211223-5269.

6. Brookfield's application contains no passage standards for kelts despite extensive research showing the critical importance of repeat spawning in Atlantic salmon

Best available information and scientific literature emphasizes the unique importance of repeat spawners, and the difficulty in passing kelts over dams. This is an environmental consequence that cannot be ignored in the licensing and certification process for hydropower projects like the Shawmut project.

Standards for kelts need to be considered and prioritized in order to promote recovery; without this consideration recovery plans for Atlantic salmon are not adequate and will likely fail. Research indicates that downstream-migrating adult salmon follow bulk flows.[41] However, even with fishways and high flow through spillways, many kelts have been observed passing through turbines, resulting in low downstream passage survival.[42, 43] Survival through multiple dams compared to that in free-flowing rivers is, at best, dismal[44, 45, 46, 47, 48]. The positive contributions kelts were found to make towards population persistence diminished with the presence of multiple dams.[49] Consideration of passage effectiveness rates for kelts is therefore an imperative component of a successful restoration plan.

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[41] Coutant CC, Whitney RR. 2000. Fish behavior in relation to passage through hydropower turbines: A review. Trans Am Fish Soc. 129(2):351–380.

[42] Calles O., Greenberg L. 2009. Connectivity is a two-way street-the need for a holistic approach to fish passage problems in regulated rivers: CONNECTIVITY IS A TWO-WAY STREET. River Res Appl. 25(10):1268–1286.

[43] Nyqvist D, Bergman E, Calles O, Greenberg L. 2017. Intake Approach and Dam Passage by Downstream-migrating Atlantic Salmon Kelts: Intake approach and dam passage by salmon kelts. River Res Appl. 33(5):697–706.

[44] Coutant CC, Whitney RR. 2000. Fish behavior in relation to passage through hydropower turbines: A review. Trans Am Fish Soc. 129(2):351–380.

[45] Wertheimer RH, Evans AF. 2005. Downstream passage of Steelhead kelts through hydroelectric dams on the lower snake and Columbia rivers. Trans Am Fish Soc. 134(4):853–865.

[46] Holbrook CM, Zydlewski J, Gorsky D, Shepard SL, Kinnison MT. 2009. Movements of prespawn adult Atlantic salmon near hydroelectric dams in the lower Penobscot river, Maine. N Am J Fish Manag. 29(2):495–505.

[47] Norrgård JR, Greenberg LA, Piccolo JJ, Schmitz M, Bergman E. 2013. Multiplicative loss of landlocked Atlantic salmon *Salmo salar* L.smolts during downstream migration through multiple dams. River Res Appl. 29(10):1306–1317.

[48] Nyqvist D, Calles O, Bergman E, Hagelin A, Greenberg LA. 2016. Post-spawning survival and downstream passage of landlocked Atlantic salmon (*Salmo salar*) in a regulated river: Is there potential for repeat spawning? River Res Appl. 32(5):1008–1017.

[49] Lawrence, E.R, Kuparinen, A., and Hutchings, J.A. 2016. Influence of dams on population persistence in Atlantic salmon (Salmo salar). Can. J. Zool. 94: 329–338. doi:10.1139/cjz-2015-0195.

The success of repeat spawners is a particularly critical factor necessary for the recovery of Atlantic salmon populations because their populations are small and recovering[50, 51], as is especially the case for the GOM DPS. These individuals have been shown to contribute substantial numbers of offspring while providing a stabilizing effect on populations. Repeat spawners often have higher fecundity than first time spawners, given the repeat spawners' greater size and experience.[52, 53, 54] Variation in the timing of spawning among year-classes diffuses the adverse effects of environmental variability on spawning success and promotes genetic diversity within populations.[55, 56] A model developed by Lawrence et al.[57] revealed that the abundance of kelts was positively related to the probability of population persistence. Thus, the loss of just a few individual repeat spawners through passage-related mortalities each season has a qualitatively greater impact on the ability of the species to avoid extinction.

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[50] Nyqvist D, Calles O, Bergman E, Hagelin A, Greenberg LA. 2016. Post-spawning survival and downstream passage of landlocked Atlantic salmon (*Salmo salar*) in a regulated river: Is there potential for repeat spawning? River Res Appl. 32(5):1008–1017.

[51] Bordeleau, X., Pardo, S. A., Chaput, G., April, J., Dempson, B., Robertson, M., Levy, A., Jones, R., Hutchings, J. A., Whoriskey, F. G., and Crossin, G. T. 2020. Spatio-temporal trends in the importance of iteroparity across Atlantic salmon populations of the northwest Atlantic. ICES Journal of Marine Science, 77: 326–344. doi:10.1093/icesjms/fsz188.

[52] Halttunen, H. 2011. Staying Alive: The Survival and Importance of Atlantic Salmon Post-Spawners. University of Tromsø. UiTMunin Open Research Drive. Available from: https://munin.uit.no/bitstream/handle/10037/3536/thesis.pdf?sequence=2&isAllowed=y

[53] Maynard GA, Izzo LK, Zydlewski JD. 2018. Movement and mortality of Atlantic salmon kelts (*Salmo salar*) released into the Penobscot River, Maine. Fish Bull (Wash DC). 116(3–4):281–290.

[54] Baktoft H, Gjelland KØ, Szabo-Meszaros M, Silva AT, Riha M, Økland F, Alfredsen K, Forseth T. 2020. Can energy depletion of wild Atlantic salmon kelts negotiating hydropower facilities lead to reduced survival? Sustainability. 12(18):7341.

[55] Saunders RL, Schom CB. 1985. Importance of the variation in life history parameters of Atlantic salmon (*Salmo salar*). Can J Fish Aquat Sci. 42(3):615–618.

[56] Moore JW, Yeakel JD, Peard D, Lough J, Beere M. 2014. Life-history diversity and its importance to population stability and persistence of a migratory fish: steelhead in two large North American watersheds. J Anim Ecol. 83(5):1035–1046.

[57] Lawrence, E.R, Kuparinen, A., and Hutchings, J.A. 2016. Influence of dams on population persistence in Atlantic salmon (Salmo salar). Can. J. Zool. 94: 329–338. doi:10.1139/cjz-2015-0195.

Declining numbers of repeat spawners have been widely reported [58, 59, 60] and associated with overharvesting and hydropower projects.[61, 62] The proportion of repeat spawners in the Penobscot River's Atlantic salmon run over the last decade has averaged 0.04%, compared to an average of 1.7% in the 1980s.[63] Average proportions of repeat spawners in the southern North American range of Atlantic salmon have decreased significantly from 4.1 to 2.7%.[64] Though many northern and mid-latitude populations have exhibited a relative increase in repeat spawners with reductions in fishing pressure, declines seen in the southern range have been attributed to anthropogenic threats such as hydropower projects and reliance on hatchery reared fish.[65] Hydropower projects elevate mortality of post-spawners during downstream migration through injuries and delays.[66,67, 68] Chaput and Jones[69] highlighted the effects of hydropower projects on repeat spawners by revealing a 4.1% reduction in their prevalence between two proximate populations in the Saint John River above and below the Mactaquac Dam. Size-dependent selection against larger fish reported at passage facilities on the Penobscot and Saint John rivers may limit the persistence of repeat spawners and must be closely examined before building new

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[58] Hubley PB, Amiro PG, Gibson AJF, Lacroix GL, Redden AM. 2008. Survival and behaviour of migrating Atlantic salmon (*Salmo salar* L.) kelts in river, estuarine, and coastal habitat. ICES J Mar Sci. 65(9):1626–1634.

[59] Nyqvist D, Calles O, Bergman E, Hagelin A, Greenberg LA. 2016. Post-spawning survival and downstream passage of landlocked Atlantic salmon (*Salmo salar*) in a regulated river: Is there potential for repeat spawning? River Res Appl. 32(5):1008–1017.

[60] Maynard GA, Izzo LK, Zydlewski JD. 2018. Movement and mortality of Atlantic salmon kelts (*Salmo salar*) released into the Penobscot River, Maine. Fish Bull (Wash DC). 116(3–4):281–290.

[61] Wertheimer RH, Evans AF. 2005. Downstream passage of Steelhead kelts through hydroelectric dams on the lower snake and Columbia rivers. Trans Am Fish Soc. 134(4):853–865.

[62] Keefer ML, Wertheimer RH, Evans AF, Boggs CT, Peery CA. 2008. Iteroparity in Columbia River summer-run steelhead (Oncorhynchus mykiss): implications for conservation. Can J Fish Aquat Sci. 65(12):2592–2605
[63] Fleming, I. A., and J. D. Reynolds. 2004. Salmonid breeding systems. In Evolution illuminated: salmon and their relatives (A. P. Hendry and S. C. Stearns, eds.), p. 264–294. Oxford Univ. Press, Inc., New York.

[64] Bordeleau, X., Pardo, S. A., Chaput, G., April, J., Dempson, B., Robertson, M., Levy, A., Jones, R., Hutchings, J. A., Whoriskey, F. G., and Crossin, G. T. 2020. Spatio-temporal trends in the importance of iteroparity across Atlantic salmon populations of the northwest Atlantic. ICES Journal of Marine Science, 77: 326–344. doi:10.1093/icesjms/fsz188.

[65] Maynard GA, Izzo LK, Zydlewski JD. 2018. Movement and mortality of Atlantic salmon kelts (*Salmo salar*) released into the Penobscot River, Maine. Fish Bull (Wash DC). 116(3–4):281–290.

[66] Holbrook CM, Zydlewski J, Gorsky D, Shepard SL, Kinnison MT. 2009. Movements of prespawn adult Atlantic salmon near hydroelectric dams in the lower Penobscot river, Maine. N Am J Fish Manag. 29(2):495–505.

[67] Östergren J, Rivinoja P. 2008. Overwintering and downstream migration of sea trout (Salmo trutta L.) kelts under regulated flows—northern Sweden. River Res Appl. 24(5):551–563.

[68] Kraabøl M, Johnsen SI, Museth J, Sandlund OT. 2009. Conserving iteroparous fish stocks in regulated rivers: the need for a broader perspective! Fish Manag Ecol. 16(4):337–340.

[69] Chaput, G., & Jones, R. 2006. Reproductive rates and rebuilding potential for two multi-sea-winter Atlantic salmon (*Salmo salar* L.) stocks of the Maritime provinces. Department of Fisheries and Oceans Canada. Can. Sci. Advis. Sec. Res. Doc., 2006/027.

passage facilities to minimize post-spawning mortality. [70,71] Furthermore, delays at dams can lead to starvation, accumulated stress, increased predation and loss of marine adaptations, lowering the chances of surviving to feeding grounds.[72]

Brookfield's failure to even consider kelt passage as part of its application requires the Department to deny certification.

7. Brookfield's proposals are inadequate for other species of sea-run fish both in terms of upstream and downstream passage.

Brookfield is obligated to pass all species of sea-run fish under both state and federal law and its proposals for passage of these species are inadequate. Brookfield's application contains no post construction testing requirement to ensure that passage measures will work for shad, river herring, or sea lamprey, let alone enforceable steps for additional fish passage construction. In addition, recent research—and experience at the Lockwood Project since installation of the interim fish lift there—has shown that engineered fish passage offers almost no benefit to shad populations. Specifically, it concluded that: "Based on our results, dams represent a significant and acute constraint to the population and, with other human impacts, reduce the fishery potential and ecological services attributed to the species."[73] And regarding engineered fish passage, that research paper concludes:

> The inability for current realistic fish passage measures to restore any more than 9% of the estimated spawning potential coast-wide is troubling news for the restoration of these fish. Our results indicate that the application of current upstream and downstream passage rates at all dams affords a remarkably small increase in the theoretical production potential relative to rivers that are wholly inaccessible upstream of the first dam. We estimate that fishway passage coast-wide at dams represents a fixed constraint of about 35% on the spawning run potential of American shad. It is possible that as advances in fish passage engineering, other protective measures, and understanding of fish behavior continue to evolve, passage efficacy may improve beyond our optimistic estimates. The use of fish passage performance criteria (e.g., Stich et al., 2019; CRASC, 2020) may also facilitate fish passage improvements by providing biologically relevant targets. These potential advances withstanding, the low theoretical return on investment of fishways is heavily influenced by the presence of multiple dams on rivers, resulting in a compounding influence on passage and survival.[74]

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[70] Maynard GA, Kinnison MT, Zydlewski JD. 2017. Size selection from fishways and potential evolutionary responses in a threatened Atlantic salmon population. River Res Appl. 33(7):1004–1015.

[71] Bordeleau, X., Pardo, S. A., Chaput, G., April, J., Dempson, B., Robertson, M., Levy, A., Jones, R., Hutchings, J. A., Whoriskey, F. G., and Crossin, G. T. 2020. Spatio-temporal trends in the importance of iteroparity across Atlantic salmon populations of the northwest Atlantic. ICES Journal of Marine Science, 77: 326–344. doi:10.1093/icesjms/fsz188.

[72] Nyqvist D, Calles O, Bergman E, Hagelin A, Greenberg LA. 2016. Post-spawning survival and downstream passage of landlocked Atlantic salmon (*Salmo salar*) in a regulated river: Is there potential for repeat spawning? River Res Appl. 32(5):1008–1017.

[73] Zydlewski J, Stich DS, Roy S, Bailey M, Sheehan T and Sprankle K. (2021) What Have We Lost? Modeling Dam Impacts on American ShadPopulations Through Their Native Range. Front. Mar. Sci. 8:734213. doi: 10.3389/fmars.2021.734213. P. 1. Accessed at: https://www.frontiersin.org/articles/10.3389/fmars.2021.734213/full

[74] Ibid.

Shad are an important resource and could support much more substantial recreational fisheries and, with effective restoration, commercial fishing for this species might also become possible again.

MDMR has restoration goals for all species of sea-run fish native to the lower Kennebec and has already stated that Brookfield's fish passage proposals will not meet these goals in comments in the draft FERC Environmental Assessment for Shawmut.[75] Brookfield's proposals in its revised application for Water Quality Certification are virtually identical to those FERC analyzed in its draft EA. In addition, the restoration of Atlantic salmon is impossible without simultaneously restoring the co-evolved species of sea-run fish:

> Of particular concern for Atlantic salmon recovery efforts within the range of the GOM DPS is the dramatic decline observed in the diadromous fish community. At historic abundance levels, Fay et al. (2006) and Saunders et al. (2006) hypothesized that several of the co-evolved diadromous fishes may have provided substantial benefits to Atlantic salmon through at least four mechanisms: serving as an alternative prey source for salmon predators; serving as prey for salmon directly; depositing marine-derived nutrients in freshwater; and increasing substrate diversity of rivers.[76]

The Department should deny Brookfield's application because it fails to provide adequate passage for all species of sea-run fish. At the very least, the Department must require more innovative fish passage, such as a nature-like fishway in addition to Brookfield's proposed technical fishway.

Conclusion

In closing, the Shawmut Dam fails to meet the Kennebec River's water quality standards and nothing in Brookfield's revised application for water quality certification has changed that. The Department should deny Brookfield's application.

Respectfully submitted, this 16th day of February, 2022.

The Kennebec Coalition (Atlantic Salmon Federation U.S.; Maine Rivers; Natural Resources Council of Maine; Trout Unlimited and Kennebec Valley Chapter of Trout Unlimited) and Conservation Law Foundation

by:

/s/ Russell B. Pierce, Jr., Esq.   /s/ Charles Owen Verrill, Jr., Esq.

[75] MDMR. 2021. MDMR Response Draft Environmental Assessment (DEA) for the Shawmut Project. August 13. P.1. FERC Accession Number 20210816-5234.

[76] 74 Fed. Reg. 29,344-01 at 29,374-75 (Determination of Endangered Status for the Gulf of Maine Distinct Population Segment of Atlantic Salmon) (June 19, 2009).

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Attachment 1

Using acoustic predator tags to characterize predation on Atlantic Salmon smolts

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The Gulf of Maine Atlantic Salmon Distinct Population Segment is federally endangered with fewer than 2,000 adults returning to spawn annually. Juvenile salmon (smolts) migrate seaward after 2–3 years of rearing in freshwater. Mortality during this 4–6 week emigration period is naturally high, yet is exacerbated by dam passage. Understandably, reducing mortality during migration is a high priority for conservation efforts. More than 5,000 smolts have been released in the Penobscot River and tracked using acoustic transmitters to better understand behavior and to characterize survival during this vulnerable migration stage. This research has shown that dam headponds and the Penobscot River estuary are areas of high smolt mortality, where more than 30% of migrating smolts are lost annually. Conspicuous losses and movement patterns in these environments (relative to free-flowing, freshwater reaches) suggest that predation may be a significant cause of mortality. In 2021, we tagged 72 smolts with acoustic "predator" tags which enabled us to recognize predation events and identify body temperatures of the predator species. Fish were released in Medway, Maine and tracked over 175km through the Penobscot River estuary. Predation rates in free-flowing, headpond, and estuarine sections of river were modeled using a multistate mark-recapture framework where individuals entered an alternative state once predated. We identified 22 smolts (~31%) as predated before exiting the system. Fish were the dominant predator species (n=16), while six events were attributed to avian (n=3) and mammalian (n=3) taxa. Predation was estimated to be the leading cause of mortality for smolts, and predation rates were highest in dam headponds. Collectively, our results suggest that predation pressure on Atlantic Salmon smolts may be greater than anticipated.

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Attachment 2

Appendix 12 of the 401 Water Quality Certification Application describes a downstream salmon smolt model, provides a table of the model, and provides results with very high whole project survival. Scenarios modeled are five May exceedance flow conditions: 10%, 25%, 50%, 75%, and 90%. Higher flows result in more spill while the two lowest have very low spill and only one of propeller unit operating (7 or 8) or, at 90%, neither operating.

It includes two proposed structural changes: 1) a ten foot deep boom in the forebay designed to direct smolts to the downstream bypass gate, and 2) one inch clear space racks on all units to deter smolts approaching the racks entering the turbines. The model has significant flaws which cause it to produce inaccurate results.

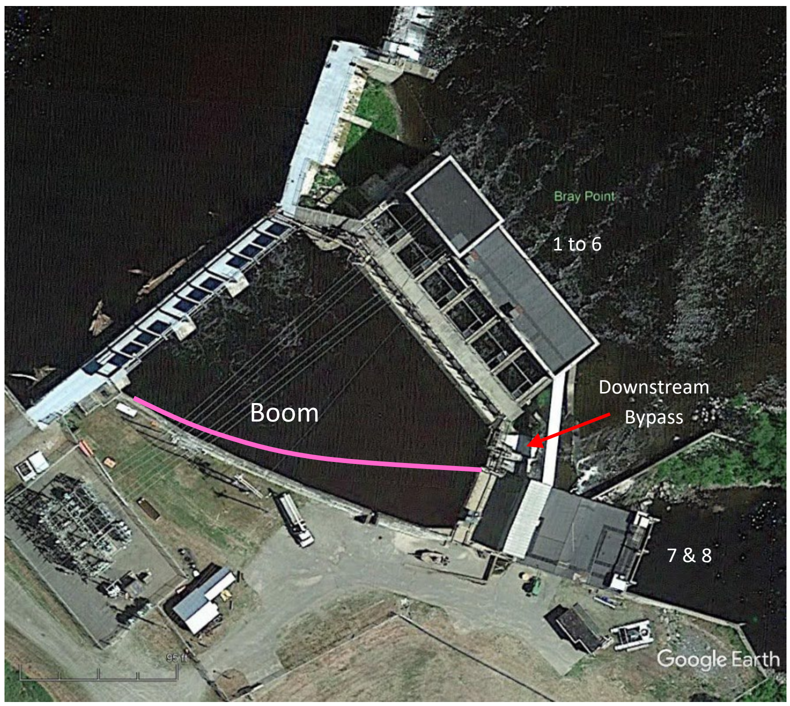
- Assumes that 1" clear space racks can be used at all units, which decreases the percent of fish passing the units.
- Assumes that 53% of fish entering power canal immediately encounter the boom and are bypassed at the Taintor or sluice gate.
- Assumes that 57% of smolts that approach all units, do not enter and subsequently use the downstream bypass.
- The percent survival for all routes is from Normandeau's 2013-2105 paired release analyses.
- Spill survival in particular is too high. Survival of fish passing through the hinged gates is 86.7% (Draft BA[1]).
- The 'Adjusted DS Bypass Effectiveness Proportion' accounts for the percent of fish that are not immediately guided by the boom (53%), approach the units, are not entrained (57%), and use the downstream bypass (43%). The rate of 0.798 is accurate only if 57% of the fish that approach units 7 and 8 are bypassed. If a lower percent of fish that approach units 7 and 8 are not bypassed this proportion declines.
- As such, the 'Adjusted Unit Proportions' are too low for four of five scenarios as fewer fish in the model approach the units which have a lower survival.

In its preliminary Section 18 prescriptions[2], the NMFS requires installation or overlays of one inch clear space trash racks with the caveat that, if velocities in front of the racks is too high, 1.5 inch clear space racks will be installed and that the boom depth will be increased to twenty feet. Clearly it is not assured that one inch clear space racks will be in place after relicensing. With one inch clear space racks, the model assumes an entrainment rate of 43% of fish approaching the racks. One and a half inch clear space as would entrain a higher percent of smolts.

[1] Draft Biological Assessment for Atlantic Salmon, Atlantic Sturgeon and Shortnose Sturgeon at the Lockwood, Hydro-Kennebec, Shawmut, and Weston Projects on the Kennebec River, Maine. December 2019. Pg. 6-17. Accession Number 20191231-5199.

[2] NOAA. 2020. Comments, Recommendations, Preliminary Terms and Conditions, and Preliminary Fishway Prescriptions for the Shawmut Hydroelectric Project (FERC No, 2322). 83 ppg. Accession Number 20200828-5176. Pages 53-54.

Not all fish that enter the power canal would initially encounter the guidance boom. The figure below shows the most likely location of the boom [no drawing of the proposed boom location is provided].[3] Fish entering adjacent to the units 1 to 6 powerhouse likely will never encounter the boom. Rather they will encounter all six units before reaching the downstream bypass. Fish entering farther from the powerhouse will be attracted to the dominant flow toward units 1 to 6 even when both units 7 and 8 are operating, never being guided by the boom (nearly a two to one or three to one flow ratio between units 1-6 and 7&8 when both or one propeller unit is operating). When neither unit 7 or 8 is operating, boom encounters will approach zero. Rather than applying a boom effectiveness rate of 0.53 to all fish entering the power canal it should be applied to only the fish that encounter the boom. Boom effectiveness would then be the rate of fish reaching the boom times 0.53.



The model assumes effectiveness/guidance of 53% based upon observations at the Lockwood Project. At Lockwood, the boom crosses the power canal upstream of the units. This is not the case at Shawmut where the boom is not upstream of all units. Combined with much lower expected encounters of the boom by smolts, it is incorrect to assume 53% guidance by the boom. As the difference in mortality for the bypass versus units 1 to 6 is nearly 9%, survival results are incorrectly inflated.

The model assumes that 57% of fish that encounter the racks will be deterred from entering the turbines and will subsequently use the downstream bypass. This would require fish that pass under the boom and approach units 7 and 8 to swim upstream, under the boom, before they could use the

[3] If the boom is anchored farther downstream the likelihood of fish encountering it is further reduced and the likelihood of fish sounding under the boom is increased as the angle of the boom to flow is increased.

downstream bypass. It is much more likely that fish will maintain position upstream of the racks become fatigued and would more likely be entrained.

The model uses route survivals derived from a paired release analysis. Due to low numbers of fish in the studies this analysis is inappropriate as it overestimates project survival.[4] Direct immediate survivals by route (S1) from Table 2 (Appendix 12) are lower. Substituting these more realistic rates reduces survival 3 or 4% depending on flow.

	Survival Rate	
Route	Model	S1
Bypass	0.995	0.962
Francis Units 1-6	0.909	0.879
Propeller Units 7 & 8	0.921	0.890
Spill	0.965	0.932

In Table 6-2 of the Draft Biological Assessment[5] the hinged flashboard section survival is 86.7 percent, notably lower than spill survival in the model or as calculated from S1 in the report tables. Depending on flow above unit capacity, smolts that pass over the dam at this location will experience significantly higher mortality than the rate in the model. This is particularly true in the first two scenarios where over 50% of the fish pass in spill.

The 'Adjusted DS Bypass Effectiveness Proportion', in part, redirects 57% of the fish deterred at the racks to the downstream bypass. This adjustment in the model is accurate only when 57% of the fish approaching units 7 and 8, when they are operating, use the bypass. As noted above it is unlikely that such a high percent of fish in front of these units will use the downstream bypass.

The model's 'Adjusted Francis/Propeller Unit Proportion' thereby reduces the proportion of fish directed to the units which have lower survival. A lower number of fish passing through the units results in a higher overall project survival.

Models are designed to represent reality. To do this they must have a structure accurately represents conditions that are modeled and inputs that are accurate. This model fails on both accounts; it assumes that one inch clear space racks will be installed, that fish entering the power canal will initially encounter the boom, and that a high proportion of fish that pass under the boom will be bypassed. Survival estimates from flawed analysis that overestimate actual route survival affect all fish and inflate overall survival. In a number of steps, this model incorrectly directs fish to the downstream bypass, where survival is high, away from the turbines, where survival is lower.

[4] Zydlewski, J., D. Stich and D. Sigourney. 2017. Hard choices in assessing survival past dams – a comparison of single- and paired-release strategies. Can. J. Fish. Aquat. Sci. 74(2): 178-190.
[5] Draft Biological Assessment for Atlantic Salmon, Atlantic Sturgeon and Shortnose Sturgeon at the Lockwood, Hydro-Kennebec, Shawmut, and Weston Projects on the Kennebec River, Maine. December 2019. Accession Number 20191231-5199.

This model does not represent downstream survival under the proposed license conditions.

Attachment 3

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Work History:

Self Employed

Current projects:

Maryland Power Plant Research Project – relicensing of Conowingo Project (FERC # 405) on the Susquehanna River and post-license studies at Holtwood (FERC # 1881) and York Haven (FERC # 1888) upstream of Conowingo. Principle areas of responsibility include: up- and downstream fish passage, telemetry data analysis, fish biology, habitat-flow analysis, and American eel passage.

Connecticut River Conservancy – relicensing of First light hydroelectric projects on the Connecticut River at Turners Falls (FERC # 1889) and the Northfield Mountain Pumped Storage Station (FERC #2485). Scoping began in 2012. First Light has filed its final license application. Reviewed study plans, study reports, IFIM review, shortnose sturgeon spawning flow needs analysis, and shad telemetry analysis. Participated in settlement talks with company, state and federal agencies, and NGOs.

SWCA, Inc. – Shortnose and Atlantic sturgeon habitat and protection plans for sewer line crossing construction on the Connecticut River, Springfield, Massachusetts.

Geosyntec consultants - Shortnose and Atlantic sturgeon habitat and protection plans for river bank stabilization on the Merrimack River, Haverhill, Massachusetts

Maine Rivers – relicensing of three projects on the Mousam River (FERC # 14856).

Kennebec Coalition – review and data analysis of downstream smolt radio telemetry studies (2012 – 2015) and the upstream fish passage plan at the Shawmut project on the Kennebec River (FERC # 2322).

Member of the Holyoke Cooperative Consultation Team for the Holyoke Hydroelectric Project (FERC #2004). Post-licensing downstream fish passage planning including configuration of the downstream passage protection structure, review of CFD analysis, analysis of telemetry data of American shad, shortnose sturgeon, and American eel during post licensing studies.

Santo Antônio , January 2010 to June 2011

TIRIS PIT tag installation, data analysis, and fish passage consultation for an experimental fish passage flume on the Rio Maderia, Brazil.

American Rivers, April 2010 to November 2011

Represented American Rivers for the relicensing of three projects on the Susquehanna River – Conowingo Dam, Muddy Run Pumped Storage Project and York Haven Dam. Participated in study plan development, reviewed study reports and prepared comment letters, attended meetings with the project owners, the FERC, state and federal agencies, and NGO's. Developed and independent analysis of American shad telemetry data at York Haven and Conowingo.

University of Massachusetts, Amherst MA January 1997 to January 2009

<u>Research Assistant</u> in the Department of Natural Resource Conservation working at the

Silvio Conte Anadromous Research Center – areas of research included the behavior and movement of adult Atlantic salmon in the Westfield River in Massachusetts using radio telemetry, upstream passage of sturgeons and riverine fishes in a spiral fishway, spawning behavior of shortnose sturgeon in an artificial 'stream, and downstream passage of sturgeons at a bar rack and louver system with a low level bypass entrance.

Massachusetts Cooperative Fisheries and Wildlife Research Unit, University of Massachusetts, Amherst MA
March 1991 to January 1997

Project Leader for Anadromous Fish Investigations project. Duties include: hire and supervise technicians staffing the Holyoke, Turners Falls, and Westfield River fish passage facilities; conduct recreational angler creel surveys, Atlantic salmon habitat assessment, and juvenile growth and survival estimates; supervise stocking of Atlantic salmon fry for the Connecticut River basin in Massachusetts; coordinate Unit operations with utility companies and state and federal agencies; and prepare budgets and reports.

Education:

Undergraduate

Trinity College
Hartford, CT 1967-71, B.A.
Major: History
Specialty: American History

Continuing Ed.

Greenfield Community College
- Photography I, II & III, Fall 1980-81
- Engineering Drawing, Fall 1978
- Drafting for Engineers, Spring 1979
- Programming Principles and Concepts, Fall 2002
- Advanced Basic for Programmers, Spring 2002
- Database Programming and Procedures, Spring 2005
- Advanced Database Programming, Spring 2006

University of Massachusetts, Amherst
- Principles of Management, Fall 1981
- Microeconomics, Fall 1980
- Macroeconomics, Spring 1981
- Social Conflicts and Natural Resources, Spring 1991
- Biological Limnology, Fall 1991
- Anadromous Fish, Fall 1991
- Biostatistics, Fall 1991
- Intermediate Biostatistics, Spring 1992
- GIS, Spring 1992
- Population Dynamics, Fall 1992
- Animal Movement and Migration, Fall 1992
- Coastal Zone Management, Spring 1993
- Ichthyology, Fall 1993
- Principles of Fisheries Stock Assessment, Spring 1994
- Aquatic Invertebrates, Fall 1994
- Freshwater Fisheries Management, 1997
- Inland Fisheries Management, Spring 1999
- Imaging in Fisheries Science, Fall 2000
- Natural Resource Modeling, Spring 2001

American Fisheries Society Workshops
- Fish Ageing, 1995
- Stream Habitat Assessment, 1996

USFWS - National Education and Training Center
Principles and Techniques of Electrofishing, 1996

DOI-USGS – Motorboat Operator Certification Course, 2000

Certified S.O. Conte Anadromous Research Center dive team member

S.O. Conte Fish Research Projects:

Atlantic salmon behavior and movements in the Westfield River, Massachusetts 1996 to 1998 – wild adult Atlantic salmon returning to the Westfield River were internally radio tagged and released into the upper Westfield River. Fish were tracked with fixed stations and with manual tracking. Movement, habitat choice, spawning, and post-spawning behavior were evaluated. Domestic broodstock Atlantic salmon were also radio tagged and released to assess their spawning potential to contribute to the salmon restoration effort in the Connecticut River basin.

Spiral fishway 2001 to 2007 – evaluation of a spiral, side baffle fishway designed for upstream sturgeon fish passage. Sturgeon, a benthic fish, need a fishway that allows upstream movement while maintaining close proximity to the bottom of the fishway. The spiral uses side baffles to reduce velocity and provide depth allowing fish to move in a sinusoidal curve along the bottom of the channel. Sturgeon movement was evaluated with a PIT tag system detecting fish at the entrance and exit of the fishway and at four points along each of two loops. Riverine fish were also evaluated in the spiral fishway.

Shortnose sturgeon spawning behavior 2002 to 2008 – the spawning behavior of wild Connecticut River shortnose sturgeon was evaluated in an artificial stream. Mating behavior, mate choice, velocity preference, egg to larvae survival, and embryo and larval dispersal timing were evaluated.

Downstream passage and behavior studies of shortnose sturgeon 2004 and 2005 – yearling, juvenile and adult shortnose sturgeon were evaluated for swimming depth, behavior at and movement along a bar rack, entrainment and impingement, and willingness to enter an opening in the bar rack at three different approach velocities. Pressure sensitive (depth) and radio tags were used to assess swimming depth for both upstream and downstream movement in a 20' by 120' flume with a velocity of 1 ft/sec. PIT tags and video were used to assess individual fish movement and behavior at a bar rack oriented 90º to flow at velocities of 1, 2 and 3 ft/sec.

Downstream movement of yearling shortnose sturgeon 2004 and 2006 – yearling shortnose sturgeon (Connecticut River stock in 2004 and Savannah River stock in 2006) were evaluated in a large outdoor oval channel with a river stone substrate to determine the timing, frequency and duration of upstream and downstream movements. Fish were tested for 48 hours on a monthly basis from June through November. PIT tags and five antennas were used to determine movement.

Low level orifice use of sturgeon at an angled bar rack and louver 2006 to 2008 – green, lake, Savannah and Connecticut River shortnose sturgeon of different year classes were tested in a 10' by 120' flume at two bar rack angles (45º and 30º) and one louver angle (26º) with two velocities at the orifice. Approach velocity (2 ft/sec) and water depth (7.5') remained constant for all trials. Fish were tested both day and night. Video and PIT tags were used to determine individual fish movement, behavior at the bar rack and passage through the orifice and pipe which transported fish downstream to a holding area.

Past Relicensing Projects:

Bear Swamp Hydroelectric Project – FERC # 2669
Relicensing of project through the ILP.
Deerfield River Project – FERC # 2323, License issued 1997
Deerfield River Compact – precursor to relicensing, all stakeholders in relicensing, including New England Power Co., met on a regular basis to discuss issues. Final report issued.
Deerfield River Settlement – followed the conclusion of the Deerfield River Compact with similar discussions as to the issues involved in relicensing with the goal of reaching agreement on environmental mitigation prior to issuing or license. Represented Trout Unlimited in

meetings with state and federal agencies, New England Power Co. and other NGO's which reached an agreement that was incorporated into and was the basis of relicensing by the FERC.

Holyoke – FERC # 2004, Connecticut River

Relicensing of project – bypass minimum flows, downstream fish passage (salmon smolts, adult Atlantic salmon, American eels, clupeids, and riverine fish), upstream passage (adult Atlantic salmon, clupeids, American eels, and riverine fish) freshwater mussel protection, flow priorities (bypass reach, canal, up- and downstream fish passage, hydrogenation, run of river protection of federally threatened tiger beetle), and disabled angler fishing access.

Comments to both company and the FERC concerning above listed issues.

Participant in CCT meetings representing Trout Unlimited concerning above listed issues. CCT consists of Holyoke Gas & Electric (project owners), state and federal agencies, and NGO's (Trout Unlimited and Connecticut River Watershed Council).

Indian River – FERC # 12462, Westfield River

Licensing of project – bypass minimum flows, freshwater mussel protection, downstream fish passage (salmon smolts, adult Atlantic salmon, American eels, riverine fish), upstream passage for American eels.

Participation in ongoing fish passage discussions regarding both up- and downstream passage issues.

L.S. Starrett Co. – FERC # UL09-01, Millers River

Installation of new turbine initiated local Conservation Commission and Massachusetts Department of Environmental Protection actions presently on hold due to a FERC order of jurisdiction dated October 21, 2009.

Intervened in Massachusetts Department of Environmental Protection appeal by Starrett of a Superseding Order of Conditions.

Commented to the FERC concerning Starrett Motion for Stay of Order of Jurisdiction regarding downstream fish passage.

Muddy Run Pumped Storage Project – FERC # 2355, Susquehanna River. Contracted by Maryland Power Plant Project to provide biological and fish passage assistance during relicensing and post licensing. Principle issues are entrainment and the impact of the project on river flows.

New Home Dam Project – FERC # 6096, Millers River

Post licensing flow issues - run of river requirement.

Northfield Mountain Pumped Storage Project – FERC # 2485, Connecticut River

License amendment allowing more storage in upper pond. River bank erosion concerns. Amendment application withdrawn.

Woronoco – FERC # 2631, Westfield River

Relicensing of project and 401 certification – bypass minimum flows, freshwater mussel protection, downstream fish passage (salmon smolts, adult Atlantic salmon, American eels, riverine fish), upstream passage for American eels, and recreation issues.

Analyzed telemetry data from downstream smolt test to provide independent review of results.

York Haven – FERC # 1888, Susquehanna River

Contracted by Maryland Power Plant Project to provide biological and fish passage assistance during relicensing. Relicensing is currently involved in settlement discussions with project owner, Olympus Power. Principle issues are up- and downstream fish passage for American shad and American eel and bypass flows.

Publications:

Kynard, B., D. Pugh, and T. Parker. 2003. Development of a fish ladder to pass lake sturgeon. Great Lakes Foundation, Final Report, Lansing Michigan.

Kynard, B., M. Horgan, D. Pugh, E. Henyey and T. Parker. 2008. Using juvenile sturgeon as a substitute for adults: a new way to develop fish passage for large fish. American Fisheries Society Symposium 61: 1-21.

Kynard, B., M. Kieffer, E. Parker, D. Pugh and T. Parker. 2012. Lifetime movements by Connecticut River sturgeon. In Life history and behavior of Connecticut Rver shortnose sturgeon and other sturgeons. B. Kynard, P. Bronzi, and H. Rosenthal Editors. World Sturgeon Conservation Society: Special Publication #4. Norderstedt, Germany.

Kynard, B., D. Pugh, and T. Parker, M. Kieffer. 2012. Spawning of shortnose sturgeon in an artificial stream: adult behavior and early life history. In Life history and behavior of Connecticut Rver shortnose sturgeon and other sturgeons. B. Kynard, P. Bronzi, and H. Rosenthal Editors. World Sturgeon Conservation Society: Special Publication #4. Norderstedt, Germany.

Kynard, B., D. Pugh, and T. Parker. 2012. Passage and behavior of Connecticut River shortnose sturgeon in a prototype spiral fish ladder with a note on passage of other fish species. In Life history and behavior of Connecticut Rver shortnose sturgeon and other sturgeons. B. Kynard, P. Bronzi, and H. Rosenthal Editors. World Sturgeon Conservation Society: Special Publication #4. Norderstedt, Germany.

Kynard, B., E. Parker, D. Pugh, and T. Parker. 2012. Downstream and Diel Movements of Cultured Yearling Pallid, Green, Lake, and Shortnose Sturgeons: An Artificial Stream Study. In Life history and behavior of Connecticut Rver shortnose sturgeon and other sturgeons. B. Kynard, P. Bronzi, and H. Rosenthal Editors. World Sturgeon Conservation Society: Special Publication #4. Norderstedt, Germany.

Kynard, B., D. Pugh, and T. Parker. 2004. Experimental Studies to Develop Guidance and a Bypass for Shortnose Sturgeon at Holyoke Dam. Final Report to City of Holyoke, Holyoke Gas & Electric Company, Holyoke, Massachusetts.

Kynard, B., D. Pugh, and T. Parker. 2005. Experimental Studies to Develop Guidance and a Bypass for Shortnose Sturgeon at Holyoke Dam. Final Report to City of Holyoke, Holyoke Gas & Electric Company, Holyoke, Massachusetts.

Kynard, B., E. Parker, D. Pugh, and T. Parker. 2007. Use of laboratory studies to develop a dispersal model for Missouri River pallid sturgeon early life intervals. J. Appl. Ichthyol. 23: 365–374.

Kynard, B., D. Pugh, and T. Parker. 2011. Passage and behavior of cultured lake sturgeon in a prototype side-baffle ladder: I. ladder hydraulics and fish ascent. J. Appl. Ichthyol. 47 (Suppl. 1): 1-12.

Pugh, D., B. Kynard. 2001. Westfield River adult salmon report Westfield River, Massachusetts, 1966 – 1968. Final report to United States Forest Service and United States Fish and Wildlife Service.

Pugh, D. 1997. Millers and Chicopee River Basins Mussel Survey. Report to Massachusetts Natural Heritage and Endangered Species Program.

Pugh, D. 1998. French and Westfield River Basins Mussel Survey. Report to Massachusetts Natural Heritage and Endangered Species Program.

Pugh, D. 1999. Blackstone, Quinebaug, and Quabog River Basins Mussel Survey. Report to Massachusetts Natural Heritage and Endangered Species Program.

Pugh, D and A. Haro. 2000. Passage of Atlantic salmon at Turners Falls fishways: PIT tag evaluation 1999. Conte Anadromous Fish Research Center Internal Report No 00-02.

Pugh, D. 2000. Merrimack, Ipswich, Charles, and Neponsett/Weymouth/Weir Basins Mussel Survey. Report to Massachusetts Natural Heritage and Endangered Species Program.

Pugh, D. 2001. 2001 Fort River dwarf wedge mussel (*Alasmidonta heterodon*) survey. Massachusetts Division of Fisheries and Wildlife Natural Heritage and Endangered Species Program.

Pugh, D. 2002. 2002 Fort River dwarf wedge mussel (*Alasmidonta heterodon*) survey. Massachusetts Division of Fisheries and Wildlife Natural Heritage and Endangered Species Program.

Presentations:

Movement and Habitat of Atlantic Salmon in the Westfield River. D. Pugh. Connecticut River Atlantic Salmon Commission Conference, 1999.

Zebra Mussels: Can We Stop The Eastward Invasion? M. Babione and D. Pugh. Northeast Fish and Wildlife Conference, 2003.

Passage of Sturgeons and Riverine Fishes in a Prototype Spiral Fish Ladder. B. Kynard, D. Pugh, T. Parker. American Fisheries Society Meeting, 2006

Behavior of Lake, Pallid, and Shovelnose Sturgeons at Passage Structures: Toward a New Paradigm in Developing Fish Passage. B. Kynard, M. Horgan, D. Pugh, E. Henyey, and T. Parker. American Fisheries Society Meeting, 2006.

Performance of Lake Sturgeons and Riverine Fishes in a Spiral Side-Baffle Fish Ladder. B. Kynard, D. Pugh, T. Parker. Connecticut River Atlantic Salmon Commission Conference, 2009.

Review of Using a Semi-natural Stream to Produce Young Sturgeons for Conservation Stocking. B. Kynard, D. Pugh, T. Parker, M. Kieffer. International Sturgeon Society Conference, 2009.

Up- and Downstream Passage and Behavior of Lake and other Sturgeons. D. Pugh B. Kynard and T. Parker. Keeyask Fish Passage Workshop, 2011.

Eel Passage Westfield & Millers Rivers, Massachusetts. D. Pugh. ASMFC Eel Passage Workshop, 2011.

Passage and Behavior of Cultured Lake Sturgeon in a Side-Baffled Fish Ladder: II. Fish Ascent and Descent Behavior. NAC. 2011.

Behavior, impingement, and entrainment of shortnose sturgeon at a vertical bar rack: with and without a bypass orifice. B. Kynard and D. Pugh. Fish Passage Conference, Amherst, MA. 2012.

Research on Up-and Downstream Passage of Lake Sturgeons at S. O. Conte Anadromous Fish Research Center. B. Kynard, D. Pugh, E Henyey, T. Parker and M. Horgan. *Scaphirhynchus* Conference: Alabama, Pallid, and Shovelnose Sturgeon Symposium, St. Louis, Missouri, January 2005

Shortnose Sturgeon Life History Requirements and the Holyoke Dam. B. Kynard, M. Kieffer, D. Pugh. Connecticut River Atlantic Salmon Commission Conference, March 2013